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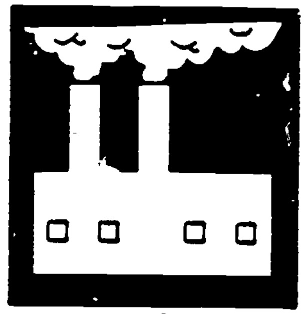
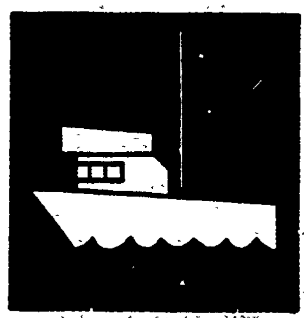
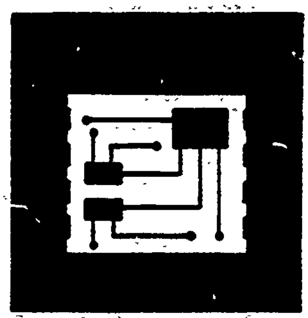
ABSTRACT

This guide was developed as a supplement to the Alaska Department of Education's industrial education curriculum. The special topics included in it focus on competencies from the curriculum for which materials were not readily available to Alaskan teachers and provide information that may not be sufficiently covered by existing curricula. Each unit begins with a teacher page that includes the competency and task(s) from the industrial education curriculum covered in the unit, an overviw of the unit, and a list of resources. The illustrated informational materials that follow the teacher pages have been designed for students' use. All of the units deal with fields that are constantly changing. They cover the following topics: mining and petroleum, communications, high technology, forestry and logging, technological impacts, and commercial fishing. They are designed to be integrated into the regular curriculum at the appropriate times. (KC)

Industrial Education Resources







Steve Cowper, Governor

Developed by the...

ALASKA DEPARTMENT OF EDUCATION
Adult and Vocational Education

William Demmert, Commissioner

Karen Ryals, Administrator for Vocational Education

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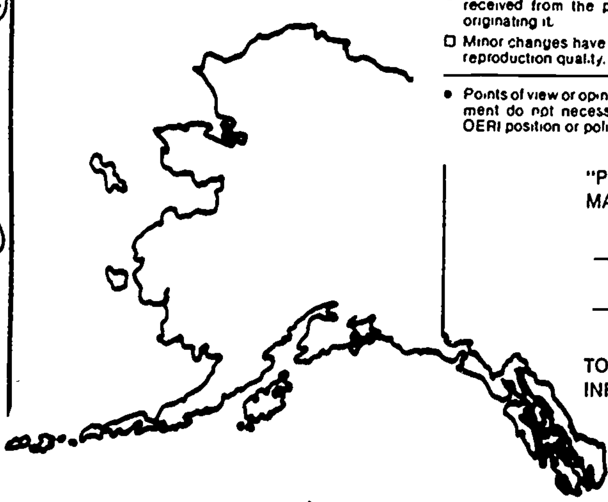

Alaska Department of Education 1987

Industrial Education

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Introduction

In 1986, the Alaska Department of Education developed the Industrial Education Curriculum. This volume, Industrial Education Materials, was developed as a supplement to the curriculum. The special topics included here focus on competencies from the curriculum for which materials were not readily available to Alaskan teachers, and provide information which may not be sufficiently covered by existing curricula.

Each unit begins with a teacher page which includes the competency and task(s) from the Industrial Education Curriculum covered in the unit, an overview of the unit, and a list of resources for more information on the unit topic. Not all of the resources have been approved by the Alaska Department of Education, so instructors should be sure to preview any materials before using them in the classroom. The informational materials which follow the teacher page have been designed for students' use. Many of the concepts covered are complex, and students would benefit greatly from hands-on activities to clarify the concepts.

All of the units in this publication deal with fields which are constantly changing. New developments in technology affect communications, mining, petroleum, forestry and logging, and commercial fishing undustries; the units on those areas seek to inform students of the uses and effects of technology. The high technology unit deals specifically with current and projected developments in technology, and the unit on technological impacts describes the effects of technology on the environment and on society. What is considered "high tech" today will probably be outmoded in the near future. Students must therefore focus not only on the ways in which industry operates in the present, but also on ways to adapt to the continuously changing technologies. It is hoped that the materials in this publication will provide students with a means of learning about industry and with an understanding of the effects of changing technology.

Acknowledgements

Special appreciation is expressed to the individuals who researched and wrote the industrial education materials: Mike Macy who wrote the units on Forestry and Logging, Linda Schultz who wrote the unit on Commercial Fishing, and Richard Steele who wrote the units on Mining and Petroleum, Communications, and High Technology. Appreciation is also expressed to Susan Sloan Doherty of The Northern Institute who administered the curriculum development project, and to Danelle Corrick of The Northern Institute, who developed the final copy.

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Finally, Verdell Jackson, Curriculum Specialist for the Office of Adult and Vocational Education, must be recognized for participating in every step of the development of this publication and ensuring that it provides Alaskan students and instructors with curriculum materials of the highest quality.

Karen Ryals
Administrator
Office of Adult and Vocational Education
Alaska Department of Education
June, 1987

Mining and Petroleum

Alternative Fuel Development
Teacher Page

Competency: Identify the importance of alternative fuel development

Tasks: Explain the importance of increasing energy production and finding new energy sources
Explain the importance of oil shale and tar sands to expanding energy sources
Explain how coal is liquified for fuel
Explain the impact of renewable energy sources on the petroleum industry
Explain the impact of solar, wind, and ocean energy sources on the petroleum industry
Explain the impact of alcohol fuel and geothermal power on the petroleum industry
Identify the value of petroleum products in environmental and health research
Discuss conservation's role as an energy source

Introduction

In this area, students can learn about a subject which has received less attention in recent years. The crash synfuels programs of the '70's was followed by the great oil crash of the '80's. Following the sociopolitical aspects of energy production can help students understand there's more to oil than just pumping it out of the ground. Interest in alternative fuels will continue as long as this nation imports over a third of its oil.

A number of sources concerning alternative fuels are available. Students can complete reports on alternative fuels, or they can experiment by creating power from alternative fuels. Students could create a burnable alcohol from plants, for example, or build a workable hydroelectric generator. If you live near a geothermal area, measurements on the feasibility of tapping geothermal power would indicate geothermal power potential. Solar projects are applicable to many areas of Alaska. Alternative fuels lend themselves to hands-on projects.

Overview

With the current slump in oil prices, it is hard to predict what the future in alternative fuel development may be. Alaska has not yet developed its potential for more traditional fuels. Yet the state, with its hot springs, large tides, round the clock sun in the summer, areas of steady wind, huge mountains and rushing rivers is actually a prime candidate for alternative energy. Expect Alaska to remain in the energy limelight in the years to come. The state may not only remain a net energy exporter, but may also expand that role, in light of development of the natural gas pipeline and coal and/or oil exports to the far east. The student who is prepared to work in energy-related fields may be the student who is prepared to work at all. A general background in energy-related fields involves a study of alternative fuel development.

Resources

Alaska Energy Education Series, Vocational Education Library, Office of Adult and Vocational Education, P.O. Box F, Juneau, AK 99811

American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005

The Energy Source Education Council, Program Distribution Office, 5505 East Carson Street, Suite 250, Lakewood, CA 90713

The National Center for Appropriate Technology, Box 3838, Butte, MT 59701

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Alternative Fuel Development

Why do we need to keep finding new sources of energy?

One might ask why people keep using fuel. People keep using fuel because, well, because they don't want to live freezing in caves. Face it, energy is the force behind our society. Without a viable energy source, we wouldn't have electric lights, we wouldn't have manufactured goods, we wouldn't have *The Cosby Show* on TV. Now wouldn't that change things for people? And besides, the population keeps growing. Maybe the population isn't growing as fast as people once predicted, but the appetite for ever more energy grows and grows. New sources of energy keep the society going and keep things developing.

And what of non-renewable sources of fuel? Obviously if something is "non-renewable," it's not going to be renewed. The earth contains just a set amount of *fossil fuels* (that is fuels which are caused by the decay of eons of organisms over time). Coal is such a fossil fuel. Oil is too. Such fuels are non-renewable. It would take untold millions of years for coal and oil reserves to build back up. Contrast such non-renewable resources with renewable ones like the water which falls over a dam. Water running through a hydroelectric power plant generates electricity, but the source of that power--the water itself--is quickly being replenished. In the same way, solar power, and power from wood are renewable resources. They are instantaneously or rather quickly replenished. And don't forget the advantage of conservation. Using less fuel for the same work, by car-pooling, for example, is a way of looking at saving fuel as a *renewable* resource.

What about oil shale and tar sands as energy sources?

What is oil shale? "Oil shale is a rock that contains *kerogen,* a rubbery substance formed by the remains of plants and animal life. Kerogen is partially formed oil that was never exposed to the heat and pressure needed to transform it into liquid crude oil. Most of the oil shale in the lower '48 is located in an area known as the *Green River formation* and located in Colorado, Wyoming, and Utah.

"Getting the oil out of our deposits of shale is a complicated process. Both an above-ground and an underground method are being developed. In the above-ground process, the shale initally will be removed from either surface or underground mines by methods similar to those used to mine coal. It will be crushed at the mine site and then transported to a processing plant. There the shale will be heated to convert the kerogen in it from its solid form into liquid shale oil. In the underground technique, the oil will be removed by crushing and heating the shale at the below-ground site, then pumping it to the surface.

"The technology for extracting oil from shale on a large scale is expensive and, unlike the technology for recovering crude oil, it is not highly developed as yet. Other problems with shale oil include control of air pollution created by mining and processing; the need during processing for large amounts of water in water-scarce regions; disposal of the residual shale, which expands 20 percent in volume during processing; and restoration of the land that is defaced in mining." [1]

Tar sands are a mixture of clay, bitumen (a thick substance like oil), sand, water, and sulfur. They are found in Alberta, Canada, eastern Venezuela, Utah, and other Rocky Mountain States. Both the federal government and oil companies are conducting research on tar sands. Most tar sands in the United States, however, lie too deep for surface mining. There is talk of somehow burning the oil in these sands *in situ* (in place) in the ground.

We need to consider some recent history when we talk of extracting energy from new and different sources. Several times as much oil as all that discovered in the U.S. lies in oil shale in the western lower '48 states. Alaska has oil shale. Will the oil from this shale and from tar sands be extracted for human use? Perhaps. The technology for making high-quality oil products from oil shale and tar sands already exists. But again, a big factor stands in the way. The factor?

Money. Extracting oil from oil shale and tar sands costs a lot. The price of oil from more traditional sources would have to rise very high to justify the amount of money needed to make oil from other sources. To extract oil from oil shale, the material has to be "cooked". That cooking is expensive. To extract oil from tar sands, the sands have to be injected with water or oil to pressurize the oil out of the sands. None of the procedures are quick, easy ways to extract oil.

Can other types of fuel be made from coal?

If you're a student of history, you might already know that towards the end of World War II the Germans made a good bit of fuel by liquifying coal. And in the world of coal, the United States is the Middle East of coal, with huge proven coal reserves. And wouldn't you know it, in the United States, Alaska is the King of Coal, with nearly a third of the coal reserves! If we could only put that stuff in our cars and drive around. . .

In fact, the very first "petroleum product"--kerosene--was made from coal in 1852. Soon after, methods for making kerosene from crude oil were perfected. This kerosene was nearly smokeless and odorless. Kerosene, however, even today, is often referred to as *coal oil.*

Coal is our most plentiful energy resource. It currently accounts for some 22% of the energy we consume.[1] Coal can be gasefied. In fact, long before we used natural gas for lighting homes and city streets, gas made from coal was used. One ton of coal can produce 57 gallons of gasoline.[1] Coal is heavy. It doesn't take a lot of coal to make a ton. But as with other types of more artifical fuels, the price of making gas and liquid fuel from coal must be competitive to make it practical. It is still cheaper to obtain liquid and gas fuels from other sources. But coal gasification plants are working or are under construction in the Rocky Mountains and in North Dakota, and coal liquification plants are operating in Texas and Kentucky.

What will renewable energy sources like hydroelectric or biomass power do to the petroleum industry?

Don't hold your breath. Obviously power from hydroelectric or biomass sources (biomass sources include wood and peat) definitely *affects* the petroleum industry. You may receive your electric lights from hydroelectric sources, and you may heat your house by wood heat, but if you drive around, you can bet your truck is powered by an oil product. Petroleum power will remain with us for some time. Some have called the 20th Century the Age of Petroleum. Petroleum has fueled expansion in transportation, plastics, even the jet age. Hydroelectric and biomass power sources--in the United States--are industries much smaller than the petroleum industry.

How will solar, wind, and ocean energy sources impact the petroleum industry?

We need a crystal ball to predict. But it's hard to replicate the power--compact, portable power--that a barrel of oil represents. Not only are people in general resistant to change, but the all-important issue of cost efficiency comes into play. As it stands, solar, wind and ocean energy sources just are not yet competitive with energy from oil. Oil is cheaper. If, indeed, other sources of energy could compete favorably with oil on a mass basis, we would probably see them implemented. But who is to say that new technologies might make these renewable sources of energy cost-efficient?

How will alcohol fuel and geothermal power impact the petroleum industry?

Alcohol fuel is made from grain. Perhaps you recall the publicity for *"gasohol"* during oil crises. Alcohol from grain can be added to gasoline to create a very clean-burning automotive fuel. Since the U.S. is the Saudia Arabia of grain, it makes good sense to make fuel from the surplus. But gasohol is not cheap. Even during the height of the 1973 Arab oil embargo when oil was at an all-time high in price, a blend of gasoline and grain alcohol (gasohol) cost more than a gallon of just plain gasoline, though gasohol burned cleaner and emitted fewer noxious gases. With but a fledgling grain industry and great quantities of oil, Alaska seems hardly suited for gasohol production.

What is the value of petroleum other than fuel?

Ever use *Vaseline™*? *Vaseline™* is a petroleum product. Read the label. *Vaseline™* is actually "petroleum jelly." According to the American Petroleum Institute, petroleum *feedstocks* (feedstocks are materials from which things are made) provide us with more than 3,000 products. Here are some of them:

- Ammonia
- Anesthetics
- Antifreeze
- Antihistamines
- Antiseptics
- Artificial limbs
- Artificial turf
- Aspirin
- Awnings
- Balloons
- Ballpoint pens
- Bandages
- Beach umbrellas
- Boats
- Cameras
- Candles
- Car battery cases
- Car enamel
- Car sound insulation
- Cassettes
- Caulking
- Cigarette filters
- Clotheslines
- Cold cream
- Combs
- Cortisone
- Crayons
- Credit cards
- Curtains
- Dashboards
- Denture adhesive
- Dentures
- Deodorant
- Detergents
- Dice
- Dishwashing liquids
- Dresses
- Drinking cups
- Dyes
- Electric blankets
- Electrical tape
- Enamel
- Epoxy paint
- Eyeglasses
- Fan belts
- Faucet washers
- Fertilizers
- Fishing boots
- Fishing lures
- Fishing rods
- Floor wax
- Folding doors
- Food preservatives
- Footballs
- Glue
- Glycerin
- Golf bags
- Golf balls
- Guitar strings
- Hair coloring
- Hair curlers
- Hand lotion
- Hearing aids
- Heart valves
- House paint
- Ice buckets
- Ice chests
- Ice cube trays
- Ink
- Insect repellent
- Insecticides
- Life jackets
- Linoleum
- Lipstick
- Loudspeakers
- LP records
- Luggage
- Model cars
- Mops
- Motorcycle helmets
- Movie film
- Nail polish
- Nylon rope
- Oil filters
- Paint brushes
- Paint rollers
- Pajamas
- Pantyhose
- Parachutes
- Percolators
- Perfumes
- Permanent-press pants
- Petroleum jelly
- Pillows
- Plastic wood
- Plywood adhesive
- Purses
- Putty
- Refrigerants
- Refrigerator linings
- Rollerskate wheels
- Roofing
- Rubber cement
- Rubbing Alcohol
- Safety glass
- Salad bowls
- Shag rugs
- Shampoo
- Shaving cream
- Shoe polish
- Shoes
- Shower curtains
- Shower doors
- Skis
- Slacks
- Soap dishes
- Soft contact lenses
- Solvents
- Sports car bodies
- Sunglasses
- Sweaters
- Synthetic rubbger
- Tape recorders
- Telephones
- Tennis rackets
- Tents
- Tires
- Tobacco pouches
- Toilet seats
- Tool boxes
- Tool racks
- Toothbrushes
- Toothpaste
- Transparent tape
- Trash bags
- TV cabinets
- Typewriter ribbons
- Ulnbreakable dishes
- Umbrellas
- Upholstery
- Vacuum bottles
- Vaporizers
- Vitamin capsules
- Water pipes
- Yarn

How many articles from this list are you wearing right now, or have you used today? Surely you get the picture. We live in a very petroleum-oriented society. In fact, the American Petroleum Institute estimates that each American consumes as much as 2.6 gallons of oil and more than 195 cubic feet of natural gas a day--every day. [1]

Annual Yields from a Barrel of Crude Oil
(1 Barrel of Oil Contains 42 Gallons)

Product	Gallons Per Barrel	% Yield
Leaded Gasoline	6.9	16.4
Unleaded Gasoline	12.3	29.4
Distillate Fuel Oil	9.1	21.6
Residual Fuel Oil	3.0	7.1
Jet Fuel	4.0	9.5
Petrochemical Feedstocks	1.2	2.8
Asphalt and Road Oil	1.3	3.2
Still Gas (Refinery Gas)	2.0	4.7
Coke	1.5	3.7
Liquefied Gases	1.3	3.1
Lubricants	0.5	1.2
Kerosine	0.3	0.8
Miscellaneous	0.2	0.5
Special Naphthas	0.2	0.4
Wax	0.1	0.1
Processing Gain	-1.9	-4.5
Totals	42.0	100.0

NOTES
(1) Leaded and unleaded gasoline includes both motor and aviation gasoline.
(2) Jet fuel includes both naphtha-type and kerosine-type fuel.
(3) Distillate fuel oil includes home-heating and diesel fuel, as well as No. 1 and No. 4 commercial fuel oils.
(4) Still gas (refinery gas) is that gas produced in refineries during the refining and cracking processes.
(5) Processing gain represents the amount by which total refinery output is greater than total input for a given period. The difference is due to the processing of crude oil into products which, in total, have less weight than the crude oil processed. Therefore, in terms of volume (barrels), the total output of products is greater than the input

Source:
Percentage yield, U.S. Energy Information Administration, DOE (6/86).
Gallons per barrel computed by American Petroleum Institute.

Can conservation be considered an energy source?

You bet it can. The U.S. represents about 6% of the world's population yet it consumes around 30% of the available oil. In fact, conservation, more than any other single factor, probably contributed most to breaking the back of the OPEC (Organization of Oil Exporting Countries) in the 1973 oil crisis. Much of the emphasis on conservation in the U.S. today originated in that 1973 crisis. The world has seen the U.S. as the great glutton of oil. And in fact, the U.S. could afford to be gluttonous when oil was cheap. But the 1973 crisis changed things, and the price of oil has never dropped to pre-'73 prices again. Conservation was seen as the most obvious and cheapest way to extend energy supplies. After the crisis, there was increased emphasis on mass transportation as a way to travel. There was increased emphasis on using electric lights less, on carpooling, on home insulation. The size of automobiles decreased. And in fact, because of conservation and increased oil exploration caused by high prices, the use of petroleum products dropped drastically. By the mid-1980's the price of oil had dropped world-wide, and Alaska's economy was in a tailspin as a result of that drop. But when prices dropped, consumption gained. The U.S. still consumes far and away more oil than any other nation. U.S. motorists every day burn 1/6 of the free world's oil on the nation's highways.

All of us can conserve petroleum and other energy products. You can go the most direct route when you drive someplace. You can offer somebody else a ride. You can enjoy yourself without having to burn fuel (by walking instead of taking that 3-wheeler). You can turn out the lights when you're not using them. Automobile manufacturers are building lighter automobiles. Jet manufacturers are constructing more fuel-efficient engines. The conclusion? Probably the easiest, cheapest, and most rewarding way to stretch our limited supplies of non-renewable resources is to wisely use them. A focus of that wise use is conservation.

[1] *From* **Jobs-Energy**, American Petroleum Institute, 860-33000, p. 9.

Petroleum Drilling and Production

Teacher Page

Competency: Identify petroleum drilling and production techniques

Tasks: Explain oil and gas drilling techniques
Explain methods of blowout prevention
Name drilling innovations
Identify different types of wells
Describe how to plug a well
Explain how a well is completed
Explain the factors determining the life of oil wells
Name ways to control production
Identify ways to stimulate production and enhance oil recovery

Introduction

Students looking for a career in petroleum technology can certainly use a strong background in drilling and production techniques. Applicants with ready skills or knowledge have an edge over others. Students can study how oil rigs work. Films in this area are important. A visit to a local refinery, a local oil rig, or lectures by officials of the oil and gas industry would be helpful.

Overview

Obviously the forefront of the petroleum industry in Alaska is the actually work of drilling and production itself. The work, though often financially rewarding, can be incredibly arduous and the schedule punishing. Additionally, job security can be very tenuous. But those with experience can make a very good living for themselves, as evidenced by hundreds of commuting workers in Anchorage, Fairbanks, and elsewhere in the state.

Resources

Alaska Oil and Gas Association, 121 West Fireweed Lane, Suite 207, Anchorage, AK 99503 (907)272-1481

American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005

ARCO, P.O. Blox 100360, Anchorage, AK 99510

Association of Desk and Derrick Clubs, 411 Thompson Building, Tulsa, OK 74103

Exxon, 3301 C St., Anchorage, AK 99510

Mining & Petroleum Training Service, 155 Smith Way, Soldotna, AK 99669 (907) 262-2788

Suggested Reading

Fundamentals of Petroleum, Second Edition, Petroleum Extension Service, University of Texas at Austin, 10100 Burnet Road, BRC-2, Austin, TX 78758 (512)835-3163, 1981

A Handbook of Oil Industry Terms and Phrases, Langenkamp, R.D., The Petroleum Publishing Company, Box 1260, Tulsa, OK 74101

Introduction to Petroleum Production, Skinner, D.R., Gulf Publishing Co., 1981. *Volume 1: Reservoir Engineering, Drilling, Well Completions; Volume 2: Fluid Flow, Artificial Lift, Gathering Systems, and Processing; Volume 3: Well Site Facilities: Water Handling, Storage, Instrumentation, and Control Systems*

Modern Petroleum, A Basic Primer of the Industry, Berger, B.D. and Anderson, K.E., Petroleum Publishing Co., 1978

A Primer in Drilling & Production Equipment, Lynch, P.F., Gulf Publishing Co., 1980: *Volume 1: The Powertrain; Volume 2: Rig Equipment; Volume 3: Downhole Operations*

Primer in Oil and Gas Production, **3rd ed.,** American Petroleum Institute, 1971

Oil from Prospect to Pipeline, **4th Edition,** Wheeler, R. R. and Whited, M., Gulf Publishing Co., 1981

Films

American Petroleum Institute, Production Department Attn: Training Administrator, 211 North Ervay, Suite 1700, Dallas, TX 75201 (214)741-6791.

Shell Oil Company Film Library, Scheduling Center, 5000 Park Street North, St. Petersburg, FL 44709 (813)541-5763.

The Standard Oil Company (Ohio), Film Library, c/o Cinecraft 2515 Franklin Boulevard, Cleveland, OH 44113 (216)621-2655.

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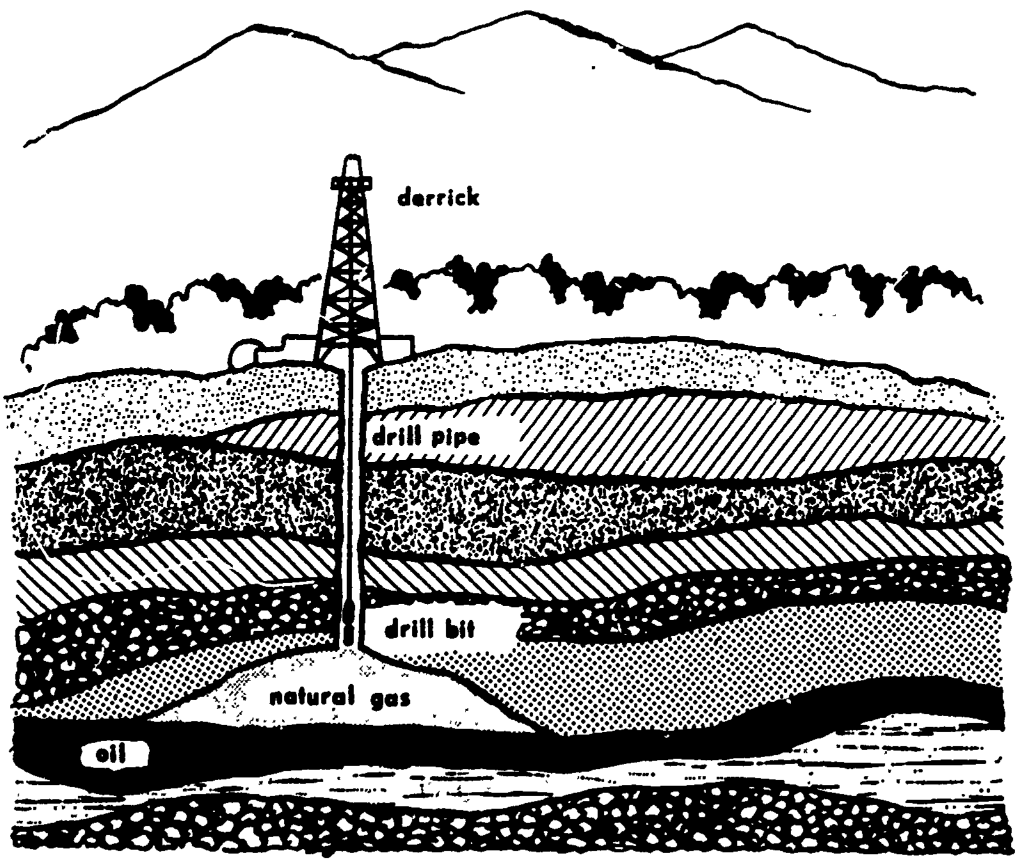
Petroleum Drilling and Production

How are oil wells drilled?

Drilling rigs can be either rotary or cable tool systems. A derrick is erected, housing the tools and pipes that go into the well. The American Petroleum Institute (API) relates that most rigs today use a portable or jackknife derrick that can be transported as a unit and then raised and lowered intact at the well. A cable system, rarely used today, raises and drops a *string* of tools consisting of a bit and a stem at the end of a cable. As the API states, "the heavy bit pounds into the earth, pulverizing soil and rock. At intervals, drillers remove the string of tools, flush the hole and remove the resulting slurry of drilling cuttings. Periodically they line the hole with steel casing to prevent a cave-in and to protect fresh underground water encountered during drilling.

Rotary drilling is different. A steel *mast* which can be later used on another well is built at the site. From that *mast* or *derrick* steel pipe is joined together. As the API relates, "instead of pounding through rock and soil, as the cable system does, the rotary drill uses a bit attached to the lower end of a string of drill pipe called a *drill string*. The bit, and the drilling pipe to which it is attached, pass vertically through a turntable on the derrick floor. The drill string turns a *bit* fastened to the lower end. The bit cuts rock and soil." 1 The *cuttings* are brought to the surface with *driller's mud,* a mixture of water and clay which is liquid enough to be pumped. Drilling mud also lubricates and cools the drill bit, supports the drill pipe and casing, and keeps fluids from invading the drill hole, and surface material from falling in. As the pipe is turned and lowered into the earth, the bit also rotates and bores deeper and deeper into the ground. As the hole is extended, new lengths of pipe are added. Each length of drill pipe is usually about 30 feet long.



"After a time, the bit will become dull. Then the crew removes the entire drill strong, disconnects pipes in stands of two or three joints each and then stacks them in the derrick. After they attach a new bit, the crew reconnects the stands of pipe and runs the drill pipe back down the hole. This process of removing, reconnecting and then resuming drilling takes place many times when a deep well is being developed. It requires skill, precision and speed--as well as caution.

"The caution prevents separating or dropping the drill pipe. If that should happen, some of the drilling tools would fall to the bottom of the hole. Drilling would then be suspended until they were found. If they could not be recovered, the entire well could be lost.

"Drillers not only worry about losing drilling tools, they also are concerned about having them stuck in the hole. Just as a conventional drill can get stuck in a piece of wood, an oil drill can get stuck in earth and rock. For this reason, among others, rotary drilling follows a non-stop schedule seven days a week.

"Drilling an oil well, is of course, more complicated than drilling through wood. There is the possibility of a cave-in and the problem of pushing the rock cuttings out of the hole. Both of these difficulties are resolved by the use of drilling mud, a mixture of water, clay and chemical additives, which is pumped under pressure into the hole through the drill pipe. When the drilling mud reaches the bottom, it is forced out through openings in the bit to return to the surface side the drill pipe. The constantly circulating fluid cools and cleans the bit and carries cuttings from the well. The drilling mud also cakes the side of the hole, preventing cave-ins and, by its weight, helps to control the pressure of any gas, oil or water that the drill bit encounters.

"As the well deepens, casing is run into the hole. Casing consists of lengths of heavy steel pipe joined together, normally by threaded couplings. The pipe serves to shut off water-permeated sands and high-pressure gas zones, prevent cave-ins and protect fresh water strata. To secure the casing and seal the walls of the hole, the crew pumps a cement slurry into the space between the outside of the casing and walls of the hole." 2

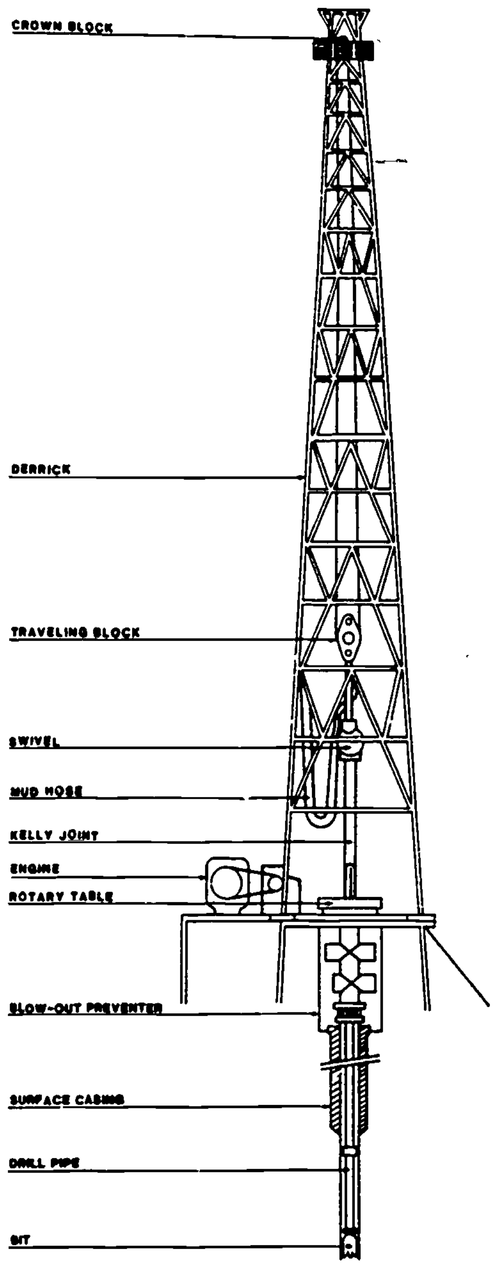


Illustration courtesy of Canadian Association of Oilwell Drilling Contractors.

What are drilling bits like?

"Bits range in size from less than 4 inches in diameter to more than 22 inches. The bits are made of hard steel, and some have industrial diamonds embedded in them. Most bits have three rotating cones covered with sharp teeth to grind through rock. Whatever their configuration, these bits are expensive--most cost several thousand dollars each." 3

As the the Petroleum Extension Service, University of Texas at Austin states, "the roller cone bit, which is used by most drillers, has two to four (usually three) cone-shaped steel devices that are free to turn as the bit rotates. Teeth are cut out of the cones, or hard tungsten carbide buttons are inserted into them. The teeth actually cut or gouge out the formation as the bit is rotated. All bits have passages drilled through them to permit drilling fluid to exit. Jet bits have nozzles that direct a high-velocity stream or jet of drilling fluid to the sides and bottom of each cone so that rock cuttings are swept out of the way as the bit drills. Diamond bits do not have cones or teeth. Rather, diamonds are embedded into the bottom and sides of the bit." 4

How long does it take to drill an oil well?

There are so many different conditions as well as the question of just how deep you need to drill. Some wells are drilled quickly and some take a whale of a long time.

As the API relates: "The deeper a well is, the longer it takes to drill it: a few days for a shallow hole to several months for deeper exploration. Some wells have taken longer than a year to complete. ...Today's wells are, on average, more than 4,500 feet deep. Many sink beyond 15,000 feet. The deepest oil well, drilled in Oklahoma, went down 31,441 feet. ...The only way to confirm the existence of petroleum is to drill a well. If oil is found, the rig that drills the well does not have the equipment to make that well a producer. The drilled well must be turned into a production facility capable of bringing oil to the surface." 5

How are blowouts prevented?

As the American Petroleum Institute (API) relates: "In old movies, you can tell when someone strikes oil: the sound track rumbles and then a cascade of black gold gushes above the derrick. The drilling crew dances under the shower of oil and the head of the team cheers, 'We've hit a gusher, boys!'

"That's good drama, but it's not the way things happen. In fact, oil wells are designed to prevent gushers. Technologically called a *blowout,* such an event would harm the environment as well as waste oil. As a result, blowout prevention is a major concern of all drilling operations.

"Normally the casing and drilling mud keep the flow of a well under control. But extra protection is added by blowout preventers attached to the top of the casing in what is known as a *stack.*

"Blowout preventers are valves that can be closed to seal off the well and control gases and liquids under pressure in the hole. Blowout preventers in a stack, usually from three to seven on a deep well, vary in size, design and number.

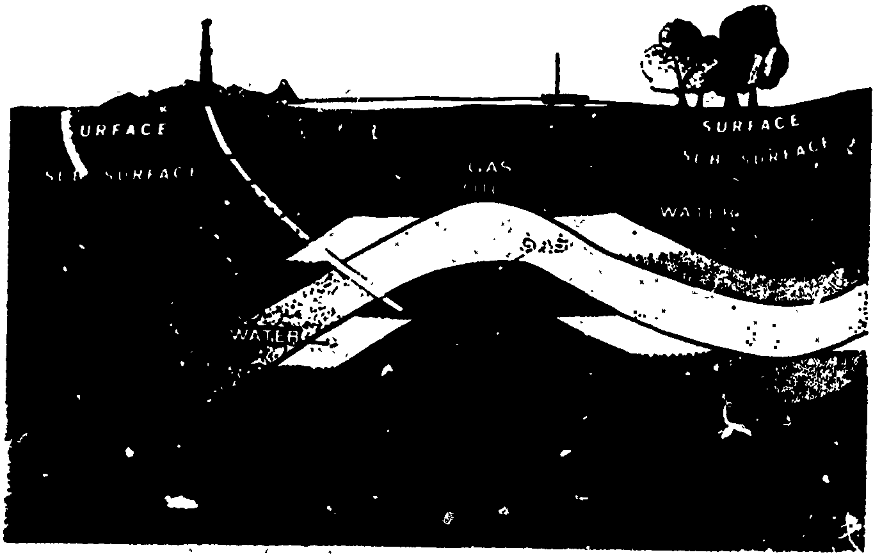
"The *annular blowout preventer* uses an inflatable bag to close the area between the casing and the drill pipe during an emergency. Hydraulic fluid is forced into the bag, expanding it and sealing off any flow from the well.

"Another blowout preventer uses hydraulic pressure to activate piston-like *rams* that close the well. The rams either close around the drill pipe (*pipe rams*) or completely shut in the well *(blind rams)*. These rams can be reopened, tested and set again by reversing the fluid pressure.

"During drilling, instruments measure and record critical aspects of the operation with special attention to what is happening in the well and the condition of the drilling machinery. Any change indicating the threat of a blowout triggers an alarm on most rigs. Crews immediately close the blowout preventer, adjust the weight of the drilling mud or take other steps to control the flow of fluids. Key crew members are normally trained to recognize early warning signs of a possible blowout and to apply prevention techniques." 6

What are some different ways to drill?

You can drill straight down or you can drill at an angle.



As the API relates: "The traditional drilling technique was a straight-ahead, into-the-earth approach. Drillers erected a derrick over the spot where oil could be located and the bit went straight down." *Directional drilling* allows drilling a site from an area adjacent. Let's say oil was located under a building or just offshore. With directional drilling, a drill string can follow a curved path as the hole gets deeper. The hole can then curve to where the oil is. Directional drilling reduces costs by reducing the number of offshore rigs needed and by allowing a number of different wells to be drilled from the same platform. 7

Are there different kinds of oil rigs?

There certainly are different types of rigs. Two obviously different types are the onshore and offshore rigs.

Though the history of oil drilling is relatively recent, the history of offshore rigs is even newer. Offshore rigs began in the late '30's off the shore of Louisiana. Offshore rigs are somewhat limited by the depth of water they drill in, but some wells have recently been drilled in water over two miles deep. As the API relates, offshore oil rigs usually consist of "enormous self-contained platforms standing on stilt-like legs embedded in the ocean floor on which conventional land-type drilling equipment is mounted. The platform is large enough to provide living quarters for the crew and to store supplies." Other rigs use a "smaller stationary platform to support the rig. It is serviced by a floating tender that houses the auxiliary equipment, supplies, crew's quarters, and a helecopter landing platform.

How are oil wells plugged?

"When a field has been depleted or when production is no longer economical, its wells are closed.

"This final act in the life cycle of the well is in two steps. First, to protect the underground area, the well hole is plugged with cement. This prevents any flow or leakage at the surface and protects all underground strata and water zones. Second, to minimize any visual impact, all pits used in the operation are filled, the site is regraded, and where practical, the ground is replanted with grass and other vegetation.

"When those steps are completed and when all salvagable equipment is removed, the well is officially plugged and abandoned. The process of abandoning a well assures adequate environmental protection and minimizes any disruptive effects the installation may have had on the area.

How is an oil well completed?

The American Petroleum Institute explains: "Completing the well has two major components: providing a channel to control and direct the flow of the oil to the surface and controlling the pressure in the well to avoid either a gusher or an irregular production rate.

"After making the strike and locating the petroleum-bearing formation, drillers control the flow of oil and gas through the use of drilling fluids and specal surface equipment. After this inital control is achieved, cement is pumped into the well between the walls of the drill hole and the outside of the well casing. This sets or secures the string of casing in the hole.

"Next, a special instrument containing either shaped explosive charges or bullets similar to those in a gun, is lowered into the well. This device uses electronic impulses to fire a charge or bullets through the casing and cement into the petroleum formation. This procedure opens up passages in the substructure that allow the oil and gas to flow into the well bore. Drillers then install tubing in the casing, and the petroleum flows through that tubing to the surface.

"Lastly, a complex set of valves and control equipment is attached to the top of the well. Often called a "Christmas tree" because of its many branch-like fittings, this equipment controls the flow of oil and/or natural gas once the well actually starts producing.

"While these steps constitute the basics of completing a well, the process may require more activities. For example, many wells need specal production safety equipment to control and regulate pressure. It is not uncommon to see wells that use, in addition to a Christmas tree, both automatic and manual surface and subsurface valves, alarms and monitoring and recording equipment.

"In other cases, multiple commercially productive formations are found at different depths of a single well. Then drillers sink separate tubing strings through the original casing in order to tap into each productive area. The oil and gas from the separate formations are directed through the appropriate tube, isolated by packing that seals the space between the casing and tubing strings. Multiple completion wells allow producers to bring more oil and gas to the surface without drilling separate wells.

"Since oil, natural gas, water and other substances are often found together, production facilities must separate them. The initial separation is accomplished near the well itself.

"After separation some preliminary processing may be required before shipment. Oil, for example, needs to be treated at the drilling site in order to remove both the remaining water and sediments that come with it to the surface. After this initial cleansing, the oil is sent to a refinery for further treatment." 8

How long does an oil well produce oil?

"The life of a producing oil well begins with the first barrel brought ot the surface and usually ends when the well is abandoned as uneconomical--the time when the cost of producing the remaining oil is greater than the price received for it. The life span of a well varies greatly from field to field. A small reservoir of oil may be productive for only a fews years; some formations, though, can produce profitably for 75 years or more.

"The recovery of oil is a displacement process. Oil does not move from a reservoir by itself. It must be pushed from the rock formation to the well bore by a displacing agent. Fortunately, two natural displacement agents are usually found along with oil: gas and water.

"The pressures exerted by these natural forces provide a general basis for distinguishing the different phases of a well's life. These phases are commonly called the *flush*, *artificial lift*, and *stripper* periods of production.

"During *flush* production, natural pressures within the well drive the oil to the surface. It is usually, though not always, the first stage in a well's life. Generally, flush operations can be distinguished by the kind of force that drives the oil to the surface.

"Some gas is found in virtually all oil accumulations. Under certain conditions all of the gas is dissolved in the oil. When the formation is penetrated, the gas expands and drives the mixture to the surface. In principle, dissolved gas drive is like gas in soda pop: it expands or fizzes up when the bottle is opened.

"Pressure in many reserviors traps a large cap of gas above the oil in addition to the gas dissolved in the oil. When the rock is penetrated, both dissolved gas and the gas cap expand and exert enough pressure on the oil to move it toward the only escape hatch available--the well bore leading to the surface.

"In many oil reservoirs, water exists under hydrostatic pressure beneath the oil. When a drill penetrates the reservoir, the pressure drives the oil to the well bore, and in some cases, to the surface. As water pressure in the reservoir is reduced by oil production, water from the surrounding porous rock flows into the reduced pressure zone, displacing the oil and driving it toward the well bore.

"When the natural pressure in a well loses its power to move the oil in the reservoir, the well moves to the second stage of its life and is put on a pump. Pumps create *artificial* pressure to displace the oil and force it to the surface.

"A variety of pump devices can be used. One kind of pump uses a surface-based power source to drive a valve plunger deep in the well. The plunger creates pressure that lifts out the oil in much the same way that a plunger clears a toilet. Also, submersible electric pumps can be lowered into the well and used to lift the oil. Finally, the gas lift method injects pressurized gas to force the oil to the surface.

"The second stage of a well's life may actually be the first if the well lacks sufficient pressure, as many do, to raise oil naturally. In most cases, however, pumps are used only after the well has exhausted its own natural forces. With a pump, a well can produce for many years.

"However, wells finally reach a point where they only produce intermittently. These wells, usually called *stripper wells*, produce only a few barrels of oil a day, but they are kept in operation because their output is at least marginally above the costs of continuing to operate them. Many stripper wells are pumped only intermittently after allowing the oil to accumulate in the well bore.

"Despite the limited production of each one, stripper wells make a significant contribution to our national energy supply. At the beginning of 1983, 416,493 stripper wells were producing 442 million barrels of oil, roughly 21 percent of the nation's domestic supplies." 9

How is the production of oil controlled?

API literature states: "The concept of controlled production began with the realization that the rate at which the oil is produced will affect the level of natural pressure in the reservoir, and ultimately, the amounts of oil that can be recovered.

"In the early days of the oil industry, when not much was known about the natural phenomena that drive oil to the surface, wells were often drilled side by side. Positioning wells close together reduced much of the natural underground pressure that was released through many wells. As a result, wells ended their productive life much too quickly. Once engineers understood that underground pressure was reduced when the production rate was too high, they began to reduce the rate of withdrawal in order to conserve reservoir energy and assure maximum production over the long-term life of the well.

"The same lack of knowledge about production dynamics led to the practice of burning off or flaring the natural gas that was found with oil and which, in early days, had no economic value. Even though the gas had no commercial value, it could have been pumped back into the formation as a displacement agent to increase the flow of oil. While rig placement and the flaring of natural gas were decreasing production, the failure to control gushers wasted some of the oil that did come of the surface.

"These early mistakes in production have long since been changed by increased knowledge and new techniques. By 1900, the industry had learned that pumping water into a reservoir significantly increased production. Later analyses of oil-bearing formations and formation samples led to the use of *porosity* and *permeability* measurements. As a result, engineers could estimate the approximate volume of hydrocarbons in a reservoir. Their analysis of the available data indicated that in those early days the industry was recovering only about 10 to 20 percent of the total oil in place. (Currently the recovery rate is roughly 33 percent, a significant improvement, but also an indication that there is more to be done.)

"As knowledge of the natural forces operating in petroleum formations increases and mastery of technology improves, the industry's ability to get more oil and gas out of the ground should continue to grow." 10

1. Crown block & watertable
2. Mast
3. Monkeyboard
4. Traveling block
5. Hook
6. Swivel
7. Elevators
8. Kelly
9. Kelly bushing
10. Master bushing
11. Mousehole
12. Rathole
13. Backup tongs
14. Makeup tongs
15. Drawworks
16. Weight indicator
17. Driller's console
18. Doghouse
19. Rotary hose
20. Accumulator unit
21. Catwalk
22. Pipe ramp
23. Pipe rack
24. Substructure
25. Mud return line
26. Shale shaker
27. Choke manifold
28. Mud-gas separator
29. Degasser
30. Reserve pit
31. Mud pits
32. Desilter
33. Desander
34. Mud pumps
35. Mud discharge lines
36. Bulk mud components storage
37. Mud house
38. Water tank
39. Fuel Storage
40. Engines & generators
41. Blowout preventer stack
42. Drilling line

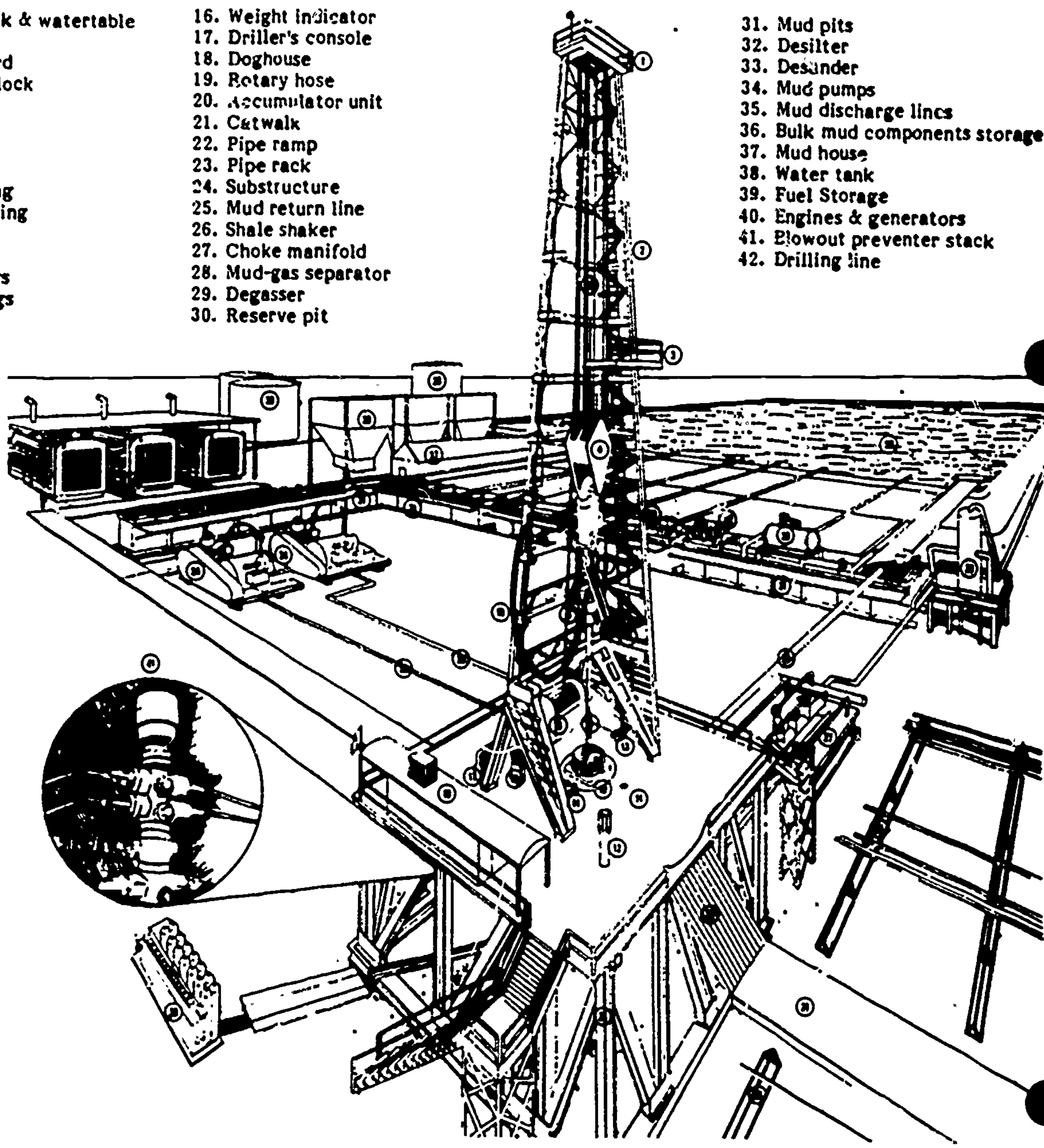


Illustration courtesy of Canadian Associatin of Oilwell Drilling Contractors.

How can more oil come out of the same well?

According to the API, "Decreasing production rates do not result solely from low underground pressure. Sometimes the underground formation is not permeable enough to allow trapped oil and gas to move toward the well bore. When this happens, nature may be given a big assist by either *acidizing* or *fracturing* the reservoir rock at the time of well completion.

"As the name implies, acidizing involves pumping acid into a producing well. When it reaches the producing formation, the acid reacts with certain materials in the reservoir rock, etching channels through which the oil and gas can flow toward the well bore. Hydrochloric acid, used most frequently, is treated with various chemicals to keep it from corroding the well equipment, to prevent it from forming an emulsion with the oil and to control its reaction rate.

"Fracturng also opens up underground channels for trapped hydrocarbons, but it accomplishes this goal by force rather than chemical reaction. A special fluid is pumped under high pressure into the producing well, thus opening fissures in the reservoir rock. Propping agents, ordinarily sand but occasionally metal, chemically compounded pellets and even walnut shells, are added to the fluid. When the pressure is released and the fluid flows back out ot the well, these agents remain behind to keep the fissures propped open so that the oil and gas can flow more easily toward the well bore.

"If the pressure that is generated by gas and water trapped with the oil is inadequate or has been depleted, pressure levels can be maintained artificially.

"Injecting gas (air, natural gas or carbon dioxide) and water are the more common pressure maintenance techniques. Both methods involve drilling auxiliary service wells to permit the most efficient injection pattern. Often pressure of the injected water or gas is regulated according to conditions throughout the reservoir. This process, called unitization, helps obtain optimum recovery.

"At some point, however, an individual well or reservoir simply does not have enough natural pressure left to maintain production. Rather than abandon the area, scientific research offers other techniques that can prolong the life of the reservoir. To begin with, producers use what is known as enhanced recovery, which consists of secondary and tertiary recovery.

"Secondary recovery is very similar to pressure maintenance. But instead of aiding or maintaining natural pressure, these methods esentially replace it. Secondary recovery involves repressuring a reservoir usually through injection of water or gas.

"Water flooding is the most widely used secondary recovery technique. In *five-spot water flooding*, four injection wells are drilled to form a square with a producing well at the center. The injection is carefully controlled to maintain an even advance on the water front.

"Secondary recovery has been successful in a number of different environments and in some cases, it has more than doubled the amount of oil recovered from a reservoir.

"Like all techniques, secondary recovery also has certain limits. When this approach has been exhausted, producers turn to tertiary methods to bring still more oil to the surface.

"There are a variety of tertiary recovery techniques. Miscible gas flooding, a variation on gas injection, involves injecting a slug of gas such as carbon dioxide which mixes with the trapped oil. Then, a fluid is injected into the well and it pushes the mixture toward the production well.

"In micellar-polymer flooding, a detergent or soaplike material is pumped into an injection well. This fluid then sweeps through the reservoir, washing oil from the rock grains as it moves. A gel or thickened water is injected behing the detergent to move it slowly and steadily.

"Thermal recovery is still another method of re-energizing oil reservoirs. It uses heat rather than water or gas. Steam injection is a variation of this technique that is widely used in shallow reservoirs containing viscous crudes.

"One method of steam injection, known as *huff-and-puff* or steam soak, entails injecting steam into the producing well over a period of about 10 days or 2 weeks. The well is then shut in for a week or more to allow the reservoir to become thoroughly heated. The heat from the steam, locked in the porous rock formation at the bottom of the well, reduces the viscosity of the crude oil and allows it to flow readily into the well. Then the well is reopened. To a somewhat lesser extent, the steam also stimulates oil recovery by cleaning up the well bore.

"*In situ* (in place) combustion or fire-flooding is another thermal recovery technique. Oil-moving energy is created by injecting air or oxygen-bearing gas into the reservoir and then igniting a portion of the reservoir oil. This starts a narrow combustion front that advances slowly (often only three inches a day) through the formation which is sometimes as large as a 40-city block area. It does not have to be fast because heat is more important than speed. To get the oil moving, temperatures may go as high as 1200° F. The burning area travels from the injection well toward the producing well, pushing the oil ahead of it. The entire process is closely controlled by careful regulation of injected air.

"These enhanced recovery methods are extremely expensive. Depending on the market price of oil, they may or may not be economically feasible. They do, however, hold out the hope that we will be able to tap into the estimated 300 billion barrels of oil trapped underground without sufficient pressure to drive it to the surface. If circumstances require, recovery of part of that oil is possible." 11

Are oil drilling condititions unique in Alaska?

Ask that question of any oil worker in the state and he or she will look at you like you were just born yesterday. Oil drilling conditions are *very* unique in Alaska, not only because of the extremes in temperature, but also the remoteness of many of the sites. At Prudhoe Bay and at other sites in Alaska, many of the workers do not work a regular work day at the end of which they can go home. No. They work twelve to twenty-day shifts, and then fly by jet or propellor aircraft back to Fairbanks or Anchorage or Kenai or wherever they live. They don't live where they work.

[1] ***Facts About Oil,*** *American Petroleum Institute, p. 13.*

[2] ***Ibid., p. 13-14.***

[3] ***Ibid., p. 13.***

[4] ***Fundamentals of Petroleum,*** *Petroleum Extension Service, University of Texas at Austin, Austin ,TX, 1981, p. 91.*

[5] ***Ibid., pp. 15-16.***

[6] ***Ibid., p. 14.***

[7] ***Ibid., p. 14.***

[8] ***Ibid., p. 14.***

[9] ***Ibid., pp. 17-18.***

[10] ***Ibid., p. 1.***

[11] ***Ibid., p. 18-19.***

Environmental Impacts of Energy Extraction
Teacher Page

Competency: Identify environmental impacts of energy extraction

Tasks: Explain ways the petroleum industry needs to protect the environment including:

a. reducing emissions and odors at refineries
b. producing low-sulfur heating oil and residual fuel oil
c. returning water to rivers or streams at the same or an improved purity
d. reducing refinery discharges
e. preventing, controlling, cleaning up, and monitoring oil spills
f. reimbursing victims of oil spills
g. preventing and controlling offshore blowouts

Explain ways to prevent oil spills
Identify environmetnal safeguards in pipelines and refineries
Identify the relationship between burning fossil fuels and the greenhouse effect

Introduction

Obviously the debate about the environmental impacts of petroleum development is one of the major debates of the 1980's. Ever since the birth of the American conservation movement, the whole issue of development versus conservation issues has remained at the forefront of American politics. This particular issue offers great possibility for student debate and purview. Students can benefit by following issues such as the development of the Arctic National Wildlife Refuge (ANWR), or drilling offshore in the Beaufort Sea. They can contact their legislators or can argue various positions in class.

Overview

Students may overlook work dealing with the impacts of development. Not only are there jobs as technicians measuring and monitoring those impacts, but all oil companies have troubleshooters and workers whose job is to minimize those impacts. With the political climate favoring low-impact development, a speciality in reducing and removing that impact is evolving.

Resources

Alaska Conservation Foundation, 340 G Street #201, Anchorage, AK 99501

Alaska Environmental Lobby, Inc., 204 N. Franklin, Suite 3, Juneau, AK 99801

Alyeska Pipeline Service Company, 1835 South Bragaw St., Anchorage, AK 99512

Department of Natural Resources, Division of Mining, State of Alaska, P.O. Box 7016, Anchorage, AK 99510-7016

Sierra Club, Alaska Chapter, P.O. Box 103441, Anchorage, AK 99510-3441

Southeast Alaska Conservation Council, P.O. Box 021692, Juneau, AK 99802

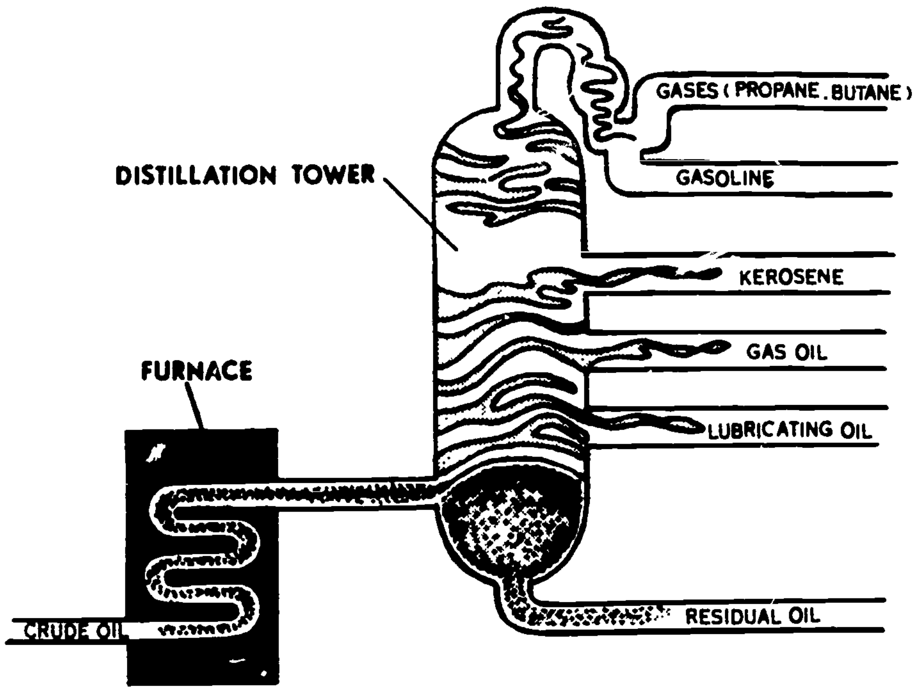
Suggested Reading

"Operating the Trans Alaska Pipeline," Alyeska Pipeline Service Company, 1835 South Bragaw St., Anchorage, AK 99512

Environmental Impacts of Energy Extraction

How can the petroleum industry make refineries less polluting?

Refineries are factories in which crude oil is turned into oil products. Refineries deal with dangerous substances and oftentimes they produce dangerous substances. Alaska has several oil refineries, though the bulk of the oil which flows down the Alaska pipeline is refined in California, Texas, and Louisiana.



In oil refineries, excess gas is destroyed or "flared" away. Today, to reduce pollution, refineries use *smokeless flares*. Refineries often need great quantities of water for cooling. For this reason, refineries are usually located on rivers or lakes. Refineries are now required to purify the water they return to the river or lake. Oil and other wastes are supposed to be removed. Refineries need not only to have systems to remove wastes from gases emitted, but also to remove solid and chemical wastes from water.

Sometimes chemicals and wastes produced in refineries leak. To prevent these leaks, pipelines and industrial areas require regular visual inspections, use of ultrasonic leak detectors, corrosion preventives and automatic shutdown systems. Additionally, refineries are usually constructed away from inhabited areas. Oftentimes the storage tanks on the property are built so that if they explode, the explosion will blast straight up, rather than out.

What about clean water?

Clean water is a major American concern. In fact, recent surveys indicate that Americans ranked clean water the number one environmental concern. The oil industry, like the chemical industry, has great potential for contamination of surface and ground water. To minimize pollution, most of the water produced with oil (brine) is reinjected into the ground. Drilling mud can potentially pollute water resources. Such fluids need to be disposed of carefully, in leak-proof containers.

Can we stop oil spills?

Oil floats on water. Oil spilled in rivers, lakes or in the ocean rises to the surface and affects a myriad of animal and plant life. Offshore or tanker oil spills have potential for envirnomental disaster. Though a major oil spill occurred off the coast of Santa Barbara, California in January 1969, releasing thousands of barrels of oil into the sea, washing up on beaches, coating sea birds with goo., offshore oil spills are rare. The oil industry has made great strides in the protection of the environment. Possibly because of the great potential for disaster, the oil industry has been careful in construction and utilization of offshore oil rigs. In fact, studies by the National Academy of Sciences cited worldwide offshore oil production as responsible for only 1.6 percent of the world's ocean oil pollution. The bulk of the oil spillage responsible for pollution of the world's oceans derives from municipal and industrial wastes, river runoff, oil tankers, and natural oil seeps.

Who fixes damages of oil spills?

The oil company doing the drilling or shipping has the moral and legal responsibility to clean up oil spills. Major oil spills can become enormous environmental disasters. In such cases federal and state governments inevitably step in, as do volunteer conservation groups. By law, any oil spills at sea beyond small amounts must be reported to the U.S. Coast Guard.

Are offshore rigs safe from blowouts?

Blowouts, when the pressure beneath the ground or the ocean bottom pushes oil out at a great rate of speed, can cause a great deal of environmental damage. The Santa Barbara Channel accident in 1969 was an undersea blowout. The spill resulted in the deaths of many sea birds and other organisms. Minor undersea blowouts have occurred since that time, but none with major consequences. Studies of the Santa Barbara diaster and resulting damage has resulted in improved technology and drilling techniques to minimize such damage. But blowouts are possible.

Is the Alaska pipeline an environmental hazard?

Obviously the construction of the Alaska pipeline changed a portion of the state in a major fashion. A swath of vegetation was removed and the ground was disturbed across some 800 miles of landscape. An accompanying "haul road" (now called the Dalton Highway) was constructed some 427 miles from the Manley cutoff of the Elliott Highway to Prudhoe Bay. Roads and construction bring change. The Alaska pipeline has been hailed as a triumph of engineering with low impact, but development, roads, communities, and services affect wildlife. A break in the pipeline above ground could spill thousands of barrels of warm-temperature oil out onto fragile frozen tundra.

Is burning oil and coal destroying our atmosphere?

Acid rain is a great concern of the 1980's. The United States is the Saudi Arabia of coal. The country has approximately one third of the world's proven coal reserves, with vast quantities untapped. The American midwest is a major consumer of coal. The states of Illinois, Michigan, Indiana, Ohio, and Pennsylvania not only contain great quantities of coal, but also burn it. The midwest contains this ready energy source as well as river systems offering cheap transportation of that coal. The American midwest is a major industrial and energy (coal-burning power plant) producer. When coal is burned it emits troublesome fumes. To keep the fumes from affecting local populations, industries and power plants use tall smokestacks to lift the gases high above the ground. These gases rise into the atmosphere, mix with other gases there, and fall as acid rain. Additionally, research is indicating that spilling these and other gases into the atmosphere may be raising the carbon dioxide (CO2) level of the atmosphere and may be causing the temperature of the planet to rise. These and other gases may be damaging the earth's protective ozone layer, an oxygenized layer of gases which absorbs damaging radiation from the sun.

Geological Theories
Teacher Page

Competency: Identify geological theories

Tasks: Discuss theories of the formation of the earth
Explain the layers of the earth including crust, mantle, outer core, inner core
Discuss the size, shape, and average density of the earth
Differentiate between sedimentary, igenous and metamorphic rock
Explain the relationship between plate tectonics and mineral deposits
Explain the relationship between weathering processes and mineral deposits

Introduction

A foundation in geology is a prerequisite for a career in mining and petroleum. Though a standard college course, geology is one found in few high schools. Students can create projects showing the processes of erosion. They can demonstrate the layers of the earth and how the earth's crust buckles and folds. Students can explain the effects of continental drift on buckling, folding, and volcanic activity. A trip to a local rock quarry or hot spring would be beneficial. A class visit by a geologist or someone who tests or lays foundations would offer some first-hand knowledge. In this area, students interested in rock collecting can shine.

Overview

As anyone in the mining and petroleum industry might relate, knowledge of geological theories affecting mining and petroleum "can't hurt." In fact as technology changes and scientific methods of prospecting change, the demand for scientific knowledge increases. Those using theories of geology might include increasing numbers of engineering and geology aides and technicians. Alaska has great potential in the mining field. Estimates are that despite the declining economy because of oil prices, mining activity will increase. Some mines, such as the Red Dog mine near Kotzebue or the Quartz Hill mine near Ketchikan, or the Greens Creek mine near Juneau offer world-class mining potential.

Resources

Alaska Lapidary Society, 3008 West 29th St., Anchorage, AK 99503

The Chugach Gem & Mineral Society, P.O. Box 4-2027, Anchorage, AK 9503

Energy Source Education Council, Program Distribution Office, 5505 East Carson St., Suite 250, Lakewood, CA 90713

Mineral Information Institute, 6565 South Dayton, Suite 3800, Englewood, CO 80111 (303)790-8291

Mining and Petroleum Training Institute, 155 Smith Way, Soldotna, AK 99669

Seward Mineralogical Society, Seward, AK 99664

Suggested Reading

Alaska Resources Kit: Minerals. Alaska Department of Education, P.O. Box F, Juneau, AK 99811 or Engelhard Industries, 6670 Wesway, Anchorage, AK 99502

Enclyclopedia of Minerals. Willard Lincold Roberts, Van Nostrand Reinhold Company, 1974

Fundamentals of Petroleum. Petroleum Extension Service, The University of Texas at Austin, Austin, TX, 1981

Gemstones of the United States. Dorothy M. Schlegel, U.S. Geological Survey Bulletin 10-42-G, 19007

Geology for Petroleum Exploration, Drilling and Production. Norman J. Hyne, PhD., McGraw Hill Books, 1984

Minerals and Men. James McDivitt, and Gerald Manners, RESOURCES FOR THE FUTURE, INC., Johns Hopkins University Press, Baltimore and London, 1974

Mining Miners & Me. J.L. McBiles, Arizona Mining Association, 100 W. Clarendon, Suite 1720, Phoenix, AZ 85013

Picture Book of Metals. Ania Brooks, John Day Co., 1972

Stones, Their collection, identification and uses. R.V. Dietrich, W.H. Freeman and Company, 1980

Films

Earth and Universe Series, Set 1, University Films/McGraw-Hill Films, 19-20 minutes; Teacher's Guide, Gr. 4-9. Contents: 1. How the Earth's Surface is Worn Down 2. How the Earth's Surface is Built Up, 3. The Air Around Us. A comprehensive study with concepts simply presented. The effects on erosion, weather, wind, plant growtth, and human activity are discussed.

"Geology: Our Dynamic Earth." National Geographic Educational Services, 4 sound filmstrips, running time 15-16 minutes each.

"Our Changing Earth," Coronet Instructional Media. 1974. 6 color sound filmstrips, 3 discs or 6 cassettes, avg. 12:30 minutes, Gr. 6-12. Contents: 1. How We Study It 2. Water and Its Works 3. Wind, Weathering, and Wasting, 4. Pressure and Change Beneath the Earth's Surface 5. Thermal Activity and Igneous Formations 6. Man and His Geological Environment. A thorough and comprehensive overview of the Earth; photography and diagrams clearnly define many complicat'd concepts.

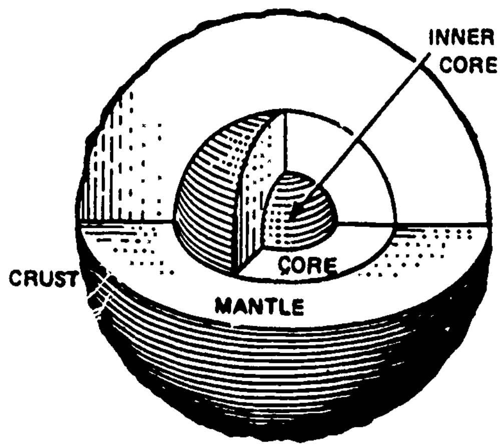
"Rocks and Minerals," National Geographic Society Educational Services. Sound filmstrip, 17 minutes, 1983. Grade: intermediate. Discusses igneous, sedimentary, and metamorphic rock, shows some types, and describes their formation and characteristics. Examines minerals as the substances making up rocks; shows types of minerals and some methods of identifying them.

Geological Theories

How was the earth formed?

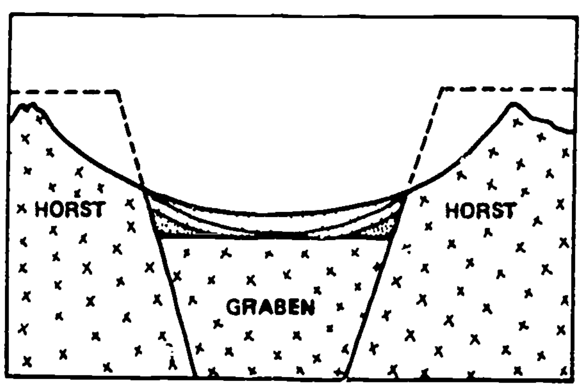
Geology. What does the word conjure up for you? Do you think of rocks? Do you think of grizzled old prospectors out in search of gold? Do you think of multi-million dollar extraction projects, digging in search of strategic minerals? Or do you think of eons and eons of changes, of the effects of weather, of time, of life on basic elements? Well, you're right. You're already geologically inclined.

The earth may have originated some 4 to 5 billion years ago. Some say the earth was formed out of a condensing cloud of cosmic dust. Theorists state that at some time during its early life the earth must have been molten and very, very hot. This very hot stage may have been caused by the compression of gravity or by the release of energy by radioactive elements. During this molten phase, the components of the earth separated to produce a heavy *core* 4,400 miles in diameter, a *mantle* of lighter material some 1,800 miles thick, and a *crust* of the lightest materials some 10 to 30 miles thick. At the same time, gases and vapor erupted to form the primeval atmosphere. Slowly the crust cooled. 1



"The earth shrank as it cooled, causing the crust to buckle and warp and a rugged surface to develop. At this time all the rocks were igneous in origin; that is, they had all solidified from a molten form called *magma*.

As the atmosphere developed and the earth cooled, rain began to fall. Water ran from the heights and collected in the low valleys and shallow depressions to form the primeval oceans. Erosion began when water removed particles of rock and carried them to lower places; sedimentation started when the particles settled out of the quiet water. Gradually, the face of the earth began to change.



Uplifted blocks of igneous rocks were worn down from their original form (shown by the broken line in the figure) and the valley between them partially filled with the resulting sediment. The configuration of an uplifted horst and down-dropped graben is a common surface feature, exemplified by the Red Sea between Asia and Africa.

The earth was barren and lifeless for millions of years. then at some indeterminate point in time, life began in the oceans. In fact, by the beginning of the Cambrian period, which was about 550 million years ago, life was abundant in the oceans. However, not until the Devonian period, about 350 milion years ago, did vegetation become widespread on the land areas. Land animals become common even later.

Because life has continuously evolved from Predambrian time, the fossil remains of animals and plants, called *fauna and flora,* succeed one another in a definite and determinable order. This has enabled the succession of rocks to be subdivided into eras and smaller subdivisions.

"The duration of the eras and subdivisions in years has been determined from studies of radioactive minerals. The presence of life is essential to the petroleum story because organic matter is one of the necessary ingredients in the formation of oil." 3

What are the layers of the earth?

Some have described the earth as being like an onion, with peels. As stated, the earth has a *core* 4,400 miles in diameter, a *mantle* of lighter material some 1,800 miles thick, and a *crust* of the lightest materials some 10 to 30 miles thick. You could imagine the atmosphere as the thin outer skin of the onion.

If the atmosphere is the outer skin of the onion, the *crust* is the surface itself. The inside of the earth consists of the *mantle, core,* and *inner core.* Water vapor and gases compose the atmosphere.

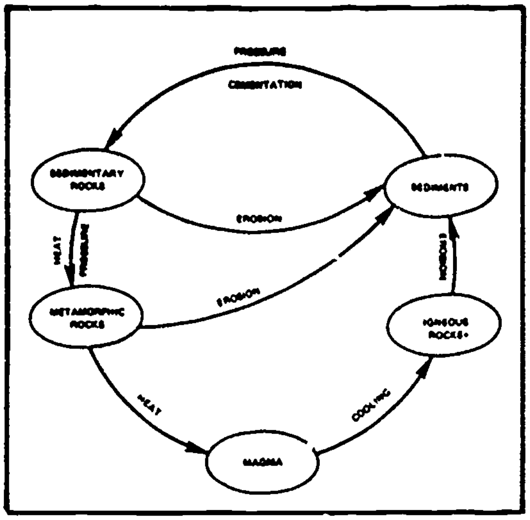
How big is the earth and what is it made of?

That is a big question! The earth is of course made up of material we are familiar with: sand, rocks, mud, water. It has a core of very high temperatures. The earth is some 8,000 miles in diameter. It's about 25,000 around at its widest point. It is one of the smaller planets in the solar system. All matter in the solar system is made of the elements which make up the table of elements. These elements are found on earth in varying quantities.

The earth's crust is comprised of a variety of minerals, each present in varying percentages in the rocks and soil. If all the minerals of the earth were distributed evenly, one cubic mile of that crust would contain (according to Professor Kalervo Rankama of the University of Helsinki) 1,000 million tons of aluminum, 625 million tons of iron, 260 million tons of magnesium, and over 12 million tons of manganese. These are the most common minerals in the earth's crust. On the other end of the scale, that same cubic mile of crust would contain "just" a million tons of zinc, 650,000 tons of copper, 185,000 tons of lead, and some 60 tons of gold. 4 But of course minerals are not evenly distributed in the earth's crust.

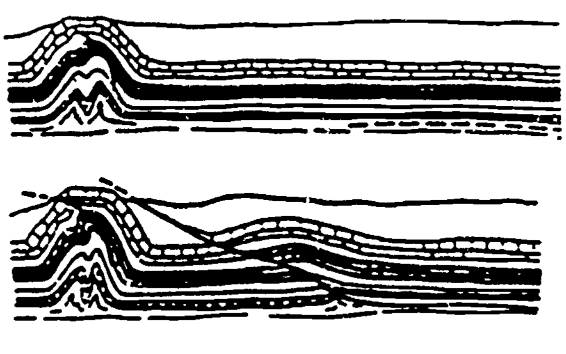
How do sedimentary, igenous and metamorphic rocks differ?

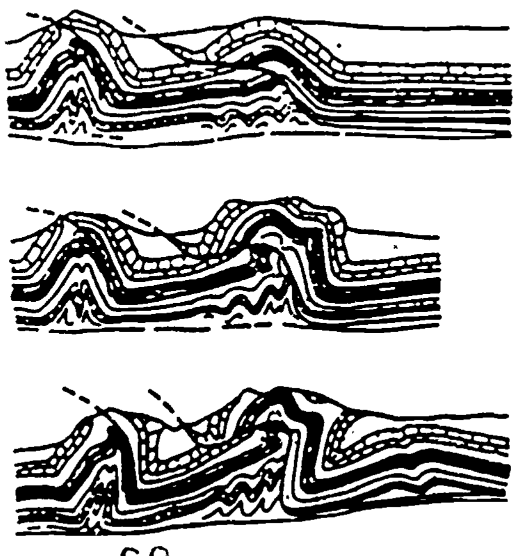
Sedimentary rocks have a complex history. They are formed from deposits from rocks that existed before. Those pre-existing rocks were themselves broken down into individual mineral grains or dissolved into salts by *weathering*. Weathering is the process in which rocks are broken down by the rain and air. *Igneous rocks* are formed when molten volcanic material is cooled either on or below the surface of the earth. *Metamorphic rocks* are those which have been altered by intense heat or pressure.



What is the relationship between plate tectonics and mineral deposits?

The surface of the earth is always moving. The surface of the earth may move upward, downward, or horizontally. This movement is especially dramatic during earthquakes. Alaska is one of the most active earthquake areas in the world. A theory explaining the movement of the earth's crust is *plate tectonics*. This theory states that the continents are moving ever so slowly around the earth's surface. Mountains are pushed upwards and cracks appear as portions of the earth's crust collide or separate from each other. Plate tectonics states that several of the continents were long ago attached. Plate tectonics explains why Africa's west coast has a bulge and great curve eastward in the very shape of the "void" of the Caribbean and the eastward "bump" of South America. Plate tectonics says the two continents were once attached.

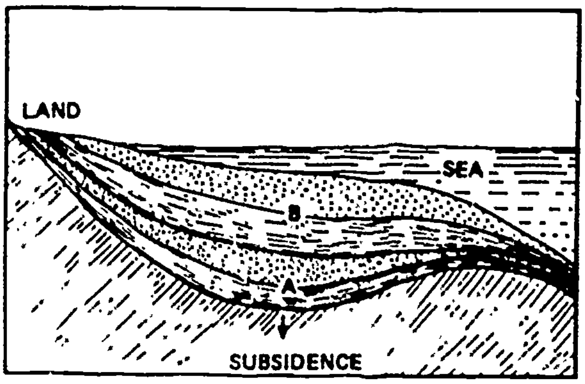




When the earth moves, rocks crack. These cracks are called *joints*. If the rock layers on one side of a fracture have moved in relation to the other side, the fracture is called a *fault*. *Displacement*, or how far the sides of the fault have moved may range from a few inches to miles wide, as along the San Andreas fault in California. Sedimentary rocks are deposited in horizontal layers called *strata* or *beds*. Forces of earth movement often deform these strata, which then buckle into folds. The upfolds or arches are called *anticlines*; the downfolds are called *synclines*. Oil and minerals are often found in these buckled areas. Geologists study the areas trapping and containing these minerals.

What is the relationship between weathering processes and mineral deposits?

Weathering is the breakdown of rock. Rock exposed on the surface of the earth will eventually break down into particles or become dissolved. Erosion is usually the result of flowing water, but it can result from the action of wind, freezing water, moving ice, and waves. The original particles that eroded from the surface of the earth were all derived from igneous rocks. Sediments continued to be deposited on sediments. The earlier unconsolidated deposits *(A)* were compacted by the weight of the overlying sediments *(B)* and in the process were transformed into sedimentary rocks. These in turn could be eroded again to produce sediments, and thus the cycle of erosion and sedimentation continued. Further, some sedimentary rocks were put under tremendous heat and pressure so that they were transformed into metamorphic rocks.



1 Fundamentals of Petroleum, Petroleum Extension Service, The University of Texas at Austin, Austin, Texas, 1981, p. 2.

2 Ibid., p. 5.

3 Ibid., p. 5.

4 MINERALS AND MEN, J.F. McDivitt, Gerald Manners, RESOURCES FOR THE FUTURE, Johns Hopkins University Press, Baltimore and London, 1974, p. 11.

History of Oil Exploration
Teacher Page

Competency: Identify the history of oil exploration

Tasks: Explain how oil is formed
Describe oil exploration techniques
Describe the relationship between use of the automobile and the availability of cheap oil

Introduction

The United States is the world leader in oil exploration. Students need a background in the history of oil exploration not only to demystify this complex and invaluable occupation, but also to indicate the potential for improvement. Even with the most advanced technologies, when the oil runs out at Prudhoe Bay, only some 30% of it will have been recovered. Students can study the history of drilling, from Drake's wells in Pennsylvania in the last century, to the offshore man-made islands in the Beaufort Sea. With the massive North Slope oil fields and America's penchant for plentiful energy, Alaska is at the forefront of petroleum technology. There are good jobs in oil.

Student papers on the history of petroleum technology, drafting-class or CAD drawings of oil rigs, even role playing the issues at stake when a major strike occurs in some historic hunting or wilderness areas are in order.

Overview

The oil industry is Alaska's biggest non-governmental industry. Oil will remain Alaska's biggest industry for some time. The oil industry has a need for skilled employees. The more knowledgeable the employee is in the oil industry, the greater the chances for employment. Oil companies have sometimes decried the lack of adequately-trained Alaskans to fill openings. Students need training in oil-related areas.

Resources

Alaska Miners Association, Inc., Statewide Office, 509 West 3rd Ave.,

The American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005

Suggested Reading

Alaska Resources Kit: Minerals. Alaska Department of Education, P.O. Box F, Juneau, AK 99811 or Engelhard Industries, 6670 Wesway, Anchorage, AK 99502

History of Oil Well Drilling, Brantly, J.E., Gulf Publishing Co., 1971

Facts About Oil. The American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005

Films and Filmstrips

Oil, from Fossil to Flame, film, Coronet films. 16mm color, 13 minutes, 1976. Gr. 3-up. Shows how oil was formed, traces history of petroleum industry and identifies major proven reserves of oil throughout the world.

History of Oil Exploration

How is oil formed?

"*Sedimentary* rocks are important to petroleum geology since most oil and gas accumulations occur in them (*Igneous* and *metamorphic* rocks rarely contain oil or gas.) Sedimentary rocks are deposited by water, wind or ice. In general, older sedimentary rocks have been compacted by the weight of the overlying sediments or cemented by minerals carried by ground water, so that they become consolidated rock. Ground water is the water present in rock pores and cracks. A simple classification of sedimentary rocks is shown in this table: [1]

Classification of Sedimentary Rocks

Clastic	*Chemical*		*Organic*	*Other*
	Carbonate	*Evaporite*		
Conglomerate Sandstone Siltstone Shale	Limestone Dolomite	Gypsum Anhydrite Salt Potash	Peat Coal Diatomite Limestone	Chert

"If some other process did not compensate for erosion, the land would be reduced to plains near the level of the sea. However, the land currently stands about as high above sea level as it ever did. Obviously, uplift of the surface must have occurred to compensate for the wearing down of the mountains.

"The surface of the earth and upper crust have moved upward, downward, or horizontally many times since the earth was formed. In fact, movements are ontinuing today, as the earthquakes that occur each year demonstrate. Sometimes only a few feet of displacement can be seen along a *break*, or *fault*, after an earthquake. However, remains of marine shells have been found in some of the highest mountains and in the deepest oil wells, proving that the rocks were deposited in some ancient sea and then uplifted or dropped to their present position. Geological evidence shows that repeated movements of only a few inches at a time will gradually raise or lower the earth's surface enough to account for total displacements of thousands of feet.

"Sedimentary rocks are deposited in essentially horizontal layers called *strata*, or *beds*. Most rock layers are not strong enough to withstand the forces to which they are subjected and so become deformed. A common kind of deformation is the buckling of the layers into folds. Folds are the most common structures in mountain chains, ranging in size from small wrinkles to great arches and troughs many miles across. The upfolds or arches are called *anticlines;* the downfolds or troughs are called *synclines*. A symmetrical fold with similar flanks dipping on both limbs is possible, as is an asymmetrical shape with one limb steeper than the other. "

Do people use their cars more and waste more oil when oil is cheap?

What do you think? Of course they do. If you had to *pay* for water just think of how much less of it you would use. In our free-market economy, price determines use. One factor which probably made automobiles so dominant in American culture was the availability of cheap gasoline. While Americans were paying 25¢ a gallon, Europeans were paying over a dollar. Imagine what they're paying today! It seems that few Americans know that the world's largest producer of oil is *not* Saudia Arabia. The world's largest producer of oil is the Soviet Union. And the world's second largest producer of oil is the United States. Yet, despite its large oil reserves, the United States, as of 1987, imported up to 35% of its needs. **Up to 35%!** If you want to know who the oil hogs of the world are, look in a large collective mirror. It is us--**U. S.** We Americans are gluttonous in our use of oil. Visit a third-world country where precious *petrol* (that's gasoline in former British colonies) is purchased in a Pepsi bottle stuffed with a rag and carefully poured into a mo-ped. In that country the gas might cost $3.00 or more a gallon, and it might take a day to earn that much money! So oil has been cheap, and Americans have used more than their share of it.

In the early 1970's there were places in the U.S. where gasoline was 19.9¢ a gallon. Could you see yourself pulling up to a gas station pump in a big pickup truck and filling the tank for less than five bucks? Ah, those were the days you might tell yourself. The oil embargo of the 1970's fixed all that. In some places--in some cases--oil quintupled, sextupled in price. And that's some rise. And oil stayed high in price--until the mid-1980's, when it dropped from sky-high to just plain high. Check on the price of oil today in the world oil market. Someplace, no matter where you live in Alaska, you can find that information pretty quickly.

But did the oil glut of the mid to late '80's make Americans revert to their wasteful ways? You bet! Even though people certainly recall the gasoline lines of the 1970's, when oil prices were lower or remained stable, out came the big cars! Follow news happenings related to oil. Follow what happens with OPEC (the Organization of Petroleum Exporting Countries). Most OPEC countries can produce oil much more cheaply than non-OPEC countries. There is a good chance that the U.S. dependence oil will grow rather than shrink. What happens with OPEC and with U.S. oil consumption may just affect how much you use that big rig of yours. (If you're lucky enough to have one!)

*1 **Fundamentals of Petroleum.** Petroleum Extension Service, The University of Texas at Austin, Austin, TX, 1981, p. 7.*

Importance of Oil to Alaska
Teacher Page

Competency: Identify the importance of oil to Alaska's economy

Tasks: Name the major oil-producing nations
Describe the importance of oil to industrial economies
Locate important Alaskan oilfields
Describe the relationship between the Alaska pipeline and the Alaska Native Claims Settlement Act (ANCSA)
Describe the construction of the trans-Alaska oil pipeline
Identify the impact of state and local regulations and taxes on oil development
Describe the future of the oil and gas industry in Alaska
Explain the impact of nuclear power on the petroleum industry
Explain the impact of power from organic waste on the petroleum industry

Introduction

A lot can be learned by looking at statistics. Of course most students are not overly fond of statistics per se. But using a simple world almanac and material from the state, as well as a globe or world atlas, the student can readily discern the importance of oil to Alaska. Have students look up various statistics and report on them. Perhaps a bar chart can be placed in front of the room showing the amount of U.S. energy consumption versus production. Have students debate the issue of exporting Alaskan oil to other countries (currently prohibited for North Slope oil). Students can write employers in the oil industry, and/or a resource person can visit the classroom to talk about jobs in oil. Students can follow the oil/tax and oil/environmental issues in the newspaper. These issues are constantly evolving. A bulletin board/collage of these articles and/or a collection of summaries of these issues would benefit the student. These issues are already a part of every student's life.

Overview

Obviously oil is going to remain important to Alaska. Not only is Prudhoe Bay the country's largest oil field, but the state holds some of the greatest potential for oil production elsewhere as well. Though energy-related industries are subject to fluctuations in market prices (as are all industries), the student prepared for employment in energy-related areas is training in an area very relevant for the state.

Resources

Alaska Oil and Gas Association, 121 W. Fireweed Lane, Suite 207, Anchorage, AK 99503-2035 (907)272-1481

Alyeska Pipeline Service Company, 1835 South Bragaw Street, Anchorage, AK 99512

ARCO, P.O. Box 100360, Anchorage, AK 99510 (907)276-1215

Exxon, 3301 C St., Anchorage, AK 99510

Mining & Petroleum Training Service, 155 Smith Way, Soldotna, AK 99669 (907) 262-2788

The World Almanac and Book of Facts, Newspaper Enterprise Association, Inc., 1986

Importance of Oil to Alaska

What are the major oil-producing nations?

The 1984 World Almanac showed the 1982 top oil-producing nations as:

Nation	Production	Nation	Production
1. USSR	22.7%	9. Indonesia	2.5%
2. United States	16.3%	10. Nigeria	2.4%
3. Saudi Arabia	12.2%	11. Canada	2.3%
4. Mexico	4.2%	12. United Arab Emirates	2.3%
5. Iran	4.0%	13. Libya	2.2%
6. United Kingdom	3.8%	14. Iraq	1.8%
7. China	3.6%	15. Kuwait	1.6%
8. Venezuela	2.5%	16. Algeria	1.4%
		17. Qatar	0.6%

Have you heard of *all* those places? You'll notice that in the production of oil, the U.S. ranks second. Major industrial powers and energy users--the USSR and the United States are the two highest energy *producers* as well. This country produces a lot of oil. Then what is the problem?

Total U.S. Energy Production, 1983-1985
(Quadrillion [10^{15}] Btu's)

	Total
1983	61.1
1984	65.8
1985	64.7

Total U.S. Energy Consumption, 1983-1985
(Quadrillion [10^{15}] Btu's)

	Total
1983	70.4
1984	74.1
1985	73.8

Americans use more than they take in. The difference is made up by *imports*. IMPORTS. And what were those imports during the same years?

Total U.S. Energy Imports, 1983-1985
(Quadrillion [10^{15}] Btu's)

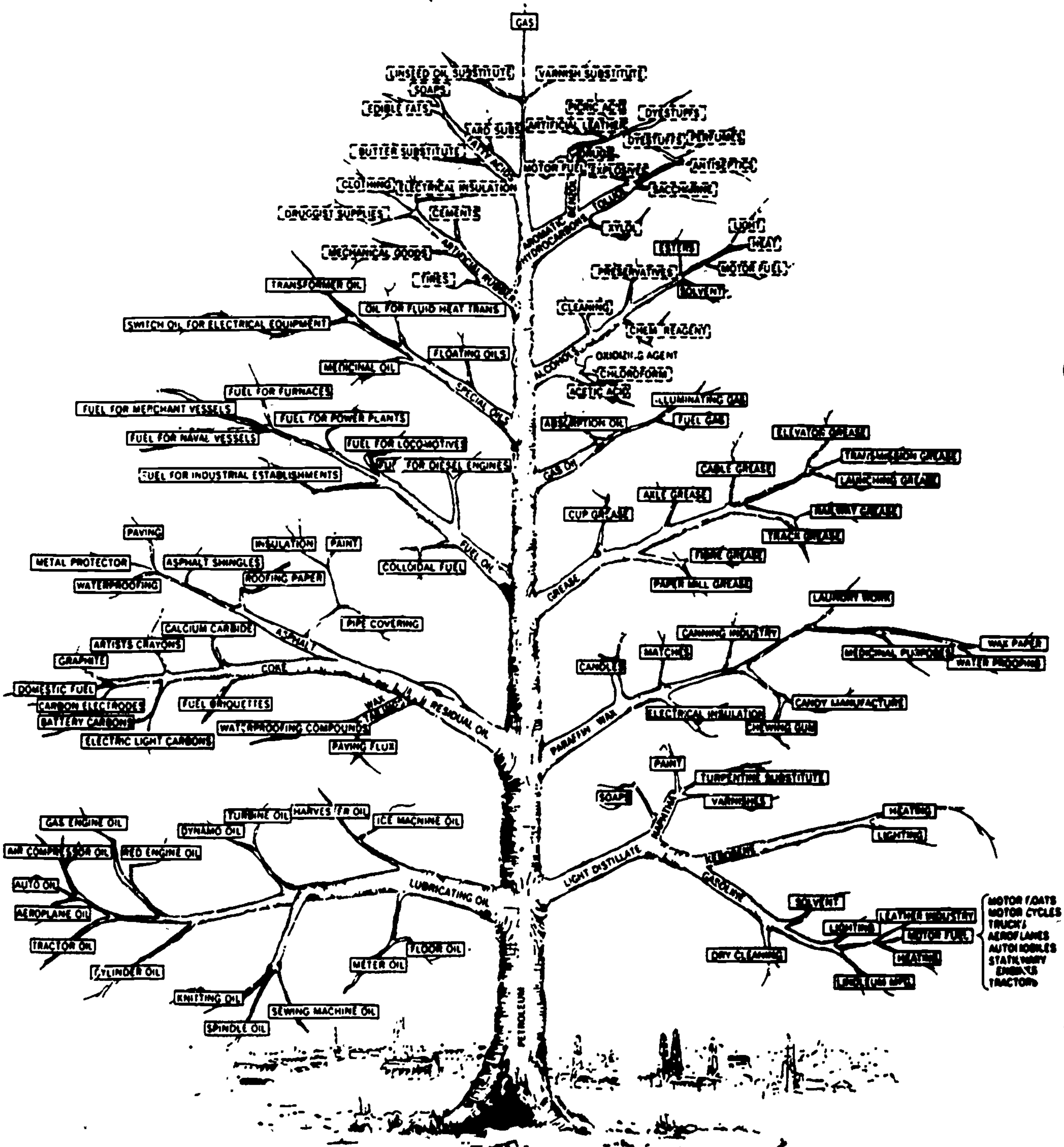
	Total
1983	8.3
1984	8.9
1985	7.7

But all the above statistics are computed with the *total* production of energy (coal, crude oil, natural gas liquids, dry natural gas, hydroelectric, nuclear, and other sources). Find out the statistics for oil. The U.S. may be the world's second largest producer of oil, but it still imports over 30% of what it uses.

Why does everybody talk about oil all the time?

Oil is important. Really important. The price of oil determined someplace in Europe or the Middle East may determine whether or not your mother, father, brother--or you--have a job in Kenai, Prudhoe, Anchorage, or Juneau. And money talks. Oil fuels economies, propels navies, and bankrolls wars. Oil is **BIG** business.

Oil is used for a variety of products. Oil is used to make gasoline, heating oil, asphalt, lubricating grease, kerosene, jet fuel, and wax. *Petrochemicals*--chemicals made from oil--are found in such diverse items as paints, plastics, cosmetics, film, batteries, vitamins, records, and synthetic fabrics. [1]

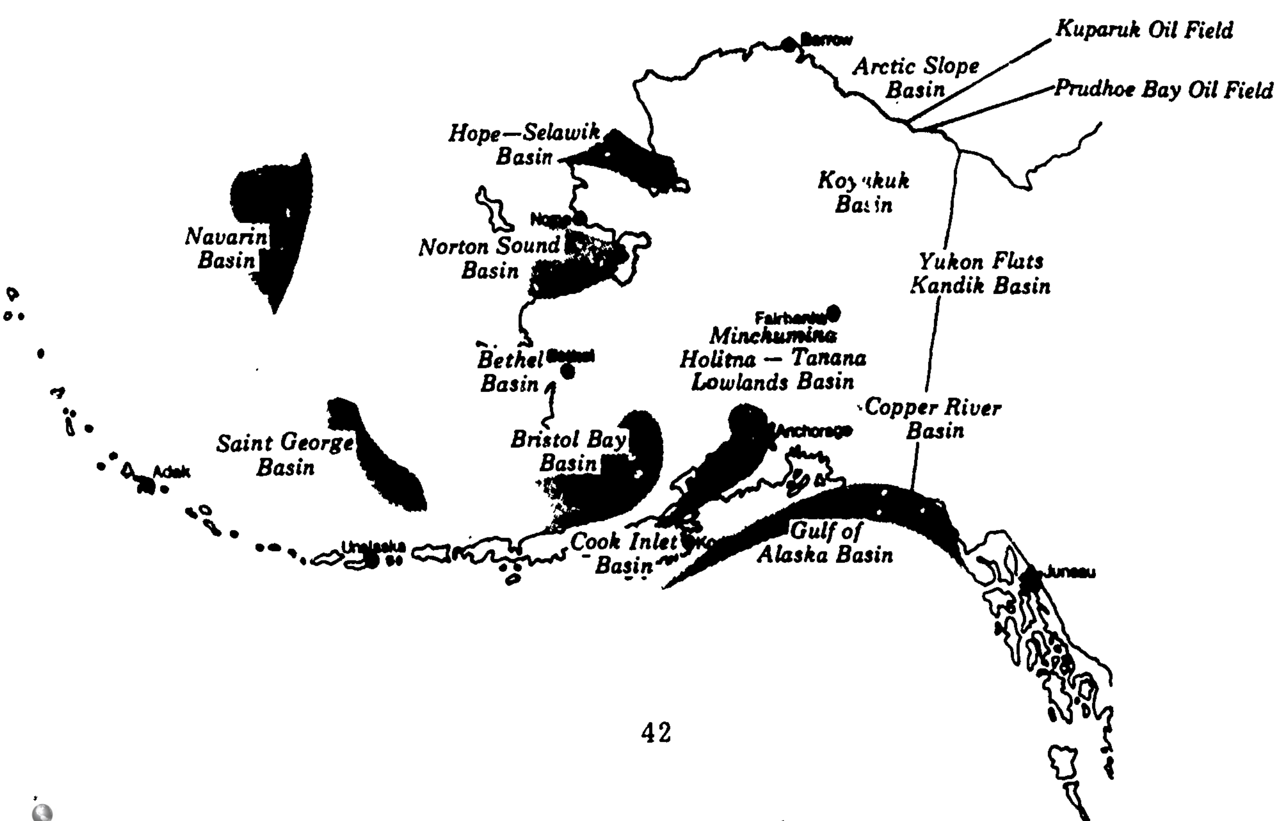


And let's look at the size of things in Alaska. Besides being the biggest state in size, other things are **BIG** in the Great Land as well. Compare the Prudhoe Bay oil field to the East Texas oil field, which has been producing oil since 1930. According to Houston-based Standard Oil Production Company in March 1987, the Alaska field production of oil surpassed the 4.9 billion barrels of crude oil and liquid hydrocarbons pumped from East Texas. **PRUDHOE BAY HAS <u>ALREADY</u> SURPASSED THE EAST TEXAS OIL FIELD!** That's a lot of oil. The Prudhoe Bay oil field is the 18th largest in the world in terms of recoverable resources. As of March, 1987, it is about half depleted. Although it contains an additional 13 billion barrels, technology does not exist to remove the oil.

East Texas continues to produce oil, but is not expected to reach the 5-billion-barrel mark until next year. The 250-square-mile Alaska field accounts daily for about 20 percent of all oil production in the United States. **<u>THE PRUDHOE BAY PRODUCTION, OVER 10 YEARS, PROVIDED ALASKA WITH ABOUT $23.4 BILLION IN ROYALTIES AND TAXES, WHICH STANDARD OIL SAYS IS THE EQUIVALENT OF ABOUT $50,000 FOR EACH ALASKAN CITIZEN.</u>** That's a lot of black gold. So now do you wonder why everybody talks about oil in Alaska?

<u>So where is this oil in Alaska?</u>

In the ground! Who hasn't heard of the great Prudhoe Bay oil strike, the largest oil field in North America. Prudhoe Bay is located 1,300 miles from the North Pole and 250 miles north of the Arctic Circle. Find it on a map of the state. Trace almost due north of Fairbanks, way up on the Arctic Ocean. So that's the giant Prudhoe Bay oil field. Did you know that oil has been pumped out of Cook Inlet, just outside of Anchorage, for over 60 years? There may be great oil fields in other areas of the North Slope. Much debate focuses on the impact of developing what has been an area of pristine wilderness, the domain of the Porcupine caribou herd, the largest in North America. Would you hazard damaging that valuable wildlife and wilderness resource for the oil resource? The debate goes on.



The first drilling operations in Alaska began in Cook Inlet in 1898, though no significant amounts of oil or gas were found. Commercial production of oil began at Katalla, near Cordova, in 1905. Wells there produced oil for nearly 30 years. In the 1920's oil companies surveyed land near Point Barrow on the North Slope. Though no significant amounts of oil were found, the area looked promising, so congress, in 1923 created Naval Petroleum Reserve Number Four," a 37,000 square mile area. This reserve, now called the "National Petroleum Reserve-Alaska," is half the size of the state of Washington. During the Second World War the Navy began drilling on the North Slope and continued to drill until 1953, but did not find oil. Exploration for oil in the Territory of Alaska continued, however, and in 1957 oil was discovered on the Kenai Peninsula. [1]

In 1968 after the major oil strike occurred at Prudhoe Bay on the Arctic Ocean, people were excited about such a strike in the new state. But how were they going to transport the stuff to market? Prudhoe Bay has an ice-bound coast for nearly 11 months of the year. A huge ice-breaking oil tanker *The Manhattan* sailed from the U.S. east coast through the "Northwest Passage", weaving through the islands of Canada's Northwest Territories. The ship made it, but only after being freed from thick ice by military icebreakers. Trying to get to Prudhoe that way was expensive, time-consuming, and hazardous. What if a tanker was crushed by arctic ice, spilling millions of gallons of oil in the fragile waters? A pipeline--from Prudhoe to Valdez--was promoted. The Trans-Alaska pipeline was finished in 1977.

Forty-miles west of Prudhoe Bay lies the *Kuparuk River* oil field. This field counts among the ten largest oil fields in the United States. Oil is currently flowing from Kuparuk east to Prudhoe and then down the Alaska pipeline. Exploration efforts are underway off the coast of western Alaska, in the Beaufort Sea off Alaska's North Slope and in other areas of Alaska.

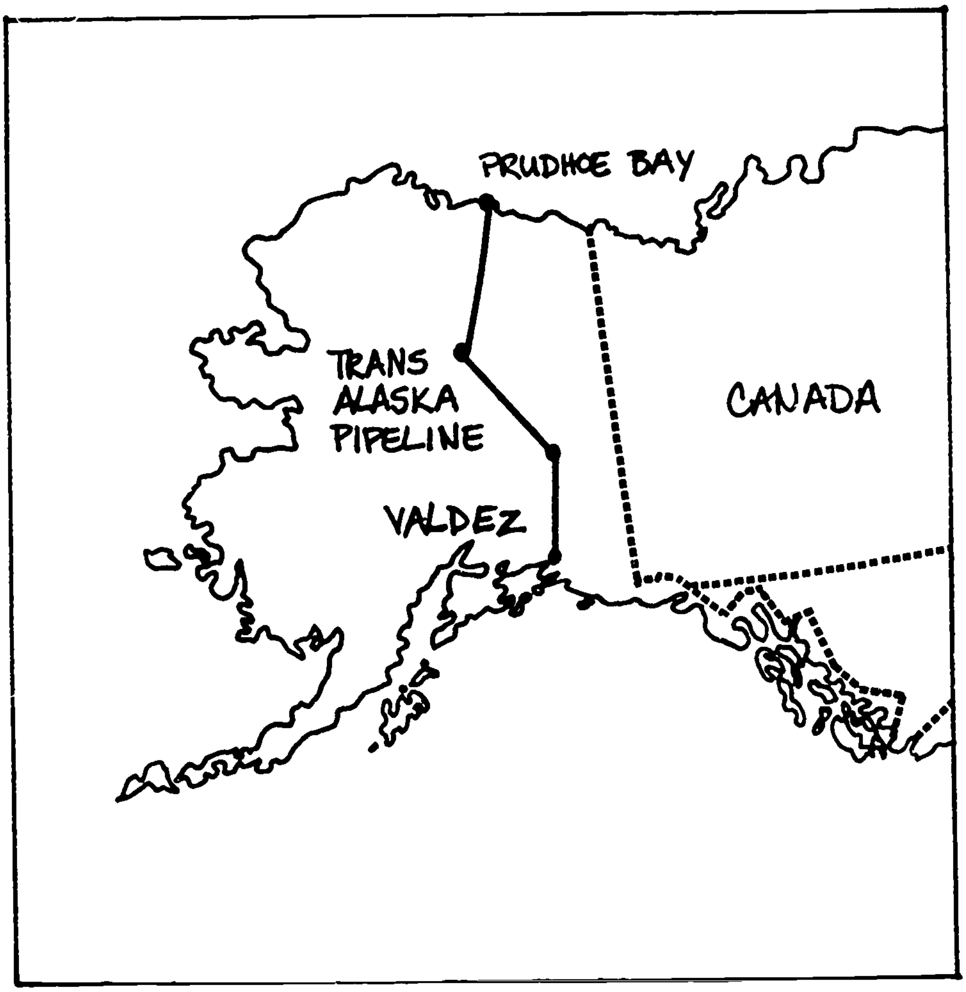
Does the oil issue in Alaska have anything to do with Native land claims?

Imagine the kinds of *royalties* (a royalty is a share of the money taken in) and taxes which derive from a major oil strike. As of 1987 it was said that the State of Alaska had taken in over $25 billion from the Prudhoe Bay strike alone! If you were a Native leader, wouldn't you want that kind of income off of your Native lands? You bet. Native organizations, the federal government and the state government are in regular negotiations over land ownership and *jurisdiction*. Obviously, each group has a different stake in the outcome of the negotiations.

What was it like when they made the pipeline?

Maybe you have seen the Trans-Alaska pipeline, or maybe you know somebody who helped construct it. The construction of the Trans-Alaska pipeline, from Prudhoe Bay on the Arctic Ocean to Valdez on the Gulf of Alaska, was one of the most significant engineering feats of modern history. Obviously with the discovery of oil on the North Slope in the late 1960's, there was a problem getting the oil to market. Additionally, there were those who felt that a pipeline all the way across Alaska (with its accompanying road) would open up and ruin the pristine character of the countryside. Native people felt they would not get their fair share of the wealth. Lawsuits slowed the development. Debates flared in Congress about selecting Alaskan lands for national parks and wildlife refuges. The rush was on.

With approval in 1973, construction camps were put in place north of the Yukon River. Perhaps you've heard tell of the camps: Yukon River, Caribou Mountain, Prospect Camp, Coldfoot, Galbraith Lake, and others. At the peak of construction, 21,600 workers were operating out of 31 construction camps along the 800 mile route. That's a lot of workers. Many (in fact most) of those workers were brought in from Outside, though many Alaskans worked on the pipeline as well. Many from Outside came into the state for the first time and have remained. Surely you've heard a story of "Pipeline Days" from one or two of them.



The Trans-Alaska pipeline, extending from Valdez to Prudhoe Bay, stretches the length of the Richardson Highway to Fairbanks. It crosses the mighty Alaska Range and Denali Fault at Isabel Pass. North of Fairbanks, where the Elliott Highway heads west to Manley, begins the Dalton Highway (known as the Haul Road), a 427-mile gravel chassis-buster driven by semi rigs hauling materials to Prudhoe. The pipeline crosses the Yukon River in a unique car-pipeline bridge with video cameras and loudspeakers placed all the way across. Then, it's the long haul--all on gravel--through the scraggly spruce forests, into the foothills of the Brooks Range, across magnificant Atigun Pass (and the Continental Divide), then the descent onto the eerie treeless plains of the North Slope. Currently, you may drive your personal vehicle as far as a check station in the Brooks Range. The drive is magnificant, though bone-jarring. But you might think as you drive; are there impacts on the landscape as a result of this achievement?

Have you visited the pipeline? It is 48 inches in diameter. More than half the line is elevated. If you've seen the pipeline, it's the elevated part you saw. Yoou obviously can't see the buried part, but you can see an area cleared of trees where the pipeline is buried, with mileposts sticking out of the ground. An Alyeska Pipeline red helicopter might rumble overhead as you walk the area. Alyeska Pipeline Service Company is the name of the company formed by eight oil companies to construct and operate the Trans-Alaska pipeline.

How do state and local regulations and taxes affect Alaskan oil development?

The State of Alaska heavily taxes the oil industry. For a decade or more, the Trans-Alaska pipeline has virtually financed the government of the State of Alaska. Local royalties, like those of the North Slope Borough, provide for the economies of that area. Like so much in life, there are several sides to the story. You might imagine that if you were a major manager in an oil company and you saw large sums of money headed out, you might want to keep those sums to manageable levels. On the other hand, if you owned a home and were financially struggling with a family, you would certainly rather some big oil company pay taxes than you.

What is your perspective? Do the oil companies pay too many taxes or too few? Do you know how much they do pay? And how do you think such taxes impact further development? Follow what happens in the newspaper. There are articles in the paper all the time about these issues.

What is going to happen to the oil and gas industry in Alaska?

Despite the high profile Alaska has received in recent times, no one knows the exact petroleum and mineral potential of the state. Vast areas of Alaska have yet to be properly assessed. Initial findings, however, show great promise in both industries in the state. You can expect to see an expanded oil and gas industry in Alaska in the years to come.

When they strike oil on the North Slope, oil is not the only substance of value which is released. Great quantities of natural gas hiss to the surface. Some of that gas is *flamed* away as waste. But happily, the bulk of that natural gas, all of it usuable clean-burning fuel is reinjected into the ground to be tapped when there is a way to get it to market. This natural gas represents considerable energy--27.3 trillion cubic feet of gas reserves at Prudhoe alone.

Recently, more talk has ensued about building a natural gas pipeline from Prudhoe Bay to the marketplace. Several scenarios have been offered for completion of that pipeline. One of them was construction of a natural gas pipeline following the Alaska pipeline and then following the Alaska Highway until it connects with interstate pipelines in the lower '48. But, alas, the lower '48 has natural gas of its own. Paying for such an expensive pipeline ($40 billion or more) just wasn't worth it. So another pipeline is proposed, to follow the Alaska pipeline, all the way to Valdez. There, natural gas would be liquified and then transported by sea to market (which just might be in Japan, Taiwan, Korea, or elsewhere). This second pipeline would be less expensive to build. Building either pipeline would provide hundreds and hundreds of jobs, many of them for Alaskans

How about nuclear power?

Alaska currently has no nuclear reactors, even though it is the largest state in the country with the most nuclear power in the world. But Alaska also has a small population. Until recent times, it was the state with the lowest population. Nuclear power plants cost a lot of money. Additionally, they are extremely controversial in terms of their safety. Some people think nuclear power is the safest and cleanest form of power available. Others see it as a time bomb waiting to go off. But don't expect nuclear power to go away. Enormous sums have been invested in nuclear plants, and frankly, nuclear power is a major producer of electricity.

In April, 1986, a major nuclear accident occurred at the Chernobyl nuclear plant about 60 miles from Kiev in the Soviet Union. This accident spewed clouds of radiation that spread over several European nations. Over thirty people died, with hundreds predicted to contact serious ailments as a result of the accident. What does this accident, the most serious yet in the still-budding nuclear power industry fortell? As with so much in commerce and development, no one knows. Suffice it to say that many people are skittish about nuclear power.

Can't energy come from wood and coal?

Of course it can. Wood and coal are "old reliables." Alaska has plenty of both. Perhaps your family heats with wood. Maybe you heat with coal. Alaska has lots. In fact, Alaska has enough wood and coal to supply its own energy needs for hundreds of years--*using just wood and coal!* Why don't we use more of it? Many consider coal a dirty fuel and wood a messy (and smoky) one. Oil is clean, burns hot, and is available. Some areas of Alaska have seen a great rise in the use of wood for heating. But it seems that all such efforts create *human impact.* For wood, the impact is often detected by the nose and eyes. Wood stove smoke pollution has become a serious problem in several communities in Alaska. Juneau has a "Wood Stove Ordinance" whereby home owners in the Mendenhall Valley are forbidden to use their wood stoves during "smoke alerts." These "smoke alerts" occur during *temperature inversions.* A temperature inversion occurs when cold air come in from above, trapping warm air below. With excessive wood smoke, that trapped air becomes polluted.

New, efficient wood stoves have reduced the *particulate matter* emitted from wood stoves. With the use of these more efficient technologies, we may see more and better wood stoves in the years to come.

1 ***The Alaska Oil & Gas Story,*** *Alaska Oil & Gas Association, Anchorage, AK, Revised January 1985.*

2 ***The World Almanac and Book of Facts,*** *Newspaper Enterprise Association, Inc., 1986, p. 146.*

Jobs in Mining and Petroleum
Teacher Page

Competency: Identify jobs in the mining industry

Tasks: Explain the job of:

a. prospector
b. geologist
c. mining engineer
d. ore processing engineer
e. placer miner
f. heavy equipment operator
g. state and federal mining regulators

Introduction

While one might see Alaska superceding Texas as the number one oil producing state, Alaska may very well be the Saudi Arabia of minerals. The state is mineral rich, and in a time when the U.S. imports many necessary minerals, those ores will gain in importance. With unresolved problems in the environmental area, however, the exact future of Alaska's mining industry is uncertain. Students need to see the importance of political and social concerns to Alaska's mineral development.

Overview

Oil is Alaska's biggest non-governmental employer. Obviously nearly all the state's revenues come from this single industry. Yet many oil developers have decried the fact that many Alaskans are not properly trained for work in this vital field. Alaskans considering work in the petroleum industry need strong background information in petroleum technology. They need specific skills. And Alaskans need to convince employers that they are as capable as anyone anywhere for petroleum work.

Alaska's mining future is bright, though tainted. The state may be on the verge of entering a new era of hard rock mining, but considerable hurdles lie in the way of large-scale operations. In fact, 1986 saw a loss in 390 mining jobs and a net decrease in 22,000 ounces of gold production, according to the state Department of Commerce.

Resources

American Petroleum Institute, 1220 L Street NW, Washington, DC 20005

Alaska Oil and Gas Association, 121 W. Fireweed Lane, Suite 207, Anchorage, AK 99503-2035 (907)272-1481

ARCO Alaska, P.O. Box 100360, Anchorage, AK 99510

Alaska Women in Mining, P.O. Box 83743, Fairbanks, AK 99701

Alyeska Pipeline Service Company, 1835 South Bragaw Street, Anchorage, AK 99512

Department of Natural Resources, Division of Mining, State of Alaska, P.O. Box 7016, Anchorage, AK 99510-7016

Exxon Oil Company, 3301 C St., Anchorage, AK 99510

Mining & Petroleum Training Service, 155 Smith Way, Soldotna, AK 99669 (907) 262-2788

Mineral Information Institute, 6565 South Dayton, Suite 3800, Englewood, CO 80111 (303)790-8291

Sierra Club, Alaska Chapter, P.O. Box 103441, Anchorage, AK 99510-3441

Sohio, A Company of Standard Oil, 101 Prospect Avenue, Cleveland, OH 44115

Jobs in Mining and Petroleum

What kind of luck would I have as a prospector?

First of all, can you drive a mule? It seems that the romantic profession of prospecter has come in for a few revisions. Sure, Alaska has its share of those who go out on the land and stake a claim, and if you visit areas like the Circle Mining District or parts of the Brooks Range, you just might find the kind of grizzled character you envisioned from a movie. But there might be a good chance that same grizzled prospector isn't making any money, which was something the movies never really emphasized either. Then, as now, mining takes investing, it takes a person or group or company with business sense, strong economic backing, and sound scientific methods. Sure, occasionally some strike it rich, and some may continue to strike it rich. But sound econmics blended with strong science and technological know-how, along with a little bit of luck would improve your chances tremendously. These days, your work as a prospector might entail technician work for a mining company or testing ore samples in a lab.

Are there jobs for geologists?

Rock hounds of the world unite! The modern world has a great appetite for minerals. The appetite is not shrinking, it is growing. There are many jobs for geologists. One must remember, though, that such a field requires a strong science, math and computer background, and a willingness to persevere in the classroom. Competition can be keen. One thing to remember is that a natural resource industry such as mining is very dependent on what happens economically. The industry chronically moves from boom to bust. Geologists may have to move repeatedly in their careers and may be faced with unemployment from time to time.

Could I make it as a placer miner?

A placer mine is one in which silt containing ore is washed through a sluice, which allows the heavier mineral particles to sink to the bottom. Alaska has a viable placer industry. The state was once invaded (peacefully) by a legion of placer miners in the days of '98. Placer miners are still around. Perhaps you know some. Perhaps you've worked at a mine site yourself. If so, you know some people to ask valuable questions. A *placer miner*--one who operates a placer mine, is an independent businessperson. As with any business, good business techniques are in order. Considerable effort is required in order to make it a go. Government paperwork, proper claim staking, permits, investments, employees, and camp stocks are all involved before you even wash that first bit of dirt.

Is there much work for heavy equipment operators in mining?

Mining involves heavy equipment operation. Profitible mines are those which utilize heavy equipment. That means bulldozers, backhoes, mechanical *sluice* devices and dump trucks. Now just because you can operate heavy equipment doesn't mean you're going to get a job in mining, but the fact you can operate the equipment sure will help. And depending on the size of the operation for which you work, skill in welding, mechanics, and hydraulics, not to mention a healthy ability as a handy person would certainly help. Many times fix-it jobs must be completed on-site. The site may be miles from the nearest road. Time means money and quick fix-its can sometimes save a lot of both.

Could I get some sort of mining job with the government?

Except in wartime (and then only rarely), the federal government doesn't mine. But federal and state governments oversee mines, and a knowledge of mining can certainly help you get a job as a mining regulator. With strict environmental protection laws and a public ever vigilant for clean air and water, there is work as a government regulator. Just ask any miner. Governments oversee mining on many levels. They check mine safety, they process mine forms, they compute statistics related to mineral output, and they assist in exploration and tabulation.

Mineral Extraction

Teacher Page

Competency: Identify mineral location and extraction techniques

Tasks: Describe mining exploration, development, and processing
Differentiate between strip, pit, tunnel, placer and evaporation mining
Explain ways of pillaring mines
Explain ways to safely deal with explosives

Introduction

Few if any school curricula in the state currently offer a course in mining techniques. Yet, statistics show employment growing in this area, with the potential for even greater employment in the decades to come. Mining employers are sensitive to the issue of Alaska hire, but Alaskans skilled as miners may be difficult to find. A solid background in the classroom, or at least an initiation to mining may help lay the groundwork for Alaskans finding the training they need. A visit to a local mine, a visit to a gem collector, jeweler, or ore shipper may help students make the connection between academic subject and job. A field trip to a placer mine or to the coal mines at Healy would greatly enhance student interest. Students might visit mines of the past and compare mining techniques then and now. They might write to mining companies.

Overview

There is a good chance that the shape and face of mining will change in the State of Alaska in the years to come. Alaska's mining present and future seems incredibly exciting and promising. Obviously much depends on world economies and political realities, but Alaska has minerals. The world needs minerals. Alaska has the sea for transportation. Minerals need a cheap method of transportation. The combination seems a perfect one.

Resources

Alaska Women in Mining, P.O. Box 83743, Fairbanks, AK 99701

Division of Mining, Department of Natural Resources, State of Alaska, P.O. Box 7016, Anchorage, AK 99510-7016

Division of Geological & Geophysical Surveys, Division of Department of Natural Resources, State of Alaska, 794 University Ave., Fairbanks, AK 99701

Diamond Shamrock Corp., 717 North Harwood St., Dallas, TX 75201

Mineral Information Institute, 6565 South Dayton, Suite 3800, Englewood, CO 80111 (303)790-8291

Mining and Metallurgical Society of America, 275 Madison Ave., New York, NY 10016

Mining & Petroleum Training Service, 155 Smith Way, Soldotna, AK 99669 (907) 262-2788

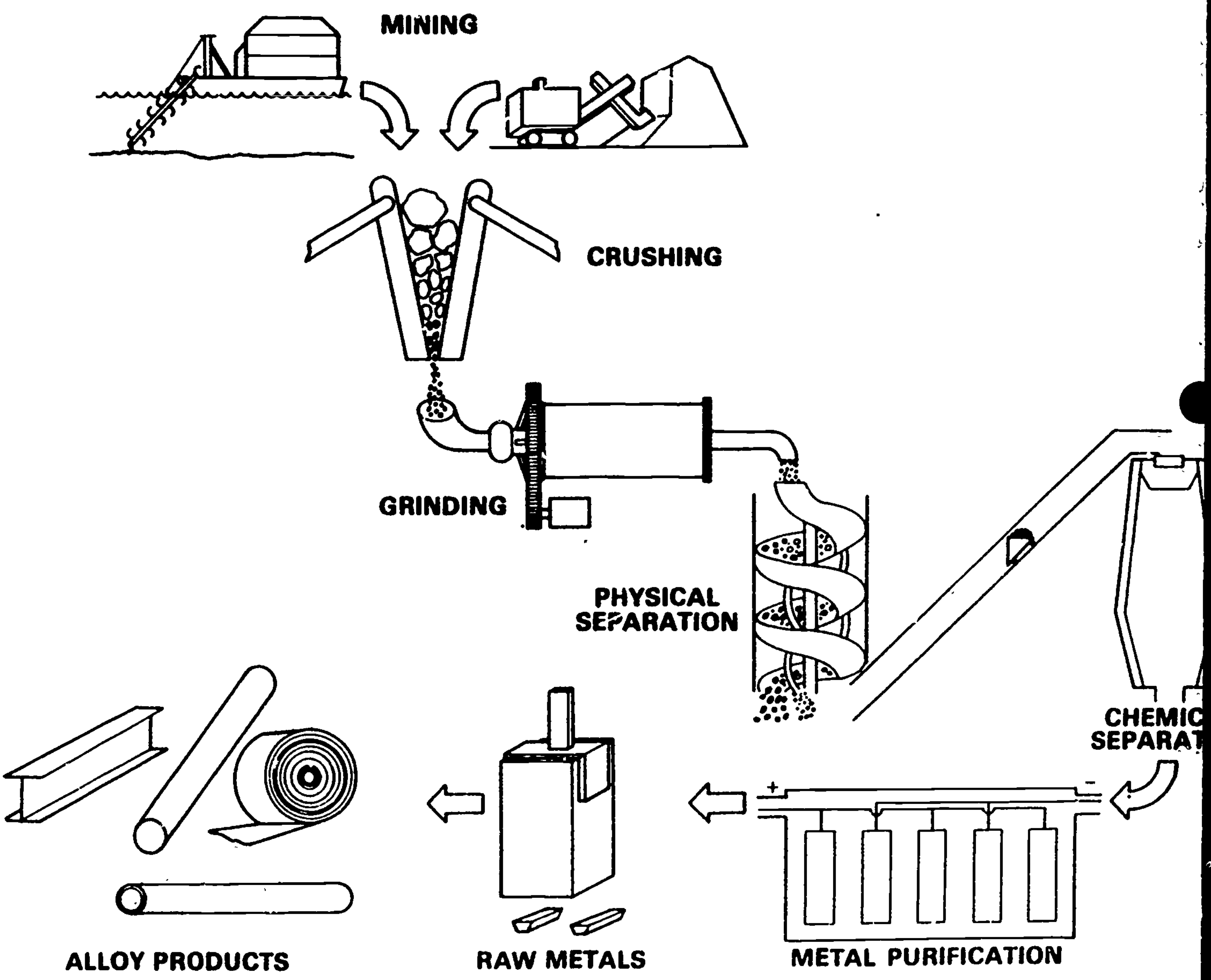
Suggested Reading

A Dictionary of Mining, Minerals, and Related Terms, Thrush, Paul W., Bureau of Mines, Dept. of the Interior, US Government Printing Office, Washington, DC

Mineral Location and Extraction Techniques

Just how do they explore for, develop and process minerals?

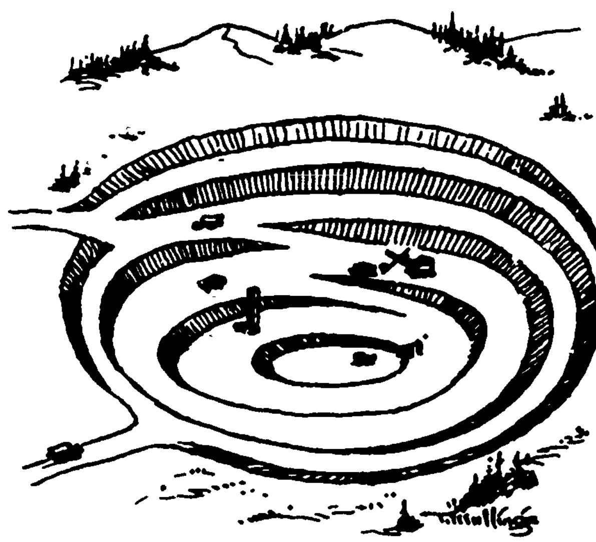
Picture the grizzleo prospectors of lure, out with their burros and sacks of flour, gold pans, picks and shovels. Alas, that image of mining may be all too close to the truth, except for the romance of the thing. Talk to a small-time Alaskan miner. That person just might tell you of the hardship, particularly in financing and planning the project, as well as government rules and regulations. But as in so may endeavors, those who persevere triumph.



Things have come a long way since the days of the grizzled prospector, in most cases. In fact there are people and places in Alaska which might fit the above scenario quite handily. But the age of high technology has hit mining with a vengeance. Obviously, if you want to find minerals you need to look in the right places, right? The hitch is how to find those right places. It is a lot cheaper to dig in five right places than to dig in a thousand wrong ones. It is also easier on the environment. This is one use of the science of geology.

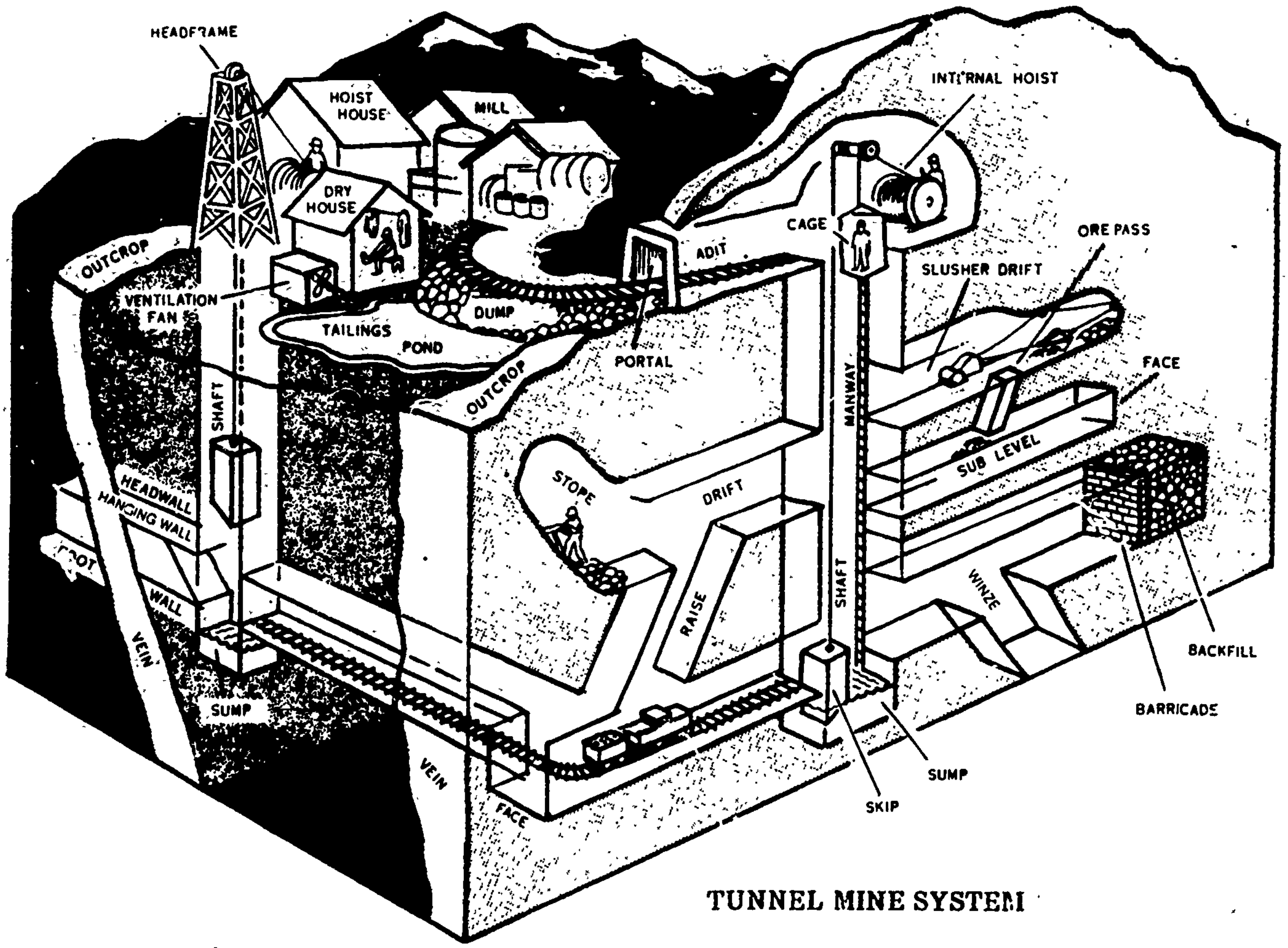
What is the difference between strip, pit, tunnel, placer and evaporation mines?

The only thing that lies between a strip miner and the mineral is a lot of dirt. In *strip mines*, the mineral (oftentimes coal) lies just beneath the topsoil and is horizontally placed. The topsoil is removed, the coal is dug, and hopefully, the topsoil is replaced. Strip mines are found in the coal-producing states of the eastern and western U.S.



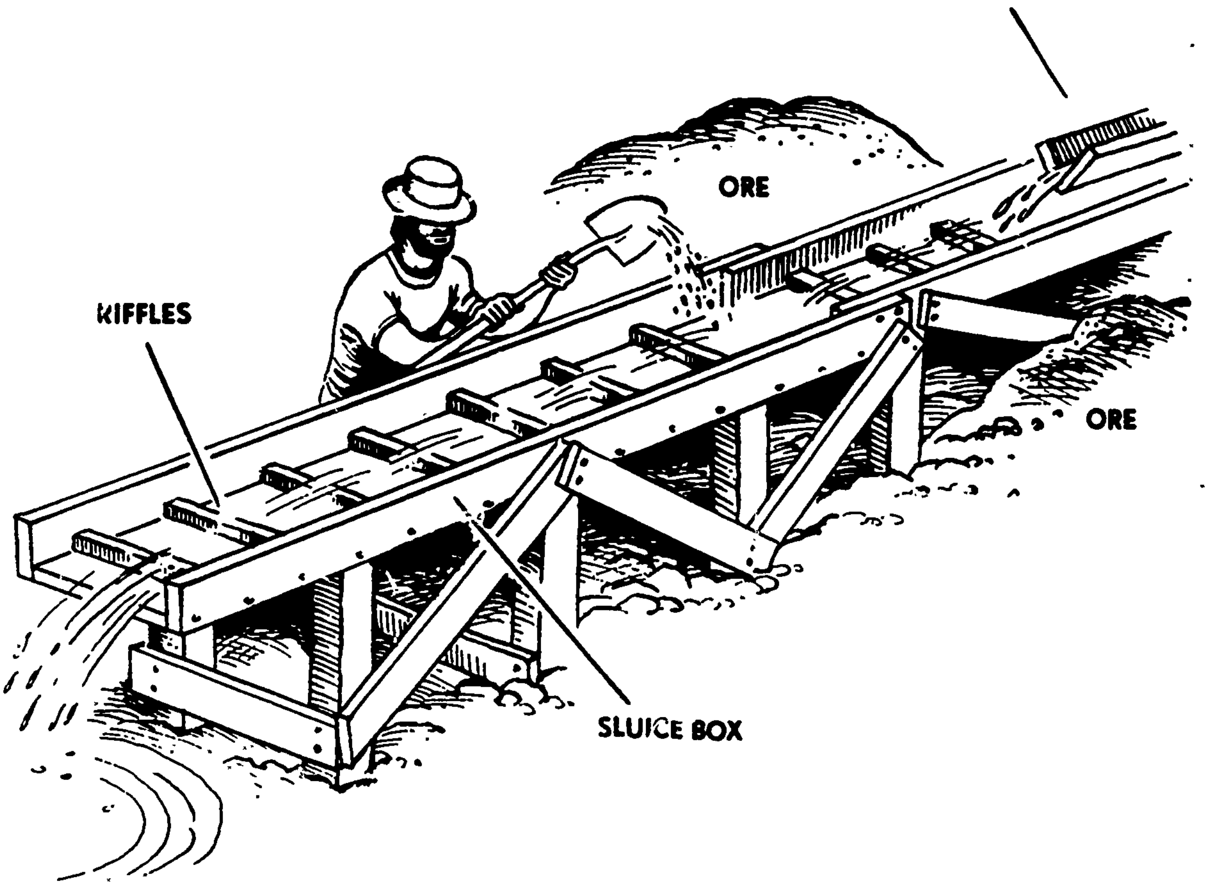
For ore that is found vertically in the earth, *pit mines* are often dug. A great pit is dug, with varying terraces or steps, which often spiral around the edge of the pit so that trucks can drive in and out of the pit. Because trucks can drive into the pit (though you can bet it's a hazardous drive around the edge of the hole), pit mines are economical for the purpose. But great quantities of material must be removed in creating the pit. That removal is not cheap.

Tunnel mines are just what they say they are--great tunnels blasted, drilled, and dug into mountainsides, or sometimes with a vertical shaft deep into the earth which then has horizontal shafts spoking out from the vertical one(s), often at many levels. Tunnel mines are expensive to dig, and hazardous to work in. Unless the mines are dug into solid rock, the roof of the shafts must often be *shorn* with timbers or steel. Shoring means bracing the roof so that it doesn't cave in. Cave ins can be disasterous. Tunnel mines have the problem of potential explosions from a buildup of gases and the problem of safe exit in case of problems. Working underground can create a host of health problems for the workers. But tunnel mines allow miners to get directly to high-quality veins of ore without having to remove the cover rock. Tunnel mines, since they lie underground, disturb the ground surface less.



TUNNEL MINE SYSTEM

Placer mines require running quantities of mineral-laden silt through a *sluice* or other device for allowing the heavier minerals to sink out of the silt. Placer mining is traditional for gold mining, possibly because gold is so heavy. Gold readily sinks to the bottom. But because placer mining must by definition stir up the silt, that silt can offend other users of the water or may damage streams and lakes.



Evaporation mines involve mineral-laden water. The water is allowed to evaporate, and presto! there's your mineral. It seems easy, and in some places on earth it is. Evaporation mining works well in hot areas with mineral-laden lakes. Utah has evaporation mines, as does Israel on the banks of the Dead Sea. Sea salt is a product of evaporation mining.

How do they keep deep-shaft mines from caving in?

Ever hear the song "Big John?" Jimmy Dean made the song popular in the early 1960's. Well, Big John was a "mountain of a man" who had killed somebody in New Orleans over a "Cajun Queen." He escaped to the mines and when there was a cave-in, John shouldered a timber with his back and saved all the miners--except himself. At the end of the song they place a plaque by the mine entrance reading:

*"At the bottom of this mine lies a big, big man--**Big John.**"*

Though his *shoring* (proping up the walls and ceiling of a mine) temporarily worked, you can see that the Big John method is a little inefficient. Though some shoring today uses steel, in many cases steel is too expensive, and timbers are still used.. Mining is hazardous work. For this reason, miners' pay is often high. Statistics show mining consistently is among the highest paying blue-collar jobs in Alaska.

How do you keep from blowing yourself up with explosives?

Obviously that's a good question. And those who can't supply the answer to that question may no longer be with us. Perhaps you were well trained as a child to recognize blasting caps and you know what those lethal little death sticks look like. Don't mess with them. If you're out somewhere and you see blasting caps leave them **BOOM!** alone. You want to keep your hands and fingers. Ask a miner about the danger of blasting caps and explosives. They'll tell you. Those who work with explosives by necessity must have training. A license is required. The explosives must be carefully handled, stored, and utilized in a safe manner. There is a science to efficient use of explosives. Those who abuse the use of these mining tools are not only subject to penalty if they abuse the priviledge, they of course can potentially kill themselves and someone else. Always know what you are doing when you work with explosives. Obtain the assistance of trained personnel. Ask the person you bought the explosives from, and remember to treat them like the loaded gun that they are.

Mining Issues
Teacher Page

Competency: Identify mining issues

Tasks: Discuss the importance of minerals to society
Trace the importance of gold to Alaska's development
Explain the reasons for building the Alaska railroad
Explain the relationship between mining and the growth of aviation and highways in Alaska
Explain how markets determine whether deposits are developed
Explain the Pacific Rim and its importance as a market for Alaska's minerals
Locate other mineral exporting nations on the Pacific Rim
Explain the competitive advantages and disadvantages of different nations on the Pacific Rim
Explain the importance of developing markets for Alaska's minerals
Name minerals imporant to Alaska's mining industry including:
a. sand and gravel
b. gold
c. coal
d. building stone
Explain the basic minerals used in building and construction, including:
a. iron
b. stone
c. gypsum
d. limestone
e. clay
Define strategic minerals
Identify mineralized areas in Alaska
Locate Alaskan seapaorts suitable for shipping minerals
Explain Alaska mineral transportation problems
Explain the importance of Alaska's coal reserves
Identify economic factors affecting marketing of minerals
Identify costs and other factors affecting choice of mining systems
Identify social and economic problems related to developing non-renewable resources
Explain environmental concerns related to mining in Alaska
Identify conflicts between mining and conservation interests

Introduction

On the Last Frontier, development versus conservation will always be an issue. The debate of development versus conservation is not an Alaskan versus "Outsider" argument--such arguments are found throughout the state, with environmentalists versus those in favor of development, Natives versus state or federal entities, newcomers versus old timers. Alaska is a dynamic state, not only in its natural resources, but in the richness of human diversity. Students need to weigh all sides of the conservation versus environmental argument, and arrive at their own conclusions.

A debate forum, or even a "public trial," with a judge, jury, prosecution and defense could present "arguments" in favor or developing or not developing a certain area. Points of the various arguments could be listed on the board or on poster paper. Let the jury and judge decide. In the end, students are deciding analogously what happens in real life.

Overview

One need not overlook the possibilities of employment in areas which are smothered in controversy. The fact that a certain area is in contention for selection or that groups are calling for greater scrutiny of a particular mine or for greater control of mining or drilling makes more jobs for those who do the surveying, deal with the accompanying paperwork, or for those who argue. Practical skills related to mining and potroleum, along with a strong background in the issues themselves will give prospective employees the edge.

Resources

Alaska Miners Association, Inc., Statewide Office, 509 West 3rd Ave., Anchorage, AK 99510

Alaska Women in Mining, P.O. Box 83743, Fairbanks, AK 99707

Circle Mining and Recording District, General Delivery, Central, AK 99730

Department of Environmental Conservation, State of Alaska, 3220 Hospital Drive, P.O. Box O (mailing), Juneau, AK 99811 (907)465-2600

Department of Natural Resources, Division of Mining, State of Alaska, P.O. Box 7016, Anchorage, AK 99510-7016

Mineral Information Institute, 6565 South Dayton, Suite 3800, Englewood, CO 80111 (303)790-8291

Placer Miners of Alaska, P.O. Box 73756, Fairbanks, AK 99707

Sierra Club, Alaska Chapter, P.O. Box 103441, Anchorage, AK 99510-3441

US Environmental Protection Agency (EPA), Alaska Operations Office, 701 C St., Box 19 (mailing), Anchorage, AK 99503 (907)271-5083

Suggested Reading

Alaska Resources Kit: Minerals, Alaska Department of Education, P.O. Box F, Juneau, AK 99811 or Engelhard Industries, 6670 Wesway, Anchorage, AK 99502

Films, Videos

Hardrock Mining in Alaska: The Searchers, Alaska Office of Mineral Development, VHS/Beta cassette. Discusses Alaska's major mineral deposits, history, mineral uses, geography, and the thoughts of various individuals involved in project develoment.

Mining Issues

What's the big deal about minerals anyway?

Put your finger on something metallic. Didn't have to look far, did you? Minerals, or products made from minerals are all around us. We use minerals in a wide range of products, from the little pieces of aluminum and steel in a hearing aid to the massive steel bridges which span bays and waterways. We burn minerals as fuel and wear them as jewelry. Nations and states small in population can wield great power because of minerals. Part of the focus on the nation of South Africa is because of her great mineral wealth. South Africa contains half the world's gold, most of the world's diamonds, and liberal shares of other minerals. Think in history of all the places and lands explored in search of gold or other minerals. How many Native peoples interacted in order to trade for minerals for shaping or carving? In fact entire periods of history have been named for products of minerals--the Iron Age, the Bronze Age.

Gold! Gold! Gold! When people think of Alaska, why do they think about gold?

If you want to know why people associate Alaska with gold, visit some of the towns and villages which were established because of that yellow metal. Take little Skagway, for example. This town, at the northern end of the inside passage of Southeast Alaska has a population of right around 500. Well, at the turn of the century, Skagway had a population of 20,000! At the time it was one of the larger cities on the west coast! People associate gold with Alaska because Alaska has gold and because gold is so flashy. Of course as a rare metal, and a metal with many uses, gold has considerable value. But also, for a long time, gold, for its own sake has fascinated humankind. Not only does evidence of the gold rushes of days gone by remind Alaskans of the importance of gold in the development of the state, but gold still plays a role in the Alaskan economy.

Did minerals have anything to do with construction of the Alaska railroad?

In fact the Alaska railroad was originally built in 1914 from Seward to Fairbanks to carry coal from the *Matanuska* and *Nenana* coal fields. Demand for coal in Fairbanks and Anchorage during World War II increased. The large military bases built in those places needed the coal for power. The demand for coal grew, and new sources of coal along the *railbelt* were sought out. So indeed, the construction of the Alaska railroad was a direct result of the need for minerals. Despite the fact that military bases in Anchorage now use natural gas for power, coal shipping by rail has a continued importance in Alaska. In 1984 a coal terminal was completed at Seward. This gigantic loading facility allowed for the export of Alaskan coal (as well as other minerals, forest products, or even grain). Coal is currently exported in 60,000-ton ships and exported to Pohang, Republic of Korea, where it is unloaded and barged to Honam. The coal is used in the 1,000--megawatt power plant owned by the KOREAN ELECTRIC POWER COMPANY (KEPCO). So if you ever see a trainload of coal headed south on the Alaska railroad, you just might be seeing something headed for Korea.

Did mining have anything to do with the growth of aviation and highways in Alaska?

Recently an arrangement was made between the Canadian government and the government of Alaska to keep the Klondike Highway, between Skagway and Whitehorse open year-round. This road, a relatively new highway, follows the historic route of the White Pass and Yukon railway route. This railway, following the historic Chilkoot and White Pass routes into Canada's Yukon and Klondike country, originated because of gold and later lead and zinc mining. Today, the Klondike highway stays open (with much snowplowing at considerable expense and effort) to allow trucks carrying lead, zinc, and sulphur ore to get to deep water ports.

Many of the first towns and villages visited by Alaska's pioneering pilots in the 20's and '30's were gold-mining communities from the gold rushes of the turn of the century. Tales are still told of the impact of that first airplane on the adults and children in mining communities like Wiseman in the Brooks Range or Nome on the Seward Peninsula. Mining--particularly gold mining--was the reason for the establishment of many villages in such far away places in Alaska. The need for ready mail service, passenger service, emergency medicine, or simply the need for spare parts provided the need for what has become a rich aviation history.

How important is financing in determining whether or not a mine is developed?

In very few cases today is developing a mine a matter of going out with a pick and shovel and hitting paydirt. Today, to make a mine profitable, heavy equipment is required. Heavy equipment--backhoes, bulldozers, and dredges all cost plenty. And a mine site must have housing and sanitation for people, not to mention ways to protect water quality. Mines are expensive.

Usually, when people want to develop a particular site, they have to *assess* the site to prove that it is a *valid* claim. That assessment must be filed annually with the federal government if the mine is on public land. Many mines are on public land, especially in Alaska, where over 90% of the land is owned by the government. In order to mine, the miner must prove that there is something valuable there. Some mines are *patented*. A patented claim means that the miner not only has the right to mine that area, but also that the miner has actual deed to the land. It's the same as owning the land.

When the miner has completed all the necessary paperwork (and there is lots of it), the miner then can seek funding. Some miners bankroll their operations themselves. Some obtain limited partners who invest in the business. Some sell stock and incorporate their business. Most of them borrow money from the bank.

Can Alaska sell its minerals in the Pacific Rim?

Alaska already is selling minerals on the Pacific Rim. Coal is being shipped to Korea and may go to Japan and other countries. Oil from Cook Inlet can now be sold in the Far East.

However, because of Alaska's remoteness, relative lack of development, and harsh conditions, in many cases Alaskan minerals are more expensive than those from other places. For example, Australia is a direct competitor with Alaska for selling coal to Pacific Rim markets. Canada also competes. But Alaska has some advantages over other sellers. For example, the round-trip voyage between Alaska and the Republic of Korea is 36 days by ship (26 days cruising) versus 45 days between Australia and the Republic of Korea. The sheer abundance of Alaskan minerals may give Alaska an edge, but that edge has not been realized as of yet.

What other areas on the Pacific Rim are mineral-rich?

Get an atlas and take a look at the huge expanse of the Pacific Ocean. Follow the Canadian coastline to the long West Coast of the United States. Find San Francisco. Follow down to Mexico's Baja Peninsula, then along the many nations of Central America. Find Nicaragua and the Panama Canal. Look at the long coastline of South America--Columbia, Ecuador, Peru, and Chile on the southeast. Trace across the wide expanse of water, noting the neglected continent Antarctica, past Easter and Pitcairn islands to the nations of New Zealand and Australia. Follow up through the 15,000 islands of the archipelago of Indonesia (Java, Indonesia's main island, is the most crowded place on earth), past Malaysia, to Vietnam. Trace over to the Philippines then up to Taiwan, the Republic of China. Follow the coast of the People's Republic of China to the Koreas, then over to Japan. Follow Japan to the sea of Oknotsk in Siberia, then over to the Bering Sea. Notice how Alaska caps this enormous area. Truly the Pacific Rim involves varied and differing places.

The Soviet Union's Siberia, several times the size of Alaska, has great mineral potential. China, with one fifth of the world's population, while having enormous mineral needs of its own, is certainly not lacking in mineral wealth. Australia is mineral-rich, as are certain islands of the South Pacific and certain areas of South and Central American, not to mention the American and Canadian west. But the Pacific Rim is the fastest-growing area economically in the world. The needs are great. The markets are there.

What area has the competitive advantage in the Pacific Rim?

As with other industries, the area with the competitive advantage might be the one with the most desirable products, the easiest proximity to markets, the greatest control of costs, and the most efficient methods. A factor very important in competitiveness is the relative value of national currency. Most of the industrialized world's currencies are allowed to "float" in international markets. That means that the value of the dollar is measured in terms of other currencies. Sometimes the dollar is ranked (and traded) as very valuable in terms of other currencies. It may seem odd, but not everybody celebrates when their currency is considered worth a lot more than somebody else's. When the dollar is high, that means you can buy more of other people's goods with that dollar, but it also means that they can buy less of yours. If you live in a place dependent on exports, your goods are priced right out of the market. Such is the case when the U.S. dollar is high in relation to other currencies.

What's the big deal about developing markets for minerals?

Markets mean potential sales. Potential sales mean trade and exports and a rise in income and standard of living. How would you like to get a job when you graduate? How would you like that job to be a high-paying job with a future? That's the big deal about developing markets for minerals. Markets mean sales and sales mean jobs.

Trade makes nations rich. Those who supply goods or services in an efficient, kindly manner are often those which profit. Sometimes the way you succeed in business personally can be seen as the way nations can benefit internationally. Minerals need markets. Markets need customers. Customers need service.

What are the most important minerals in Alaska?

It depends on what is thought of as important. Since our economy is largely fueled by oil and oil products, one might say oil is the most important mineral. For centuries the focus in minerals was gold, and indeed, gold has played an important role in the development of Alaska. But in Alaska the value of sand and gravel produced in a recent year was nearly twice the value of gold produced and nearly three times the value of coal produced.

Alaska has a number of strategic minerals. These minerals are needed in times of war. One mine in Alaska, for example, contains nearly 10% of the free world's molybdenum, a metal important in making jet engines.

What are the minerals needed in building and construction?

Ironically the most important minerals in terms of dollar value in the United States are sand and gravel. Sand and gravel are used in building. Think of all the uses for crushed rock--from the road you drive on to the cement in the foundation in your house. Sand and gravel are big business.

Because sand and gravel are so heavy and in such great demand for building, they are seldom transported distances equivalent to that of other minerals. So sand and gravel typically are mined as close to construction sites as possible. You can often see sand and gravel mines off to one side of a highway project every few miles or so. Towns are sometimes located far from adequate sources of sand and gravel. When that is the case, the materials are brought in from great distances. For example, the Kuskokwim Delta in Southwestern Alaska lacks adequate rock for foundations, airstrips, roads, or to halt erosion of the banks of the Kuskokwim River at Bethel. Gravel is brought in from Goodnews Bay and granite has been barged as far away as from Valdez. What a long way to bring rocks!

Obviously houses use steel, and of course large buildings do too. Steel is made from iron ore and coke (a derivitive of coal). Though Alaska has great quantities of coal, the state is not known for commercial mining of iron ore. Most of the iron ore used in making steel in the U.S. comes from the massive iron deposits in Minnesota near Lake Superior.

Clay, mixed with water is fired in kilns to make bricks. Special clays, mixed with water, allow cement to set. Gypsum is a fire-resistant ingredient of sheetrock, the familiar wallboard of houses. Fiberglass, used in home insulation, is made of spun glass fibers. Class comes from silicon, sand: another mineral product. So many parts of our houses come out of the ground.

What are strategic minerals?

The dictionary defines "strategic" as:

1. *Of or pertaining to strategy.*
2. *Essential to the effective conduct of war.*

Strategic minerals are those which are needed to conduct a war. Though it's certainly a grisly thought and one which some folks don't like to consider, nations plan for shortages in times of war. The minerals needed to conduct a war would certainly include those which make steel lightweight and strong. Lightweight, strong steel allows jet engines to whir and jet airframes to lift. Strategic minerals include:

cobalt--used in jet engine parts; the U.S. imports 92% of its needs.

columbium--used in pipeline steels for transporting oil and gas and in structural steels; the U.S. imports 100% of its needs.

chromium--used in chemical and metallurgical; the U.S. imports 82% of its needs.

nickel--used in the iron and steel, chemical and space industries; the U.S. imports 78% of its needs.

platinum--used in aircraft parts; the U.S. imports 98% of its needs.

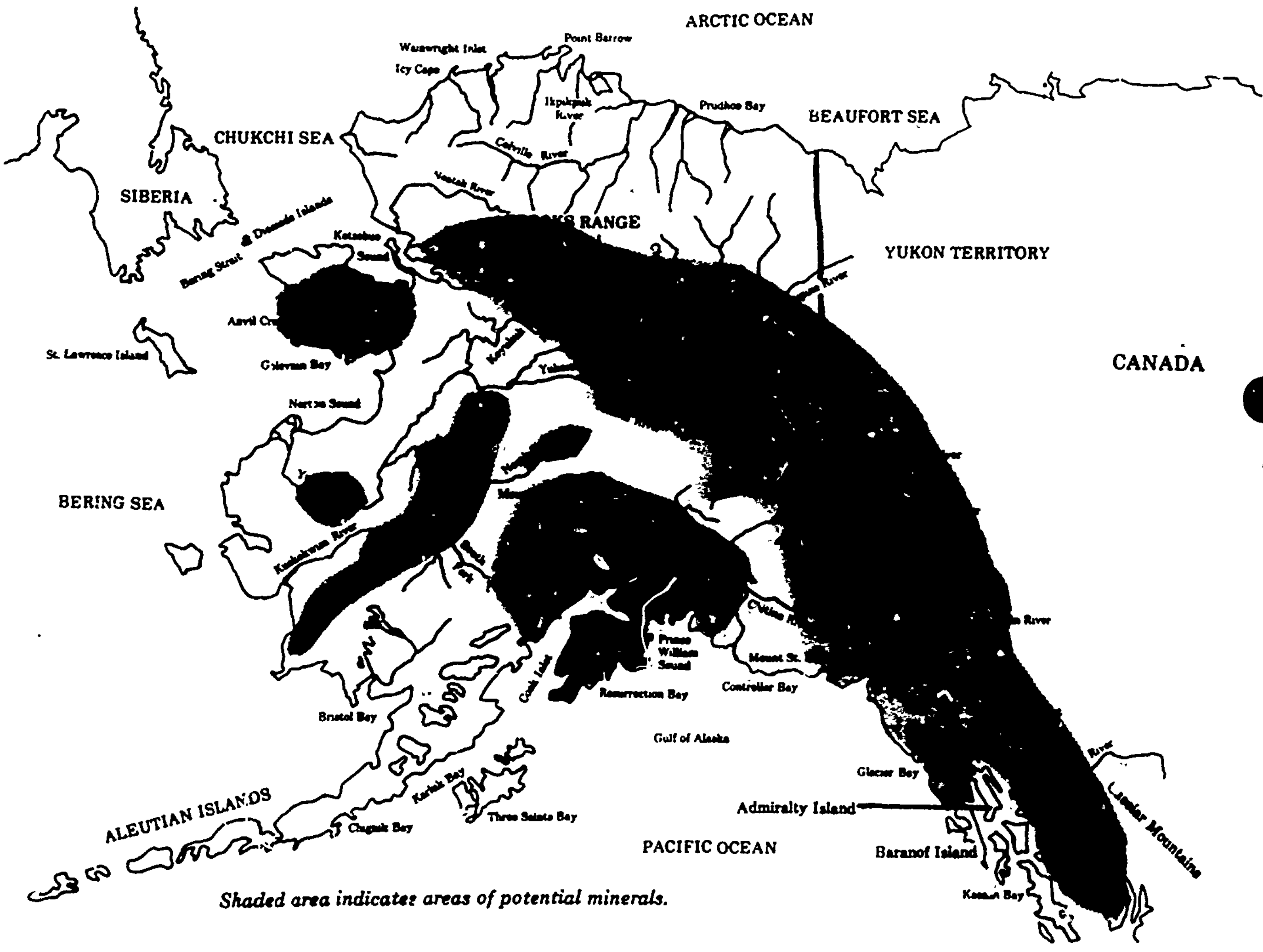
tantalum--used in electrical components and machinery; the U.S. imports 91% of its needs.

titanium--used in jet engines, airframes, and for space and missile applications.

The United States has scant quantities of these strategic minerals. Most of the world's reserves of these are found in the USSR, South Africa, Zimbabwe, and other countries. Can you see why a vigilant nation such as the U.S. gets uneasy when it comes to strategic minerals? Though the U.S. maintains a stockpile of strategic minerals, relations with South Africa and the Soviet Union are strained. Trade can be interrupted or halted.

Where are the mineralized areas in Alaska?

There is no single mineralized area in Alaska. As a place of great geological forces--great earthquake faults, volcanos, giant mountain ranges, enormous glaciers, and prehistoric seas, the state has a wide range of mineral resources. From the copper deposits of the Alaskan peninsula, to the gold and silver projects on Prince of Wales Island, to the prospects for coal in the Selawik Hills, to the Red Dog zinc mine, to the North Slope coal, to the gold mines of the Circle Mining District, Alaska *is* mineralized.



Shaded area indicates areas of potential minerals.

According to Robert B. Forbes of the Alaska Division of Geological & Geophysical Surveys the most promising Alaskan mineral projects include the Quartz Hill molybdenum deposit near Ketchikan (molybdenum is an alloy metal used as a hardening agent in steel), the Greens Creek copper-lead-zinc-silver-gold deposit on Admiralty Island in Southeast Alaska, and the Red Dog zinc-lead-silver-barite mine, north of Kotzebue. It is said that the Quartz Hill depost of molybdenum contains about 10% of the free world's known reserves of the metal.

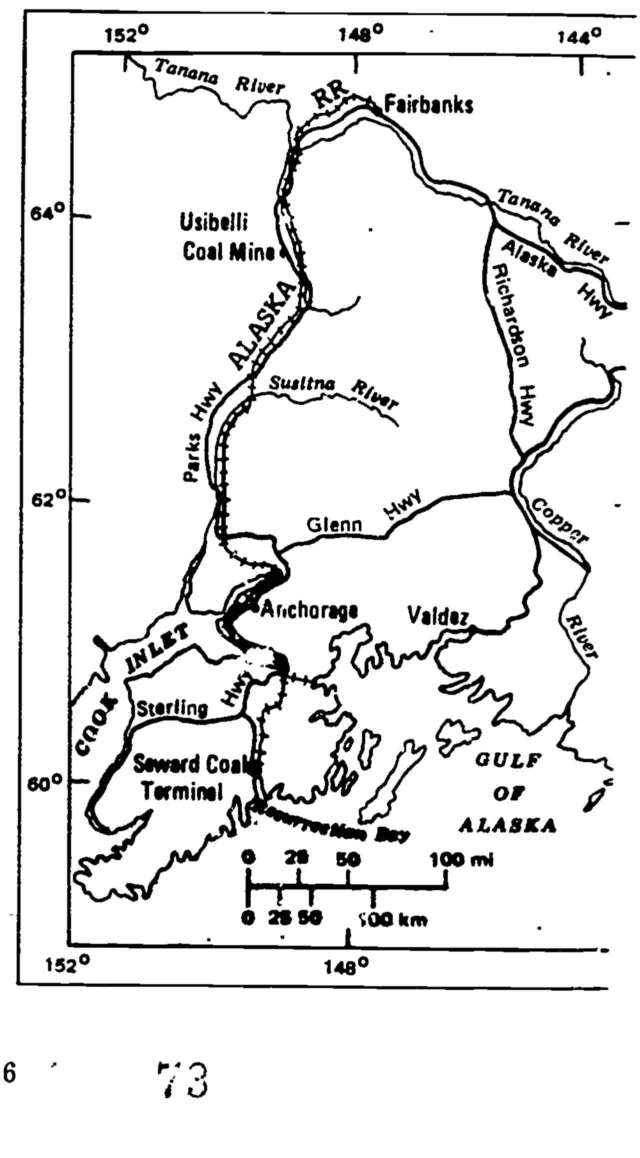
Where can the minerals be shipped from?

Shipping Alaska's minerals requires deep water ports. Such ports need docking facilities for large ships (those 60,000 dead-weight tons (dwt) in size and larger). Shipping in large ships means lower transportation costs and resulting lower costs for Alaska's mineral products. Just after the turn of the century, to support a major copper strike on the Copper River at McCarthy and Kennicott, a railroad was constructed from Cordova to McCarthy. This Copper River railroad no longer operates and Kennicott is a ghost town. Since no railroad extends from Alaska to the lower 48 through Canada, and since the Alaska Highway is so long and shipping on that highway would be prohibitively expensive, Alaskan minerals must be taken to deep water seaports. The state, with over 35,000 miles of coastline has plenty of natural harbors, but roads and railways to the coast and docking facilities would have to be utilized, built or upgraded to ship Alaska's mineral wealth.

For the Red-Dog mine in Alaska's northern region, a 57-mile haul road and port facility will allow shipping of the ore. Unless and until Alaska is linked Outside by rail, Alaskan minerals will be shipped by sea.

Are there problems in transporting these minerals?

It depends on where the minerals are. Obviously with much of the state lacking interconnecting roads or railways or major seaports, there are definite problems in moving the minerals. The Alaska Railroad extends from Fairbanks to Seward, with a sideline to Whittier. The railroad is accessible to the railbelt and those areas connecting the railway by road. Most of the state is not accessible by either. The only major road connecting the state to the outside world, the Alaska Highway, is long and hardly a feasible means for shipping heavy loads. Roads and seaports are required to move minerals to market. For the Red Dog mine, north of Kotzebue, a 52-mile road and a major seaport is needed. The sea is frozen there for a good part of the year. Large precipitous mountains may stand in the way. The route for roads may cross federally-designated wilderness or valuable Native lands. Alaska is far from markets for many products.



Does Alaska have a lot of coal?

As the state Office of Mineral Development stated in 1985: "the extensive bituminous and subbituminous coal resources that underlie Alaska's North Slope may be greater than those of any single province in the world." [1] Eureka! Alaska has coal varying in grades and location. From the Bering River, east of Cordova, to the Beluga field just west of Anchorage, to the fields of Healy and the Alaska Range, to the massive coal fields of the North Slope, Alaska has coal. Coal is perhaps Alaska's most under-utilized resource. In fact Alaska has enough coal to supply the U.S. energy needs at present consumption levels, for centuries. But of course the problem with that mineral, as with other minerals, is location, transportation to market, and price.

What determines where we can sell minerals?

It usually depends on who wants to buy them. But not always. Take crude oil for example. When the Alaska pipeline was constructed, legislation was passed in the U.S. Congress forbidding the export of North Slope crude oil. This legislation was enacted to guarantee that Alaskan North Slope oil stayed in the U.S. Additionally, the U.S. government might have laws prohibiting export of certain other minerals to certain other countries. Take uranium for example. Uranium can be used to make nuclear weapons, so there are laws about who can buy it.

Are some kinds of mining just too expensive to try?

Many places in Alaska contain valuable minerals. Not all of those places are in areas open for mining. Many of the areas open to mining are in areas too expensive for cost-effective mining by current means. Take the world-class gold mines around Juneau and Douglas, for example. At the turn of the century the Treadwell mines in Douglas were the world's greatest gold mines. Though considerable quantities of the yellow metal came out of the Juneau and Douglas mines, mine flooding and manpower needs during World War II led to their closure. The ore remains. Low world gold prices, however, have made gold there too expensive to pursue.

Environmental regulations add costs to mineral extraction. Reclaiming land, that is adding back topsoil after strip mining (a technique in which the top layers of soil is removed to expose the ore), and reseeding the areas, costs a lot. The construction of settling ponds, regular water testing, buying special equipment which won't damage the tundra when driving across it, and yearly assessment work all cost money. Many miners complain about all the costs and expenses. Many mines are closed because of the restricting regulations.

Does mining certain areas mess up peoples and cultures?

Mining itself cannot be said to mess up peoples and cultures. But mines can bring in money, employment, and construction. New developments might lure in outsiders to high-paying jobs. Anytime groups of people from varying backgrounds come together there can be drastic changes. Add high wages, and complicating factors such as quick changes in lifestyles or a rise in the use of alcohol can occur. Those who live near major mineral discoveries need to consider the impacts of development. But on the other hand, mineral development can provide employment. It can provide a tax base which allows basic and supplemental services to all residents. Health clinics may be built in villages, subsistence users might find a cash-paying job, schools might find funding for special projects.

Does mining ruin the environment?

Some mining--strip mining without reclaimation--can be said to ruin the environment. Placer mining can release large quantities of silt into waterways. In an era of environmental consciousness, that silt can be seen as endangering to health in areas downstream. The silt can be seen as environmentally damaging. Placer miners find gold by washing silt through a sluice. With enough action, the silt is continually stirred up, letting the heavier gold sink to the bottom. Massive amounts of silt are pushed through the sluice to maximize the possibility of finding gold. Since the sluice is designed to suspend as much silt as possible in the water, the sluice, by definition, muddies the water. By today's laws, placer miners must construct *settling ponds* where the suspended silt is allowed to settle to the bottom once again. But of course such settling ponds themselves quickly silt up, and heavy rains can burst restraining dams and dikes, allowing great quantities of silt into streams. Villages downstream may complain.

Who's right--the miners or the conservationists?

There are no quick and easy answers. If you're a miner, you might believe miners are right, if you're a conservationist, you might be convinced the you are right. Whatever the case, you can bet that mining is a very controversial subject, probably because in order to mine, you have to remove the material the minerial is imbedded in or covered by. Minerals are often located in spectacularly scenic or wildly remote areas. Mines bring changes.

The federal Clean Water Act and regulations of the Environmental Protection Agency can retard mining development, especially of placer mining. Miners are required to meet *turbidity* (turbidity means cloudiness in the water) standards. Clean water may always be an issue with mining. Inherently mining disturbs the ground. Some argue for relaxing clean water standards. Some opt for new technology which reduces environmental disturbance. Some opt for less consumerism, lower population growth, conservation, and recycling to reduce the need for the resource. Mining issues are human issues.

[1] ***Alaska's Mineral Industry, 1985***, *Office of Mineral Development, Division of Mining, Diivision of Geological & Geophysical Surveys, Special Report 39, 1985, p. 5.*

Communications

Computer Communications Methods and Systems

Teacher Page

Competency: Identify computer communications methods and systems

Tasks:
- Differentiate among several types of computers
- Explain computer terms and principles
- Contrast methods of electronic storage
- Explain magnetic tape use in printed communications
- Explain facsimile machines and optical scanners
- Discuss the impact of computers on communication
- Explain ways computers "talk" to each other
- Explain how a dot matrix printer produces a letter
- List jobs in computer communications
- Describe historical developments in electron generation
- Contrast electronic input and output devices
- Describe simple communication systems linking people to people, people to machines, machines to machines, and machines to people
- (A) Discuss electrical theory, control, and transmission as they relate to electrical applications in telecommunications
- (A) Discuss basic elements of electronic telecommunications such as: semi-conductors, integrated circuits, and computer circuits
- (A) Describe basic principles of acoustical communication, electronic telecommunication, and computer information storage and retrieval systems
- (A) Identify major developments in telecommunication technologies
- (A) Describe the operation of major components used in various telecommunications systems

Introduction

Obviously the watchword of the field of telecommunications is computers. Computers save time, money, and are able to go through the complex calculations which involve the coordination of ground electronics, satellites, and receiving stations. Though such equipment becomes ever more complex, with miniaturization it becomes, in a way, more simple. In this area fast developments are underway. Because of the high stakes and because of the lucrative rewards, companies in this field have numerous and useful publications, posters, and even pet names for their projects. Alascom, RCA, The American Radio Relay League, and other companies have information on specific satellites which they use.

Overview

Jobs involving the use of computers in telecommunications might involve technician work installing and repairing transmission and receiving equipment. Whatever the position, an overview of the field of telecommunications will greatly help the applicant in finding and keeping work.

Resources

American Radio Relay League, 225 Main St., Newington, CT 06111

AT&T Bell Laboratories, 101 J.F. Kennedy Pkwy, Short Hills, NJ 07078

The AT&T InfoQuest Center, *"Secondary School Curriculum Guide"*, 550 Madison Avenue New York, NY 10022 (212) 605-5140

Educational Technology Publications, 720 Palisade Avenue, Englewood Cliffs, NJ 07632 (201) 871-4007

European Space Agency/Information Retrieval Service, Via Galileo Galilei, C.P. 64 00044 Frascati, Italy (06) 94011

Federal Communications Commission, Satellite Radio Branch, Washington, DC 20554

International Radio and Television Society, 420 N. Lexington Ave., New York, NY 10170

International Telecommunications Satellite Organization (INTELSAT), 3400 International Drive NW, Washington, DC 20008 (202) 944-6800

Motorola Communications and Electronics, Inc., Public Relations Office, 1309 E. Algonquin Rd., Schaumberg, IL 60194

NASA Headquarters, Public Information, Washington, DC 20546

National Computer Graphics Association, 2722 Merrilee Drive, Suite 200, Fairfax, VA 22031 (703) 698-9600

RCA News & Information, Commercial Communications Systems, Government Systems, Route 38, Bldg. 206-1, Cherry Hill, NJ 08358

Space Education Assocation, 746 Turnpike Road, Elizabethtown, PA 17022

Suggested Reading

Build a Personal Earth Station for Worldwide Satellite TV Reception. Blue Ridge Summit, PA Tab Books, 1982

Communications and the World of the Future. H. Hwellman, M. Evans, NY, 1975

Telecommunications in the World 2000, I.B. Singh, Ablex Publishing Corp., Norwood, NJ, 1983

Telecommunicatios Tomorrow. American Telephone and Telegraph Co., Public Relations Office 10 Canal St., Chicago, IL 60606

Films/Filmstrips

"Faith in Numbers (Connection Series)," 60 min. Free Loan. Historical connection resulted in development of the computer and can help us anticipate future events. Illinois Bell Film Library, HQ 4 H, 225 W. Randolph, Chicago, IL 60606.

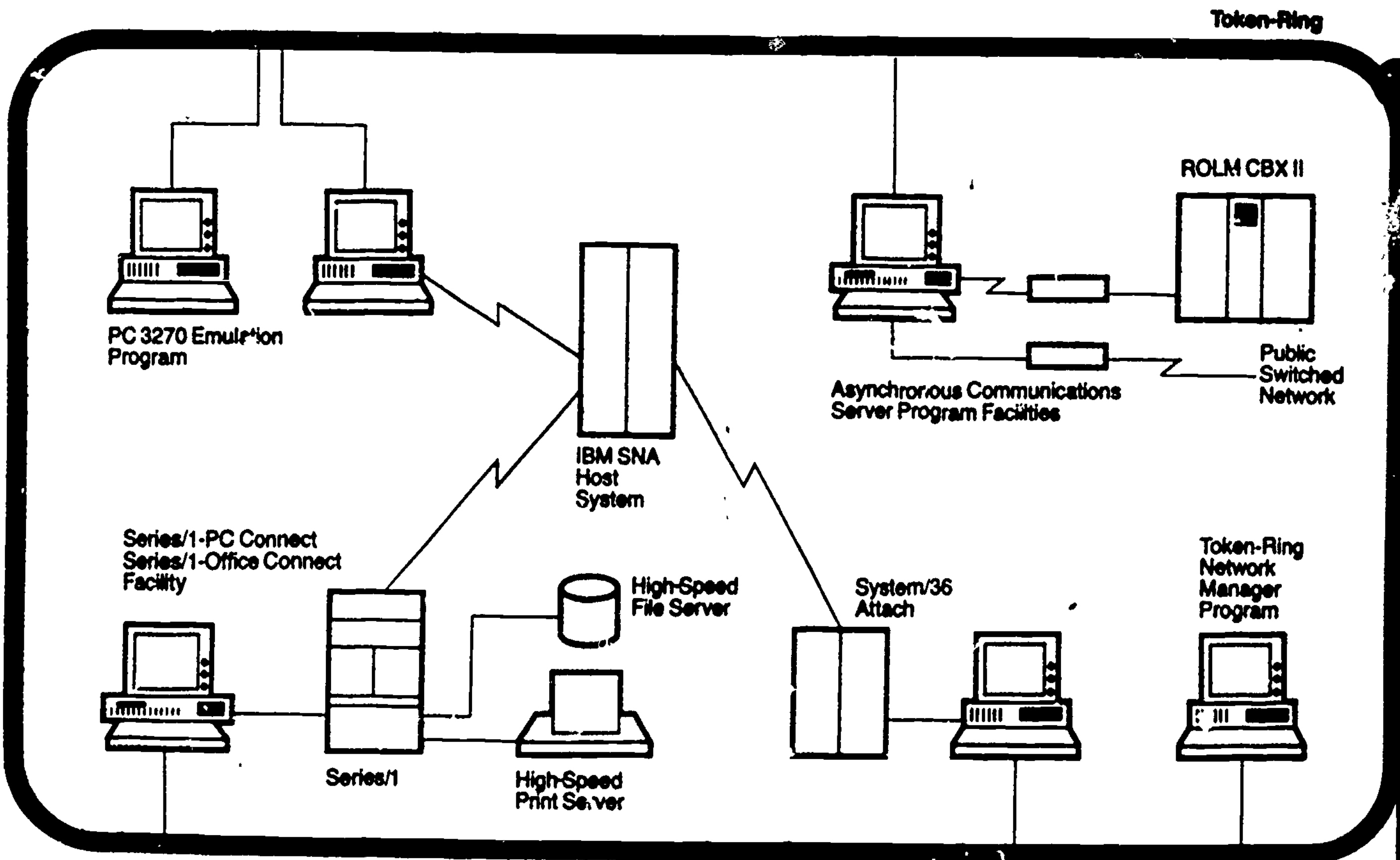
"Why Communications Satellites?" 12 min., FSC-1067. $7.75. Using animation and live action photography, the need for satellites in in distance radio and television communications is explained. Indiand University Audio Visual Center, Bloomington, IN 47405.

Computer Communications Methods and Systems

What are some different kinds of computers?

Just about anyone in school today (in the USA) has used a computer. What you have probably used is a *microcomputer*. Sometimes microcomputers are called *personal computers* or PC's. Many people have PC's at home. In fact, this text was typed on an *Apple Macintosh Plus™* PC. But the "computer revolution" is a comparatively recent phenomenon. Despite the fact that computers as we know them were developed in comparatively recent times (after the Second World War), this whole idea of comptuers in homes and computers in classrooms has happened in the late '70's and '80's. You're lucky to be living in such exciting times! How would you like to be scratching your lessons on a slate or computing your algebra using an abacus? (Many people in the world still do both.)

Divide the computer world into the following: *microcomputers, minicomputers,* and *mainframe computers*. Now that wasn't so hard, was it? This division of the world of computers is based on the size of the machines as well as what they can do. Some mainframe computers which can complete millions of calculations in fractions of seconds are called--you guessed it--*super computers*.



Do I need to know basic computer terms and principles?

Yes. Yes. Yes. Know *at least* the following:

ASCII--American Standard Code for Information exchange. A 7-bit code to represent alphanumeric characters
bit--unit of computer information (comes from "binary digit"). Always has the value of "0" or "1"
byte--the base two number system in which the only allowable digits are "0" or "1"
chip--an integrated circuit
component--constituent part
integrated circuit (i.c.)--tiny complex of electrical components, made of semiconductor materials
K--means "kilobyte"--1,024 units of stored matter
micro-chip--small integrated circuit, a memory chip
microprocessor--computer processor wholly contained on an integrated circuit chip
modem--short for "modulating, demodulating." Transmits and receives information to and from other computers by telephone
RAM--random access memory
ROM--read only memory
software--a computer program detailing proper procedure
terminal--work station away from the main computer that allows several people access to a single, main computer
transistor--electronic device made up of a semiconductor and at least three electrodes
wafer--thin slice of silicon used as a base for electronic microchips [1]

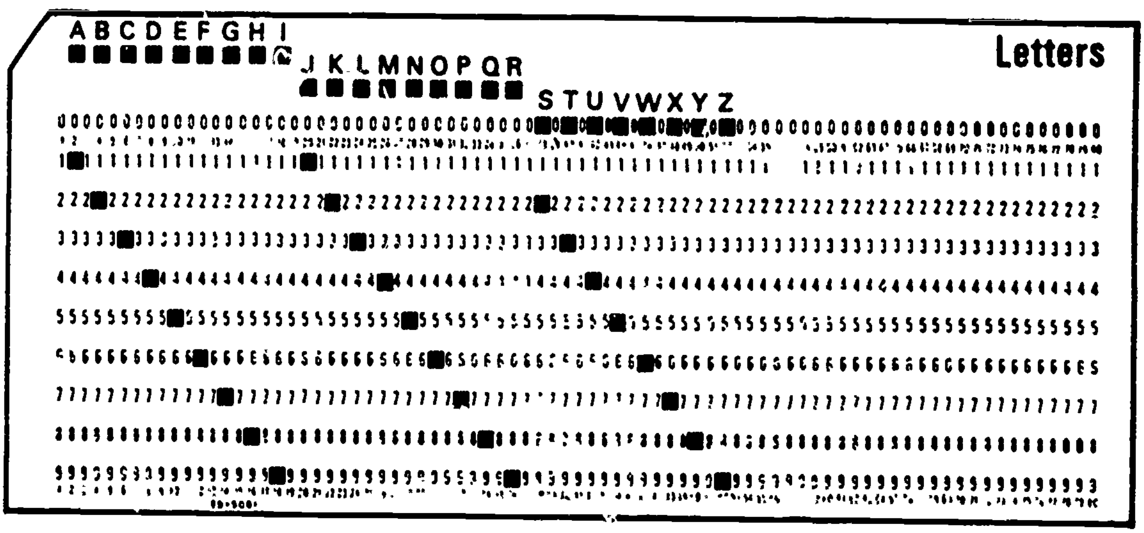
How is information stored electronically?

Let's see...you push this button while holding this one down. That's it! You've saved the material! But what is the concept behind that saving? That is the question.

Computers store information in binary code. That means computers store all information as either a "1" or a "0". Hard to believe complex mathematical computations or digitalized photographs could be reduced to such simplicity, eh? If you figure out all the two place-holder combinations of 1's and 0's (10, 01, 11, 00), you see that there are not enough combinations to represent the alphabet, the numbers, and punctuation. Each letter or number thus, is usually represented by a group of eight *bits* called a *byte*. The memory of small computers hold up to 512,000 bytes. Many times, when referring to computer memory, the zeros are represented by the letter K. So a computer is said to have 128K or 256K or 512K.

Computers have two types of memory. One type, **ROM**, is a set of permanent instructions telling the computer how to work. ROM, stands for "Read Only Memory." The computer can only *read* ROM. The other type of computer memory is **RAM**, which stands for "Random Access Memory." In RAM, the computer stores all the data and instructions it receives from the input. The computer also stores all the changes a person makes on the screen in RAM. But RAM disappears when the computer is turned off. That is why memory is stored outside the computer --on cards, on tape, on floppy discs, or on laser discs.

No computer can hold all the information it needs or that is needed for the computer to process. With some computers, information is stored outside of the computer on punched cards. Punched cards allow the computer to "read" the holes (each hole representing a binary "1"), and thus to store and process information. The use of punched cards for computers is not new. In fact, the 1890 U.S. census was completed using punched cards. Some numerical control machines (which are actually computers) control the actions of machines with paper tape. Some small personal computers store information on cassette tapes. In a much larger version of the same concept, large mainframe computers store information on reels of magnetic tape. Considerably more familiar, perhaps, are the 5 1/2-inch *floppy discs*. These plastic discs have magnetically sensitive surfaces. The circular disc encased in the plastic sleeve is coated with--of all things--rust. The advantage of floppies over tapes is that the computer can access bits of data from anywhere on the disc, versus stacks of cards or tapes, which have to be run from the beginning. The latest development in the world of outside computer memory is laser discs. Bits of plastic upon which binary code is stored as microscopic pits to be "read" by a laser beam, laser discs can hold up to 80 million words! That's as much as all the volumes of a major enclyclopaedia!



What are facsimile machines and optical scanners?

Doesn't it seem odd that with all the fancy electronic devices so much in use that people still fold paper, put it in envelopes, put a stamp on the envelope, and physically drop those envelopes in mailboxes? Then the mail deliverer has to come by in a truck, pick up the envelope, put it in a satchel, carry it around, it's sorted at the office, then physically sent to some home or office. It can take days (or weeks) to get there. We've all heard horror stories about delays at the post office.

Facsimile machines change all that. Rather than physically sending a letter across the country or across the world, a facimile machine makes a copy of the letter (like a Xerox copy), and it is that electronic image which is sent--electronically. Instantaneously, on another facimile machine in another place, a copy of that document appears. No envelopes, no stamps, no post person. In fact, great newspapers in the world are currently produced simultaneously in a number of places by facimile machines. That's how you can read Sunday's **New York Times** in Anchorage on Sunday. (It's produced in Los Angeles and brought up by jet.)

Optical scanners allow a computer to "read" images or word. Much work in offices involves simply "keying" something which has already been typed before. Much of the writing process involves taking notes on material already published, and writing and editing that material into your own words. Optical scanners allow a computer to "read" the typed material and to recognize letters. By recognizing letters, the computer reads for you. As you can imagine, there are innumberable typestyles and type sizes. For example, you can read cursive writing (usually) and you can also read large bold letters, **can't you?** A scanner is not always so smart. But scanners are becoming smarter. You can set the machines so that they recognize various typestyles. Some are pre-set to recognize of the most common typestyles. A scanner might look like a typewriter ribbon with a wire leading to a digitizer outside your computer or it might look like a small copier. Scanners can ready line by line or section by section. Scanners make mistakes.

Other types of scanners can "read" images and pictures. Have you ever seen booths at festive events where photographs are turned into computer images? Scanners read light and dark places on photos and digitize those places into shades of gray (or soon enough into plots of color!) The photo information is thus digitized into computer information. In this way "digitized" photos could be integrated as part of your computer-written document.

Similarly, mechanisms which operate a bit like scanners, but allow the computer to recognize the human voice and to type words from that voice will provide great changes in the office. Much of what a typist does is *transcribe* manuscripts from written or spoken material. What will happen when computers can read and listen?

How have computers changed communications?

Not so very long ago, when you wanted to make a long-distance call, you had to call via a long-distance operator. The long-distance operator would use long-distance lines to connect to a long-distance operator somewhere far away, and those operators would "patch" your call together. Occasionally, you would deal with more than two operators. No more. Computers now route switching. They interpret "touch tones." They catalog and time calls and send you the bills. They route telephone and television messages from halfway around the world instantaneously.

Do computers really "talk" to each other?

It would be frightening to walk into a room and to hear a couple of them discussing the weather, wouldn't it? In fact, when computers became common, they required new terms to describe new concepts. One of those concepts is having two computers communicate with each other. Thus, the term to "talk" to each other. Computers can be linked to each other by *networking* or they can talk to each other by *modem.* Networking allows computers, usually in the same office, to be linked together. Oftentimes, with computers, at any one time only a small part of what the computer can do is being utilized. By networking computers, perhaps one computer which is a little more powerful than another can, when connected with the other computer, allow the smaller computer to *access* some of the larger computer's functions. Sometimes computers which are located across the world from each other are networked together, allowing workers in one office to communicate directly with coworkers in another.

How does a dot matrix printer produce a letter?

"Dot **matrix printers** are a type of *impact printer*. This means that they print data by striking characters (letters, numbers, or symbols) against a piece of paper. A typewriter is one type of impact printer.

A dot matrix printer imprints a pattern or group of tiny dots on paper. Each pattern of dots makes up a single character. A specific pattern of dots is called a *matrix,* giving the printer its name, *dot matrix.*

Patterns are formed by a set of tiny pins in the printing head. During printing, the computer sends instructions called *print codes* to the printer. The print codes cause specific pins in the printing head to strike an ink ribbon and the paper. A specific set of pins forms a specific character. Better quality dot matrix printers have greater dot density. *Dot density* is the number of dots or pins per character. Inexpensive printers, which have fewer pins, form characters with "white space" between dots. Better quality printers have more pins to produce characters that appear to be almost solid. 2

Dot matrix printers are extremely fast. Some models can print several hundred *characters per second (CPS).* However, the print quality of dot matrix printers is not as good as that of other impact printers." 3

Is there a job for me in computer communications?

By the time you read this, who knows exactly what will be happening. In fact, the flood of new jobs which emerged in the '70's and '80's in the electronic field declined towards the end of the '80's. But suffice it to say that despite some drops, employment will hold steady in this important field. Besides, jobs in computer communications include all those jobs *using* computers, and those jobs number in the hundreds of thousands and millions!

How do input devices differ from output devices?

Just as the term states--input devices put information into computers and output devices put information out of a computer. An example of an input device might be a computer keyboard or the dial of a telephone. Examples of output include printouts from a printer, or the ringing of a telephone which was dialed. Other input devices include microphones, digitizers (for transferring photographic or typewritten information into computer information), or even a computer touch-screen; they all allow information to be put into the computer. When you think of linking output devices to other devices' input and even directly to people via digitizers or voice interpreters, some people get the creeps. "You're not linking a machine to me!" you might say to yourself. But, as in so many areas of technology--psst--it sneaks up on you. And things never seem to happen just the way the movies say they will. What may be frightening to some today may end up just an everyday device in the future.

Okay, out with the crystal ball. What are some major developments in telecommunication technologies?

Fiber optics. Laser technology. Compact discs. You've heard the terms. Expect results. And expect things to get more compact and more powerful. The introduction of the laser into information storage will allow much more information to be stored and retrieved with considerable economy of space.

*1 From "The **AT&T INFOQUEST Center** Secondary School Curriculum Guide, New York City Board of Education, Division of Curriculum and Instruction, New York, NY, 1986, p. 35.*

*2 From **DISCOVERING TECHNOLOGY: COMMUNICATION** by Ronald E. Jones and Janet L. Robb, copyright (c) 1986 by Harcourt Brace Jovanovich, Inc. Reprinted by permission of the author, pp. 291-292.*

*3 **Ibid,** p. 292.*

Effects of Telecommunications on Society
Teacher Page

Competency: Analyze the effects of telecommunications on society

Tasks: Discuss the information revolution's impact on individuals and institutions
Discuss implications of the automated home
Predict future telecommunications systems
Describe jobs in the telecommunications field

Introduction

Technology has perils. Technology can provide options. It can wall people in. Students need to debate the relative advantages and drawbacks of telecommunications. Perhaps the skepticism of technology of the late 20th century is warranted. Perhaps for every plus on the side of advanced technology a minus can be considered. The class can be split into half, with each student to give a 1-minute appeal in favor of, or against advances in telecommunications. An elected student can act as judge in this debate. Students can identify the ways that telecommunications technologies have impacted *them*. Students need a solid appreciation of the way things were prior to the information age.

Overview

One might not see work directly asssessing or repairing the effects of telecommunications, but the arrival of any such technology has its cost. Such technology may displace workers. It may impact cultures. The effect of telecommunications on society might be the fact that people don't visit anymore--they sit at home and watch TV. But on the other hand, it may allow someone to call up a life-saving diagnosis via modem on a computer screen. The effects of telecommunications need to be considered at all stages of the employment--and enjoyment--fields.

Resources

Action for Children's Television, 46 Austin Street, Newtonville, MA 02160

American Council for Better Broadcasting, 120 E Wilson Street, Madison, WI 53703

The AT&T InfoQuest Center, *"Secondary School Curriculum Guide"*, 550 Madison Avenue, New York, NY 10022 (212) 605-5140

Citizens Committee for Broadcasting, 609 Fifth Avenue, New York, NY 10017

Council on Children, Media and Merchandising, 1346 Connecticut Avenue, NW, Washington, DC 20036

Educational Technology Publications, 720 Palisade Avenue, Englewood Cliffs, NJ 07632 (201) 871-4007

International Telecommunications Satellite Organization (INTELSAT), 3400 International Drive NW, Washington, DC 20008 (202) 944-6800

National Association for Better Broadcasting, P.O. Box 43640, Los Angeles, CA 90043

National Audience Board, 152 East End Avenue, New York, NY 10028

National Citizens Committee for Broadcasting, P.O. Box 12038, 1513 P Street, NW, Washington, DC 20005

Office of Communications, United Church of Christ, 105 Madison Avenue, Suite 921, New York, NY 10016

RCA News & Information, Commercial Communications Systems, Government Systems, Route 38, Bldg. 206-1, Cherry Hill, NJ 08358

Suggested Reading

Communications and the World of the Future, H.H. Wellman, M. Evans, NY, 1975

Discovering Technology Communication, Harcourt Brace Jovanovich, Orlando, San Diego, Chicago, Dallas, 1986

Future Shock, A. Toffler, Random House, New York, NY, 1970

Pushbutton Fantasies, V. Mosco, Ablex Publishing Corporation, Norwood, NJ, 1982

Telecommunications in the World 2000, I.B. Singh, Ablex Publishing Corp., Norwood, NJ, 1983

Telecommunicatios Tomorrow, American Telephone and Telegraph Co., Public Relations Office 10 Canal St., Chicago, IL 60606

The Third Wave, A. Toffler, Bantam Books, New York, NY, 1980

World Future Society Catalog, 4916 St. Elmo Ave., Washington, DC 2001[illegible]. Currently no charge

Films and Filmstrips

"Countdown (Connections Series)," 60 min. Free Loan. Depicts a series of events which began with the cannonball in the 15th century and led to the invention of television. Illinois Bell Film Library, HQ 4H, 225 W. Randolph, Chicago, IL 60606.

Effects of Telecommunications on Society

How has this so-called "information revolution" affected me personally?

If you're up on things current (and of course you are), you know that people all over the place are talking about the *"information revolution"* and the *"age of information."* You should at least be *informed* about that. It wasn't so long ago that a letter for interior Alaska had to go by ship to Anchorage, then by train to Fairbanks. Twenty years before that letters to the rural bush went by dogsled alone. If you wrote for a Sears catalog, you might get it the next summer. Well today with *telefax* machines you can zap a letter to Timbuktu (well not quite to Timbuktu, but at least to New York or Paris) at the speed of light.

How easy it is today for those raised in the age of information to take its wonders for granted. But know that instant information, instantaneous transmission of messages is a phenomenon of this century. Such a phenomenon has allowed for the concept of the global village, with all humans tied together with common needs and considerations. How have telecommunications affected you personally? If you live in a rural village in Alaska, perhaps you remember when television first came to your community. A powerful medium such as television nearly always changes those it touches. For better or worse, telecommunications bring changes.

Is this so-called "automated home" really going to appear?

Need a cup of tea? Call the robot! Want your car warmed up in the morning? Snap your fingers! Even more automated labor-saving devices may be the wave of the future. Despite fancy terms like "automated" and "electronic", a lot of basic functioning will still be done by people. Think of the way things were done not so long ago. How was the toast made--over a fire in the fireplace? How was that letter written? Did you dip a pen in ink? People have fantasized about the way machines and computers and electronics are going to change households, and they just may. But remember there are some inventions which are really hard to improve upon, like the mousetrap, for example.

Forward-looking technology companies envision all shopping by "teleshopping"--by computer and video, paying for items via computer and personal number. All electronic functions of the house--from warming the coffee to warming the car--could be controlled by a bedside control unit. People could play cards via their computer screen--with someone in Georgia, California, or Europe. You could call up videos on your home screen without having to go out to the video store. You could call texts and articles from the Library of Congress without ever having to leave your house. You could have your house heat turned down the minute you leave and the place all warmed up just before you come back.

What does the future in telecommunications hold?

Who can predict? Can you envision two-way televisions in every household? (By the way, such devices were invented way back in the '60's but never caught on.) Or maybe your vision is really wild and you can see yourself climbing into a phone booth and dialing yourself across town. Hate to get a wrong connection. Probably one of the most exciting areas in all of industry is the development in telecommunications. Fueling the rapid changes in this field is the ever-increasing miniaturization of silicon chips. Nearly every year the amount of microcircuitry which can be etched onto a silicon chip doubles. While this increasing miniaturization probably can't continue forever, it certainly is altering the functioning of people and machines.

Perhaps picture phones will finally come into vogue. Perhaps voice digitizers will finally be affordable. To type a letter, all you'll have to do is speak into your computer microphone. The machine will do the typing (such affordable machines are not far off!) A person might be able to weave him or herself through the mazes of city hall right at home. Centralized control of lights and equipment might allow them to be extinguished when they should be, instead of when somebody remembers to shut them out, allowing for increased energy conservation. Travelers will be able to make airline and hotel reservations from home, and factories will be increasingly efficient as they can order the parts they need when they need them (electronically) instead of having to expensively stockpile the parts ahead. Drivers will be able to summon a map of the area in which they are driving with the best routes highlighted. A patient will be able to perform considerable self-diagnosis via a medical data-bank. People will be able to work at home, using their own computer screens.

Skeptics bemoan. Machines aren't the answers to everything, they might say. With every development comes a pitfall. Judge for yourself. Perhaps one can compare the effects of developments in telecommunications to those in transportation. Yes indeed it was (and is) quaint and romantic to travel by dogsled and we revere those who do it. But come on. For every day, useful work, human beings (at least in this culture) look for an easier way to do things. To say that is the American way is probably an understatement. Possibly no other culture in the history of humankind has so pursued technology and change.

Can I get a job in telecommunications?

Sure. Apply for one. The jobs in telecommunications are as varied as the wind. Telecommunications is big business. You could be a telephone lineperson, a phone repairperson, a switchboard operator, a computer programmer, a satellite launchpad assistant, or one of many thousands of office workers in that field. Don't limit yourself. Try for what you like. In fact, varied training in the basics of telecommunications can help you get a job. Knowing the basics of electronics, like electron theory and principles of circuitry, helps.

Like so much today, the world of telecommunications is changing so fast that employers want solid employees with a wide background. They want dependable people with an ability to learn. A solid education with a varied background, with a bent towards the technical, is best. Those with specific technical skills (like electronic technician or programming whiz) might find a higher-level technical slot than those with a general background. But suffice it to say that the strong will survive, and to compete, one must attain *skills*.

Areas open in telecommunications include research and development, applied engineering, finance and business (an area important for nearly all industrial and commercial applications), marketing and sales, and programming and management of information.

Home Communications
Teacher Page

Competency: Identify recent innovations in home communications

Tasks: Identify ways cable systems may communicate between homes
Explain how a video tape recorder can be used in home communications
Contrast a video disc player with a phonograph
Describe the communications potential of home computers
(A) Name types of computer-generated audio
(A) Describe advances in acoustical information storage and retrieval

Introduction

In this unit the student has the opportunity to study some of those areas so very attractive to teenagers: music and tele-communicating. Innumerable jobs in this field exist; the field is ever changing, ever expanding, and ever interconnecting. Students might investigate recent computer applications, especially as they relate to the home. They might design the interrelationships of such systems using CAD software. They might look into the use of micro -chips in appliances such as stoves, microwaves, even personal cameras. They might help explain the integration of computers with laser disc technology.

Overview

From sales to maintenance and repair, home communications and computers is a field with a future. Though the fields are technical and require a certain artistic flair, the writing of software will remain important. But as one computer teacher indicated, the writing of software should be considered an art, not an obligation. Strong information about computers in general will allow the student to adapt to changes in the workplace. The changes are underway. Recent developments in superconductivity may make computers much smaller and more portable than they currently are. Students need to be willing to experiment, to adapt, and to try new things. Employment in the home use of computer technology might include sales of computers and related parts. It might include computer repair and upgrading. Demand will grow for repairpersons. Technicians will be needed to install and test devices.

Resources

***AlaskaNet,* Alascom Inc.**, 210 East Bluff Road, P.O. Box 6607, Anchorage, AK 99502
(800) 478-6500 or, in Anchorage call 264-7391

Compuserve, Inc., 5000 Arlington Centre Blvd., Columbus, OH 43220 (614) 457-8600

European Space Agency/Information Retrieval Service, Via Galileo Galilei, C.P.64, 00044 Frascati, Italy, Phone: (06) 94011 Telex: 610637 ESRINI

Executive Net, 4646 Admiralty Way, Suite 301, Marina Del Ray, CA 90291 (213) 822-1411

General Electric Information Services Inc., 1580 Lincoln Street, Suite 1000, Denver, CO 80203 (303) 832-7111

GTE Telenet, 8229 Boone Boulevard, Vienna, VA 22180 (703) 442-1000

Newsnet, Inc., 945 Haverford Road, Bryn Mawr, PA 19010 (800) 345-1301 or (215) 527-8030

The New York Times Information Service, Inc., (NYTIS), 1719A Route 10 Parsippany, NJ 07054 (201) 539-5850

The Source, Source Telecomputing Corporation, 1616 Anderson Road, McLean, VA 22102 (800) 336-3366

Xerox Computer Services (XCS), 5310 Beethoven Street, Los Angeles, CA 90066 (213) 390-3461

(For a more complete list of available data bases and computer services, contact Alascom Tymnet)

Suggested Reading

Byte, Box 590, Martinsville, NJ 08835. Current subscription price: $21.00

Creative Computing, 39 East Hanover Avenue, Morris Plains, NJ 07950. Ahl Computing Inc.

Discovering Technology Communication, Harcourt Brace Jovanovich, Orlando, San Diego, Chicago, Dallas, 1986.

The Futurist, 4916 St. Elmo Ave., Bethesda, MD 20814-5089, World Future Society, current subscription price: $20.00

Popular Computing, Box 307, Martinsville, NJ 08836

Home Communications

Are homes going to become hooked up together?

They already are--by telephone. A telephone is a machine which *sends* and *receives*. A computer is a machine which *computes*. Wouldn't it be ingenious if the two of them were themselves hooked together you might ask? Certainly! And they already are. By *modem*. A modem is a device which fits on a computer and allows that computer to send information over the telephone lines to another computer. A modem can allow you to shop at home, all from the convenience of your personal computer! A modem will allow you to tap into weather reports (say you want to take your Piper Cub up for a spin), electronic mail, or data bases.

How does a VCR fit in all of this?

Already VCR's can interface with computer equipment. A VCR is a machine for transposing light into pieces of electronic information which is then later displayed on a screen. Interface a VCR camera with a computer and you can *"digitize"* an image. Perhaps you've seen such digitizers creating computer-generated pictures at the state fair or other such events. But doesn't it seem odd to have one TV-screen (or *monitor*) for the VCR and then to have another for the computer? Can't these machines interface in their use as well? Yes! Yes! Yes! Some televisions double as computer monitors. But the *resolution* (determined by the number of *pixels* --small pinpoints of light) of the television is not quite as sharp as that of a monitor. At home, some already use their personal computers to create screen boards for their home video shows. Can you see the day when you can *load* some video tape footage of a friend into your personal computer, zoom in on the person's nose, and, with the computer paint program, fix any little blemishes which might be there? Now that's going to be fun.

Should we count compact discs in too?

You bet. Maybe you can see how all of this is coming together. That compact disc in a compact disc player is read by a low-powered laser beam. And a similar compact disc can hold information equivalent to hundreds or thousands of computer floppy discs! As much as high -technology is branching into a myriad of areas, it is *interfacing* and coming together.

A compact disc is such an efficient way to store electronic information that whole volumes of books can be etched on a single disc. As **Time** magazine recently stated: "A CD (compact disc) surface area 6 ft. long and 6 ft. wide would be sufficient to store the words in every book ever written." [1]

As **Time** relates:

> "The disc that stores music and data with equal ease is a technological marvel. Molded out of the same durable plastic used in bulletproof windows, the discs are engraved by laser beam, leaving microscopic "pits" and "lands" (flat areas) representing streams of binary digits. Each pit is no larger than a bacterium; some 2 billion fit on a 4.72-inc. disc, laid down in a continuous spiral nearly three miles long. With this capacity, a single 4.72-in. disc can store up to 25,000 pages of text." [1]

The disadvantage of compact computer disks, however, lies in the fact that they cannot be erased and you currently cannot write on them outside of the factory. You can access thousands of pages of text, but you won't be able to store your own material on them--*yet*. So, you would have to get a whole new disc to update your information. And, compared to regular floppy disks, compact discs aren't cheap. But as the appetite for even more information reduced onto even smaller spaces increases, expect compact discs to play a role.

And all of this can be directed by the home computer?

Homes in the developed world contain a collection of differently functioning equipment. Got a toaster? How about an electric oven? Refrigerator? Burglar alarm? Think of all the little gizmos around the house. And then there's the telephone. It's an output *and* an input instrument. Couldn't you direct all of those things from one central computer terminal? Yes, no, and maybe. When the inventors of the Apple Computer began their project in the garage in California, what they envisioned was just such a home-centered terminal. What they got, however was the word-processor/spreadsheet maker/home game unit we see today. Very few toasters are turned on by the home computer. But who knows what will happen? Already your home computer can dial and redial numbers on your *modem*. The home computer can send messages to friends and acquaintances via *electronic mail*. Maybe it'll turn on the coffee pot and keep track of those eggs in the refrigerator door.

How are computers used in sound production?

"Hit me with your laser beam! "

(from the song "Relax" by the rock group Frankie Goes to Hollywood)

Computers are used quite a bit in sound production. Ask any famous rock star. Computers often control the sound boards. They may generate the synthesized music. Electronic musical technology is driving the music business these days. According to the March 1, 1987 **New York Times,** Americans bought 392,000 digital keyboards in 1983. Two years later, sales of the instruments topped 1.3 million. The **Times** went on to say: "computers are firmly entrenched in the making of modern music. And that has meant a boon not only for those in Silicon Valley, but for software writer as well. Computer-generated music is replacing musicians in many sound productions, even movies. There are those who worry that electronic music may take the human flair out of musical production. Some software packages allow the operator to plug a musical keyboard right into the computer. Others will write the musical score as you play the music.

So how is sound and information going to be stored in the future?

You'll have to get your crystal ball out again. Nobody knows for sure. But one thing *is* for sure: the more you use computers, disc players, and VCR's, the more you want fancy systems which make collecting and storing information, sound, or pictures even easier. Are you a computer user? If you are, you probably want a state of the art PC with gobs of RAM, a dual disk drive, and/or a gargantuan hard disc. It looks like information storage is heading for miniaturization along with electronic means of storage. So expect things to be smaller and more powerful-- *much* smaller and *much* more powerful! Recent innovations have shown that ceramics made of certain substances can become *superconductors* at temperatures approaching room temperature. A superconductor is a material which conducts electricity without loss of energy. The repercussion of this development may be astounding; wires conducting great currents of electricity will no longer have to be large in diameter. Computers circuits will no longer have to contend with the problem of generating too much heat. Computers will be able to become all the smaller. Can you imagine a fully-functioning personal computer strapped to someone's wrist? Superconductivity will allow computers to vast amounts of information within the confines of a miniscule, microscopic space.

1 "From Mozart to Megabytes," Time magazine, March 16, 1987, p. 71.

How a Television Functions
Teacher Page

Competency: Understand how a television functions

Tasks: Define terms associated with televisions and their operations
Explain the principles associated with televisions and their operations
Contrast television and radio
Explain the function of the television camera
Identify TV's impact on society
Explain what is meant by line-of-sight transmision
Explain TV-related jobs

Introduction

Obviously one of the most powerful applications of technology in the 20th century, especially in western culture, has been the advent of television. Television has the power to reach into all aspects of our lives, from bringing images of far-away places, to offering live coverage of altercations and difficulties halfway around the world. Television is here to stay. The impact of the medium is of particular note in a state with cultures operating so far from mainstream America. Television has changed Alaska's bush. With television, students can write for varied information, or they can visit a television production studio. With its strong public broadcasting system, Alaska offers great opportunities for those who wish to learn the broadcasting field. Those who wish to work in broadcasting can--either as an employee or volunteer. Students can "stage" their own television productions, using home video equipment. They can create their own music video using home VCR equipment. They can explore the intricacies of cutting video film, of camera operation, of on-the-air continuity, and of radio and television writing. Obviously a background in speech and language is a plus in this field.

Overview

Students and others are relatively familiar with work in the field of television. The powerful medium that is television often depicts itself, from the **Mary Tyler Moore Show** to the movie **"Network."** Work in television incorporates a wide range of possibilities. TV stations employ custodians, building supervisors, engineers, technicians, camera operators, sales people (for advertising), copywriters, administrators, and of course on-the-air talent. The field actually has excellent potential for one who does not fret starting at the bottom and for one who can tolerate the relatively low wages. Those who work in the field can vouch that it is not as glamourous as it may seem. Many of the jobs involve mundane sales calls or fevered preparation. Flexible, energetic employees work best.

Resources

Alaska Broadcasters Association, P.O. Box 102424, Anchorage, AK 99510

American Broadcasting Companies, Inc. (ABC), 1330 Avenue of the Americas, New York, NY 10019

American Women in Radio and Television, "Careerline," 1321 Connecticut Avenue, N.W., Washington, DC 20036

CBS, Inc., 51 West 52nd St., New York, NY 10019

Citizens Committee for Broadcasting, 609 Fifth Avenue, New York, NY 10017

Corporation for Public Broadcasting, 1111 16th St., NW Washington, DC 20036

International Radio and Television Society, 420 Lexington Ave., New York, NY 10170

National Academy of Television Arts & Sciences, 291 S. La Cienega Blvd., Beverly Hills, CA 90211

National Association of Broadcasters, Employment Clearinghouse, 1771 N. Street, N.W., Washington, DC 20036

National Broadcasting Company, Inc. (NBC), 30 Rockefeller Plaza, New York, NY 10020

National Cable Television Association, 1724 Massachusetts Ave., NW, Washington, DC 20036

National Citizens Committee for Broadcasting, P.O. Box 12038, 1513 P Street, NW, Washington, DC 20005

Public Television Network of Alaska, c/o KTOO Radio, 224 4th St., Juneau, AK 99801

Television Information Office (of the National Association of Broadcasters), 745 Fifth Avenue, New York, NY 10022

Turner Broadcasting, Cable News Network, 1050 Techwood Drive, Atlanta, GA 30309

Weatherscan, Loop 132, Throckmorton Hwy., Olney, TX 76374

Suggested Reading

Broadcasting, 1735 DeSales St., NW , Washington, DC 20036. Broadcasting Publications, Inc., current subscription price, $60.00

"Careers in Cable," National Cable Television Association, 1724 Massachusetts Avenue, NW, Washington, DC 200_7

Discovering Technology Communication, Harcourt Brace Jovanovich, Orlando, San Diego, Chicago, Dallas, 1986

The New Television Technologies, L.S. Gross, McGraw-Hill Book Co., St. Louis, 1980

Perspectives on Radio and Television, F.L. Smith, Harper & Row, Publishers, NY, 1979

Television/Radio Age, 1270 Avenue of the Americas, New York, NY 10020, Television Educational Corporation Publishing Office, current subscription price, $40.00

Films

"**Tomorrow's Television: Get What You Want or Like What You Get,**" 62 min. #82646 $18.50. Examines the competitive struggle between various segments of the communication industry and shows how this inhibits and influences what is shown on television. The film offers no solutions, but does present enlightening material representing both sides of the argument. University of Illinois Film Center, 1325 South Oak St., Champaign, IL 61820.

How a Television Functions

What are the parts of a television and how does it work?

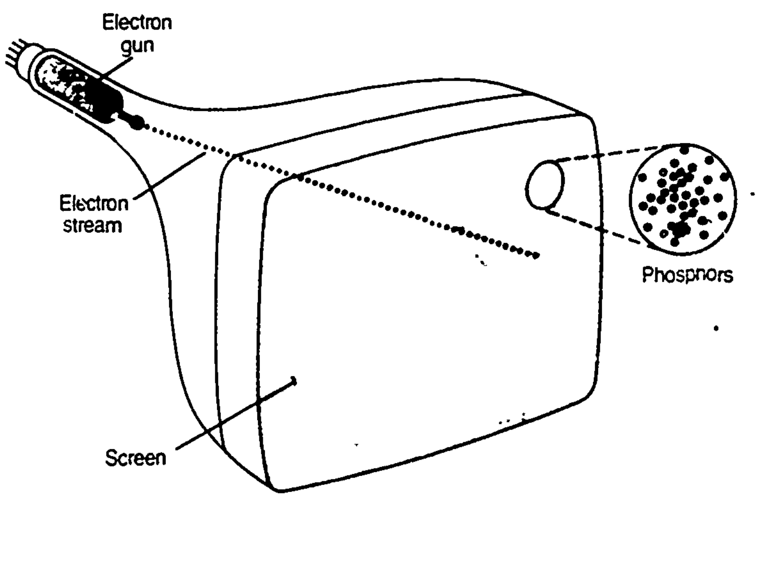
You've got your on-off switch and you've got your remote control. That's all you need to know, eh? Well, maybe you're a technical sort, or maybe there's a future job for you in television repair. (A recent governor of Alaska got his start in just that way--now *picture* that!)

And of course, to get a TV to work, you've got to plug it in! But seriously, when you watch television, perhaps you don't realize what a sophisticated creation you're seated before. In fact, the invention of the television did not come about as a single invention at all, but came rather as the end product of a series of inventions. And one thing you may not have known, is that TV took a little time in catching on--in becoming popular.

A television itself is essentially a receiver. The television is designed to convert television signals into pictures and sound. As Jones and Robb state in Discovering Technology COMMUNICATION:

"Basically a television set consists of an *antenna*, a *tuner*, an *amplifier*, a *separator*, a *speaker*, and a *cathode-ray tube*.

"The television's anteanna receives all television signals in the surrounding area and routes them to the tuner. The tuner is designed to single out particular television signals. The tuner is operated by moving the channel selector dial or by pushing a button. The signal from the desired station is routed to an amplifier and a separator. The amplifier strengthens the signal. The separator divides the television signal into its separate audio and video signals. The audio signal is routed to the television speaker. The speaker, in turn, converts the signal into sound."



The video signal goes to the cathode-ray tube. This tube is the "picture tube" of the TV set. An *electron gun* shoots electrons onto the inside surface of the screen. That inside screen surface is covered with tiny dots called phosphors. How brightly the dots glow depends on the strength of the electron beam. Essentially the imagine on a television screen is made of these tiny phosphors glowing, blending together to form a picture.

As Jones and Robb continue:

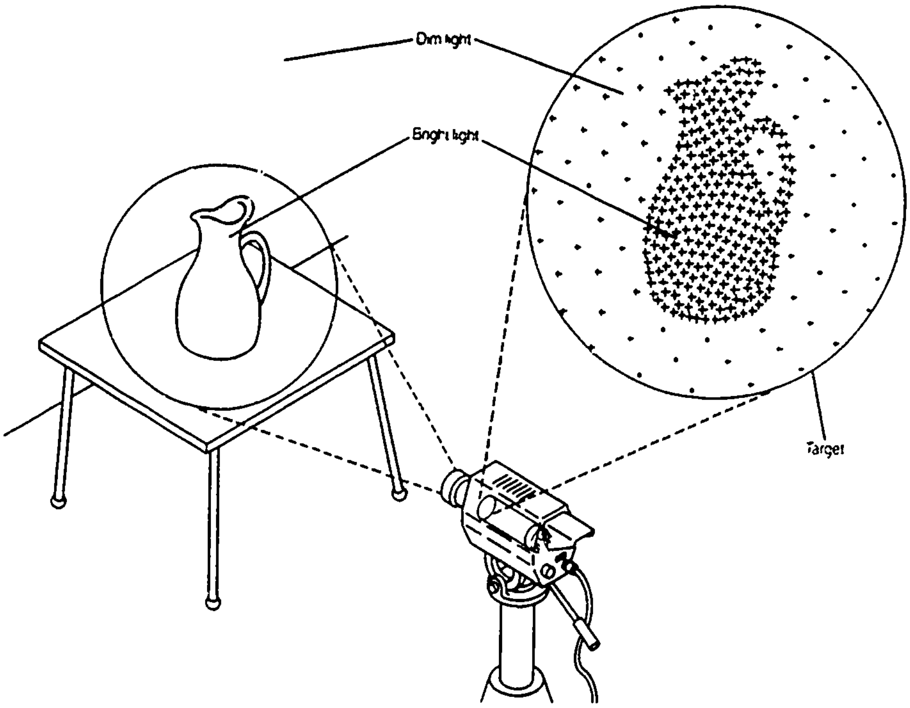
"The movement of images on the television screen appears to be smooth. The images are actually made up of 30 separate pictures per second. ...A cathode-ray tube in a color television contains three electron guns. The inside surface of the screen is covered with red, green, and blue phosphors. These phosphors are arranged in groups of three. Each electron gun sends out an electron beam that only strikes one color of phosphors." 1

Radios and TVs are completely different gadgets. One transmits sound and pictures and the other transmits only sound.

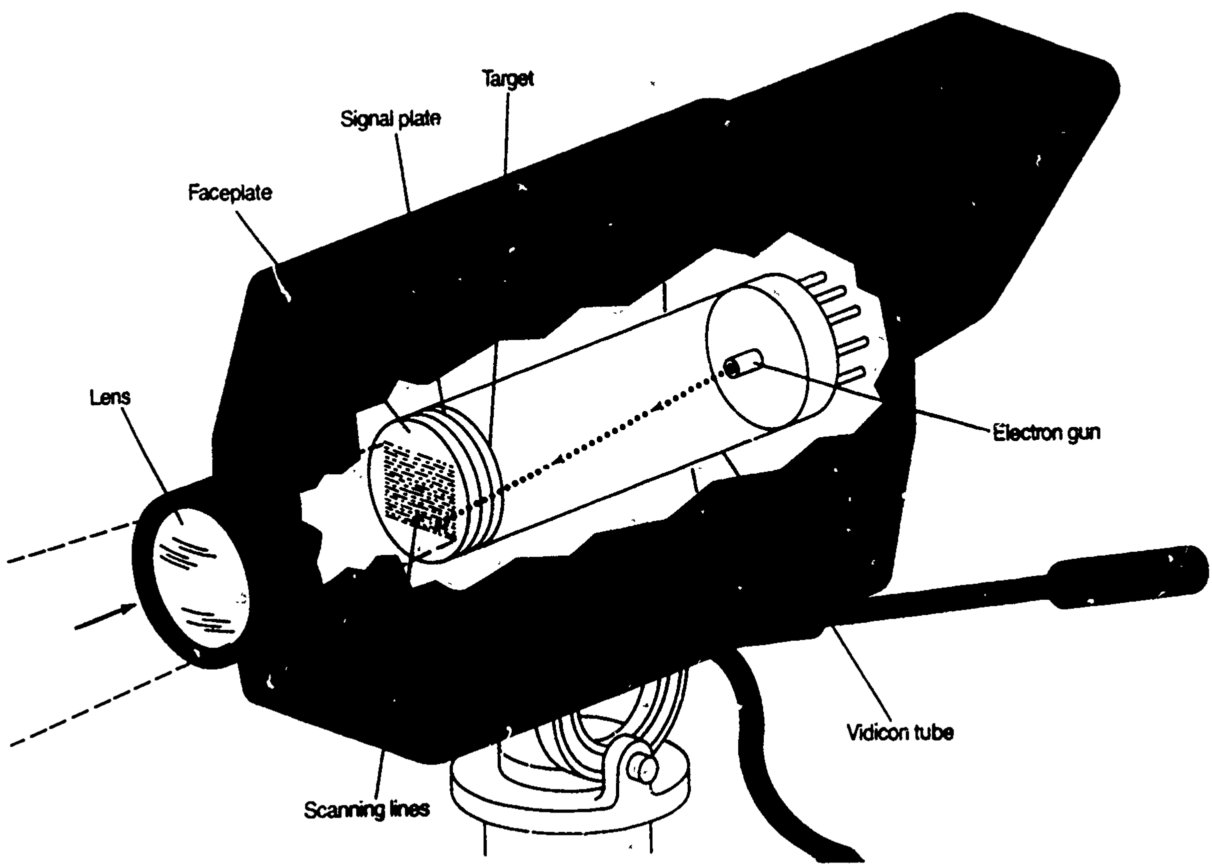
Exactly what does the TV camera do?

It takes pictures of things! More accurately, it turns light into electronic impulses. That's all. It turns visual images into electrical current. The television accomplishes this magic act with the *vidicon tube*. The vidicon tube is located inside the television camera. At the front end of the vidicon tube is a transparent glass called the *faceplate*. The faceplate is coated on the inside by a special layer called the *signal plate*. Another plate, called the target, is located just behind the signal plate. 2

As Ronald E. Jones and Janet L. Robb describe:



"Light reflects off an object and enters through the camera lens. The lens directs the light through the transparent faceplate and signal plate and focuses it on the target. The target is made of a photosensitive material that conducts electricity when exposed to light. When light strikes the target, negatively charged particles called *electrons* are attracted from the target's back surface to its front surface. When this happens, positively charged areas are left on the back surface of the target. The intensity of these positively charged areas depends on the brightness of the light. The brighter the light striking the front surface of the target, the more positively charged the areas become on the back surface. In this way, the light striking the front of the target is duplicated as positively charged areas on the back of the target. 3



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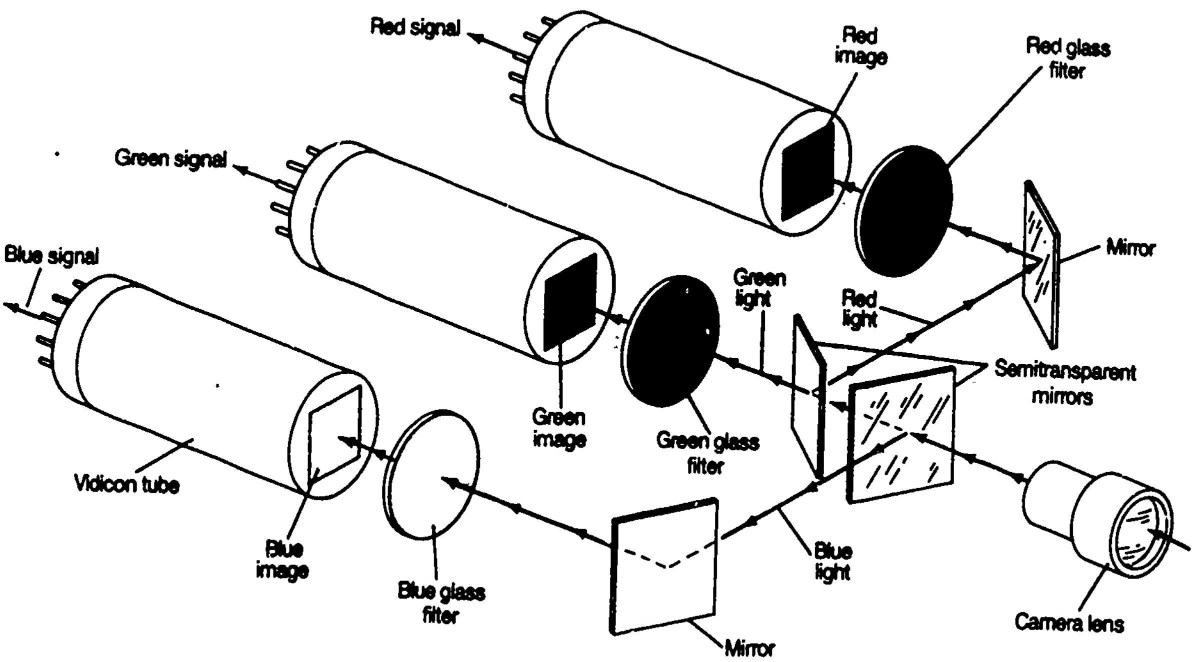
"An electron gun is located behind the target inside the vidicon tube... The electron gun shoots a thin beam of electrons at the back surface of the target. The beam moves across the target from left to right and from top to bottom, just the way you move your eyes when you read a book. The beam covers every point on the target line by line. This orderly movement of the electron beam is called *scanning*. The target is scanned very quickly. The electron gun scans the entire target thirty times each second.

"As the beam of electrons scans the target, it hits areas that have stronger and weaker positive charges. Electrons from the beam are attracted by the positively charged areas. The electrons pass through the target to the signal plate. These electrons create an electric current in the signal plate. The strength of the electric current is constantly changing, depending on whether the electron beam is scanning a strong or weak positive area on the target. The changing current from the signal plate is called the *video signal.*" 4

Jones and Robb describe the transmission of color television:



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"In color television every color can be created with combinations of red, blue, and green light. To accomplish this, color cameras have three vidicon tubes, one for each of the three colors. The light entering the camera from a scene is tripled with mirrors. Each of the three complete scene images is directed to a separate vidicon tube in the camera. A filter attached to the front of each vidicon tube allows only one color to pass. Each tube then converts its particular color of light into a video signal. The video signals from each of the three vidicon tubes are transmitted to television sets, where they are combined into a color picture." 5

Does watching TV really mess people up?

Take a look around you--then answer that question. Obviously, if you do too much of just about anything, you're bound to fry your brain. But television has been noted as particularly dangerous, or one might say, controversial. Perhaps you live in a part of Alaska where television has just arrived. Or perhaps you know somebody who was there when the "boob tube" came in. Ask that person if TV changed the community. You might be surprised at how strongly they answer!

One difference between television and other ways of receiving information is that television is less interactive. If you have a conversation with someone, hopefully both of you talk. With television, only the machine talks to you. Maybe that's why some call people who sit untold numbers of hours in front of the tube "boobs" or "vidiots." Besides, though graphic and very realistic, the spoken voice of television cannot completely replace the written word. Try reading a page of text to yourself, and then try reading that same page out loud. It surely took you much longer to say all the words than it did to read them silently. The half-hour evening news broadcast cannot replace reading the news for yourself. Yet studies have shown that a large percentage of Americans get all their state and national news from the "tube."

When people say "line-of-sight transmision" what do they mean?

Things must be transmitted in a straight line. That's it. Maybe you have seen little towers on top of hills way off in the distance in Alaska. Those towers may be receiving and relaying transmissions *line of sight*. That means nothing can stand between the *transmitter* and the *receiver*.

Jones and Robb in High Technology Communication say:

"Television signals travel from the transmitting antenna in straight lines. This means they do not follow the curvature of the earth. They are also easily stopped by large objects such as buildings and mountains. For these reasons television signals cannot travel farther than 60 or 70 miles (96-112 km) along the ground without assistance.

"Television signals are assisted to their destination by relay stations. Relay stations are placed on hills or mountains. A large reflector on top of each relay station collects television signals. An automatic transmitter inside the station then strengthens the signals and transmits them to the next relay station.

"Satellite relay stations are used to transmit television signals over even greater distances. Satellites orbit the earth and receive signals from special television transmitters. The satellites then send the signals to various transmitting stations located elsewhere on earth. The transmitting stations receive a satellite's signal, amplify it, and then broadcast it in the surrounding area." 6

Can I get a job in TV?

Sure you can. Lights, cameras, action. You could be a star, baby. But seriously, there are a number of jobs in broadcasting, and not all of the jobs are in *front* of the camera. In fact, some of the most interesting, most important jobs might just be on the other side of the lens. There are jobs in writing, in camera operation, in engineering, in advertising, in office managing, in maintenance and repair. Communications is an all-encompassing field. In fact, the world's largest corporation, AT&T is a *communications* corporation. Communication is big business.

If you are interested in broadcast announcing or sitting in front of the camera, Alaska may be a good place to get started. Sure, openings are limited, and with such a relatively small population, Alaska may have relatively fewer openings, but the state's sound public broadcasting system has plenty of need for volunteers. You could have your own radio show or help gather news or report the weather. You could learn important skills which would apply to work for pay later.

*1 From **DISCOVERING TECHNOLOGY: COMMUNICATION** by Ronald E. Jones and Janet L. Robb, copyright (c) 1986 by Harcourt Brace Jovanovich, Inc. Reprinted by permission of the author, p. 252-253.*

*2 **Ibid.**, p. 248.*
*3 **Ibid.**, p. 248.*
*4 **Ibid.**, p. 250.*
*5 **Ibid.**, p. 250.*
*6 **Ibid.**, p. 251.*

How the Radio Works

Teacher Page

Competency: Understand how the radio works

Tasks: Define the terms associated with radios and their operations
Explain the meaning of AM and FM radio dial numbers
Explain how sound is transmitted and received
Describe radio industry jobs
Sketch a simple sender-receiver radio circuit
Construct a simple crystal set receiver

Introduction

Nearly everyone is familar with the radio. Radio, of course, has an interesting and varied American history. Early American film and television stars got their start in vaudeville or radio. Even those who are unfamilar with or who find television distasteful can show an interest in radio. Radio has long offered options, from the national propaganda devices Voice of America or Radio Moscow, to the mindless prattle of rock AM.

Possible Learning Experiences

The students can make a radio show on tape and play it for other students, including music. Students can work in small groups to produce 30 and 60- second commercials advertising new products. They may role play jobs in radio. Require students to use their proper job titles when referring to aspects of the production. You can show the movie "Radio and Radar". Students can dissect a radio to identify its parts and operation. Try inviting a local electronics technician into the classroom to demonstrate basic services and maintenance on radios. Interested students can study radio repair and instruction manuals to learn how radios are put together and how they work.

Overview

The cry "radio is dead" has been heard for a long time. Nothing could be further from the truth. Radio has found and continues to find a solid niche in the media world. Radio employment will continue, though increasing automation has reduced actual technical staff to a minimum. Jobs exist and continue to exist in the production and sales ends of radio. As stated elsewhere in these materials, because of the folksy function of public radio and of some private radio stations in Alaska, the state is a good place for those interested in the media to start. Radio serves a function in Alaska, and in that respect, perhaps has less of a glamourous stigma than it may have in other markets. As such, students interested may find entry-level work more readily here than Outside, or they may be more readily welcomed as a volunteer. Radio jobs vary, like those in television, from engineering to sales, administration, copywriting, secretarial, and of course all the associated services, such as janitorial work. Hands-on work as a radio volunteer can allow a student invaluable experience.

Resources

Alaska Broadcasters Association, P.O. Box 102424, Anchorage, AK 99510

Alaska Public Radio Network, 4640 Old Seward Highway, Suite 202, Anchorage, AK 99503

American Federation of Television & Radio Artists, 1350 Avenue of the Americas, New York, NY 10019

American Women in Radio and Television, "Careerline," 1321 Connecticut Avenue, N.W., Washington, DC 20036

Corporation for Public Broadcasting, 1111 16th Street, NW, Washington, DC 20036

International Radio and Television Society, 420 Lexington Ave., New York, NY 10170

Mutual Broadcasting System, Inc., 135 West 50th Street, New York, NY 10019

National Association of Broadcasters, 1771 N. Street, N.W., Washington, DC 20036

National Public Radio, 2025 M Street, NW, Washington, DC 20036

Public Broadcasting Service, 955 L'Enfant Plaza North, SW, Washington, DC 20024

Suggested Reading

Discovering Technology Communication, Harcourt Brace Jovanovich, Orlando, San Diego, Chicago, Dallas, 1986

Fundamentals of Radio Broadcasting, Hasling, J., McGraw-Hill, St. Louis, 1980

Mass Media in America, (3rd Ed.), Science Research Association, Chicago, 1980

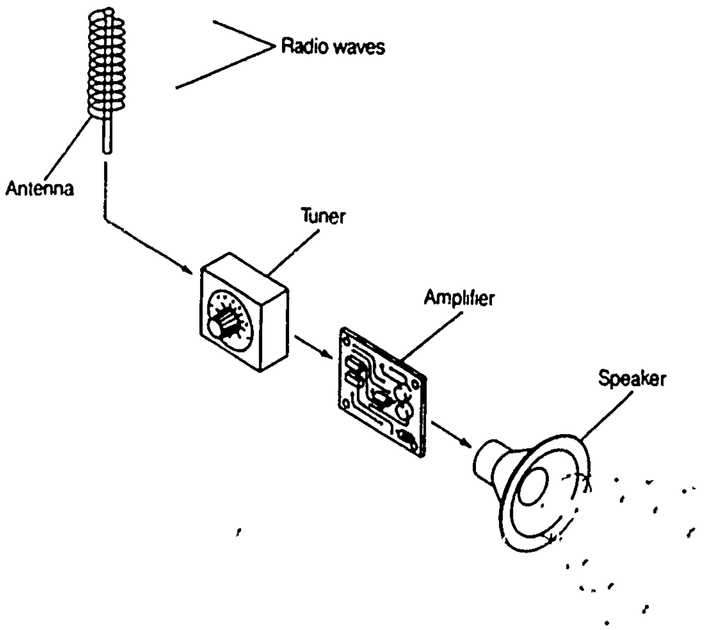
The Wired Society, J. Martin, Prentice-Hall, Englewood Cliffs, NJ, 1977

How the Radio Works

How do radios work?

Jones and Robb explain in Discovering Technology Communication:

"A radio is a device that receives radio waves and converts them into sound. A radio has four essential parts. In its simplest form, a radio consists of an *antenna*, a *tuner*. an *amplifier*, and a *speaker*.



"**Antenna.** The *antenna* of a radio is basically a wire or a series of wire loops connected to the radio. Radio waves from the transmitting antenna strike the antenna. This causes an electrical signal to flow thrugh the antenna and into the radio. This signal changes direction in the same pattern as an electrical current flowing through the transmitting antenna. The electrical signal produced in the antenna is routed by wire to a tuner.

"**Tuner.** At any given moment, the radio waves of many different radio stations are all striking the antenna at once. However, each station transmits its radio waves at a different frequency. The *tuner* is the electronic device in a radio that allows you to single out one frequency. In this way, you can hear one station's signal without interference from other stations. The frequencies are displayed as numbers on the tuner dial. A radio station identified as 90.6, for example, can only be received when the radio tunar is set on 90.6.

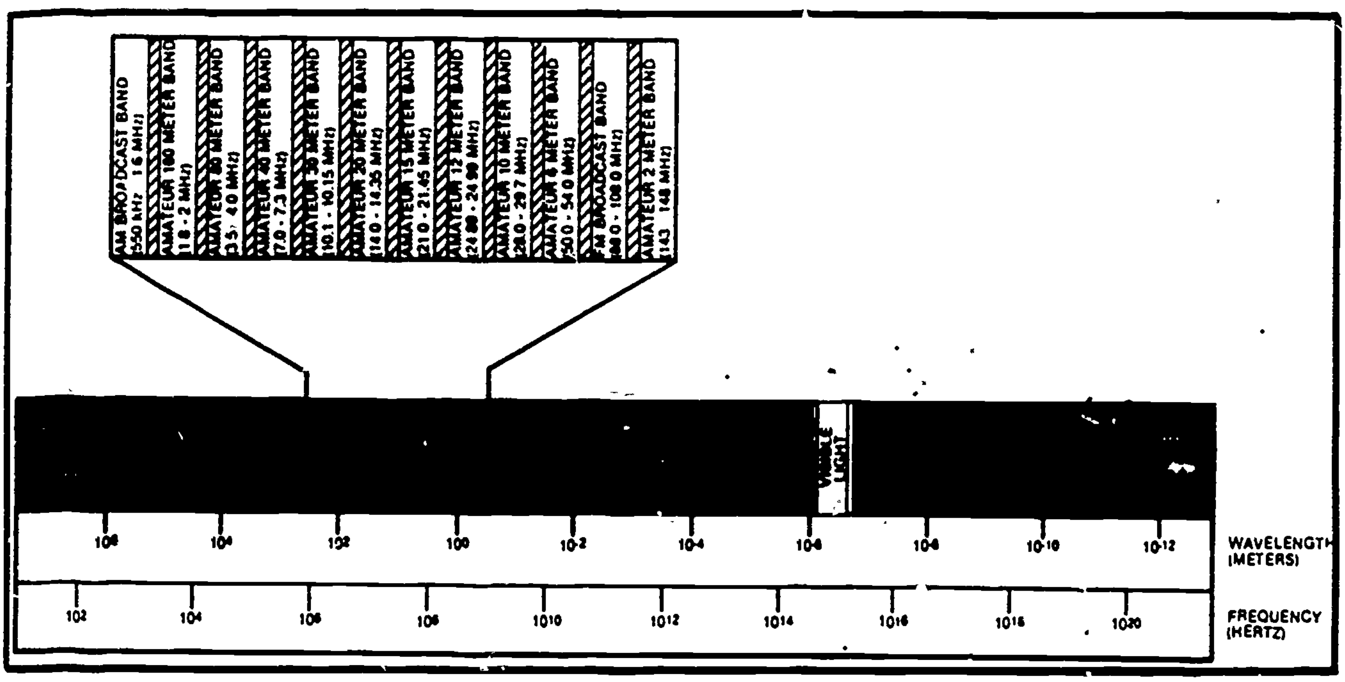
"**Amplifier.** The signal received by the antenna and selected by the tuner is weak. The signal must be made stronger to operate a speaker. An *amplifier* consists of electronic circuits that strengthen the signal. The strengthened signal is then directed to the speaker.

"**Speaker.** A *speaker* is a device that changes an electrical signal into sound. The most common type of speaker is called the *dynamic speaker.* The *dynamic speaker* produces sound through the vibration of a stiff paper cone. The point of the cone is connected to a coiled wire. The coiled wire lies within the poles of a powerful magnet. When an electrical signal passes from the amplifier through the coiled wire, a magnetic field is produced around the coil. This magnetic field reacts with the magnetic field produced by the magnet. This causes the wire coil to vibrate, which, in turn, vibrates the cone. The vibrating cone starts the air next to it in motion. This vibration of air produces sounds we can hear." 1

What do those numbers on the dial of AM and FM radios mean?

Jones and Robb say in Discovering Technology Communication:

"The radio wave travels out from the antenna much like a water wave from a dropped pebble. Each time the current changes direction, another radio wave begins its journey away from the antenna. The number of radio waves leaving the antenna in one second is referred to as the *frequency*. Every radio station in a given area broadcasts at a different frequency. This difference in frequency is important. It is the difference in frequency that allows the listener to single out a particular station on your radio. The frequencies are displayed as numbers on the tuner dial. A radio station identified as 90.6, for example, can only be received when the radio tuner is set on 90.6." 2

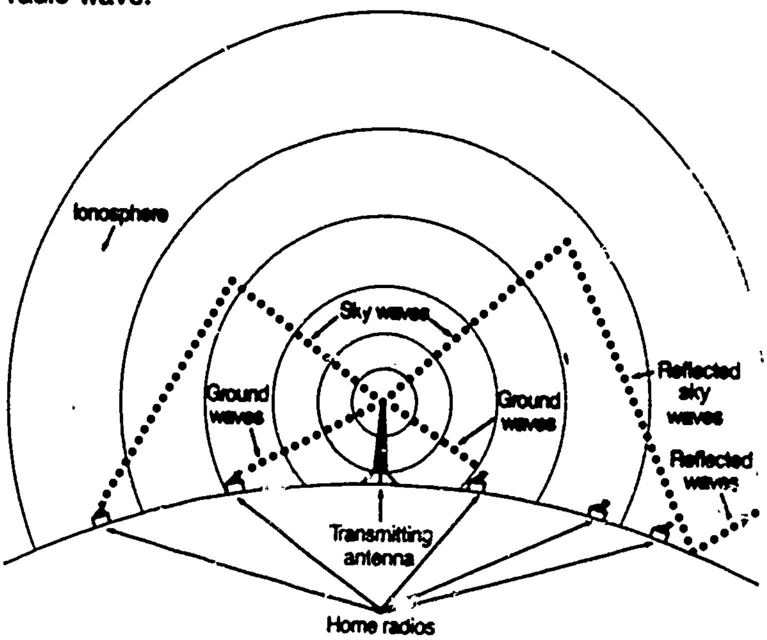


AM stands for "Amplitude Modulation." This technique combines an information signal and an RF carrier. In double sideband voice AM transmission, the voice information is used to vary (modulate) the amplitude of a radio-frequency signal.

How is sound transmitted and received?

As Jones and Robb say in <u>**Discovering Technology Communication**</u>:

"Radio waves are created as the transmitter duplicates the audio signal in the transmitting antenna. As the current patterns of the audio signal change, the region of energy that surrounds the antenna is disturbed. This region of energy is called the *electromagnetic field.* When current travels in one direction, the electromagnetic field stays close to the antenna. However, when the current changes direction, the field is cut off from the antenna. The cut-off energy is the radio wave.



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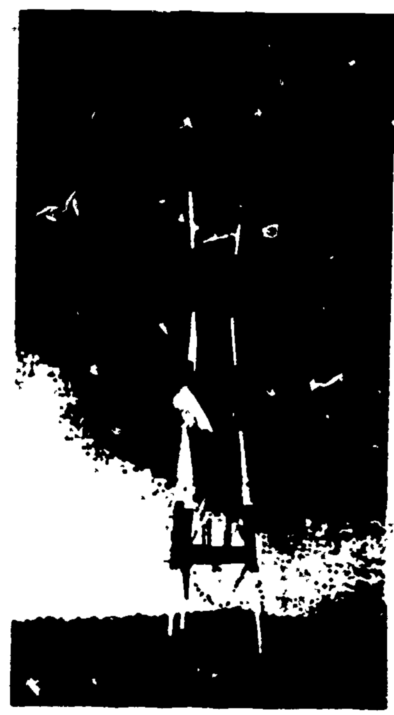
"When radio waves leave a transmitting antenna, they spread out in all directions. One group of waves travels along the surface of the earth. These waves are called *ground waves.* The remainder of the waves scatter out into the sky and are called *sky waves.*

"Ground waves do not travel very far. Radio stations [illegible] waves to carry a radio broadcast long [illegible] waves travel skyward until they meet a [illegible]d particles in the atmosphere called the [illegible] Some sky waves then bounce off the [illegible] and return to earth far away. For example, radio s[illegible]s transmitting from Chicago have been received as far away as Florida." 3



Are there a lot of jobs in radio?

Radio is a strong business. There are over 10,000 commercial radio stations in the United States alone! Despite television, despite VCR's, despite compact disks, radio remains a powerful medium. One strong reason for the continuing popularity of radio may just be the automobile. Try driving a car and watching television at the same time. Better still, *don't try it!* Radio is one of the few media you can enjoy *while you're doing something else.* Many boob tubers claim they're *thinking* while watching TV, but we know differently! So don't think radio is washed up. It's not. There are jobs in radio.

Commercial radio, like commercial television and other forms of *media,* depends upon a *market.* A market is a region in which goods may be bought and sold. Obviously commercial radio has commercials. Those commercials sell goods and services within a given market. Radio stations compete for *market share,* or the greatest number of listeners. A fact of life in radio or television or any media for that matter, is that your first concern may be assuring that you get your market share.

You may know a lot about radio and you may know a lot about music, but if you want a job in radio, your start may be as an *account executive* or *copywriter.* Account executives sell the advertising which goes on the air and *copywriters* write the advertising *copy.* (Copy is the written material which is read on the air.) You might have a job in radio *continuity,* making sure that all the commercials, music, news, and more come together. You might have a job in the radio station office, keeping track of the accounts, or you might work in radio *production,* arranging music, or *announcing* on the air. Did you say **ON THE AIR!** Yes! Even that is possible. As in television, in a small market, or in a series of small markets with strong presence of public broadcasting (as is the case in Alaska), your chances of wearing any of a number of hats in the radio business is excellent. One thought, though: competition is keen, so wages might not be high. But if you're talented and relentless, you will succeed! Now that's the spirit!

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*2 **Ibid.**, pp. 236-237.*

*3 **Ibid.**, pp. 236-237.*

How the Telephone Works
Teacher Page

Competency: Understand how the telephone works

Tasks: Define the terms associated with telephones and telecommunications
- Explain the principles of telephones and their operations
- Describe the nature of sound
- Identify the inventor of the telephone
- Describe the principles of microphone operation
- Explain how the voice causes changes in electrical impulses in the phone
- Explain how the receiver converts the transmitted current to audio-frequency
- Explain the function of the diaphram in the sender and the receiver
- Sketch a typical telephone circuit
- Explain ways telephone electrical impulses are transmitted
- Explain phone industry jobs
- (A) Contrast information transmission by acoustical energy with that of other energy sources

Introduction

Like so many important inventions of the information age, the invention of the telephone is an American (albeit via immigrants) phenomenon. The telephone business is **BIG** business. In fact, even after the breakup of AT&T, that company was still the **world's biggest** company. AT&T employs more people than the population of some small nations. With the divesture of that company, a host of smaller companies have surged to fill the void. The telephone business is fast integrating with the computer business, which is fast integrating with electronics and lasers and even ceramics (ceramics are proving to have characteristics of *superconductors)*. Some predict changes in these fields will be rapid, others see the changes as gradual. Whatever the pace, change is all-encompassing.

Students in this area can investigate a particular area of the telephone or telecommunications. Those who like to tinker with electronics can enjoy a special treat in this area. Nearly every community has someone who repairs or installs telephones, even the smallest villages in the state. Those who live in Anchorage have the advantage of visiting major telephone switching sites or inviting those who supervise worldwide communications to the classroom. Remaining at the forefront of this galloping field would require an army of educators.

Overview

Work in the field of telephone communications can vary from the technical to the bureaucratic. The 1980's is being labeled the dawn of "The Age of Information." Telephones have played a great role in initiating that age. A technical bent will help students in nearly every phase of the telephone business. As in all jobs involving high technology, because of rapid changes, employers look for workers with an ability to adapt to those changes. They look for those with strong basic communicative and work attitude skills. Having the *ability* to learn is important.

But a purview in electronics, theories of integrated circuits, and basic technical skills will give the student a background for further training or a basis in the field. Though employment varies in such a wide field, such a background will benefit students who install or repair telecommunications hardware and those who sell, deliver, or administer such equipment. For work in the latter areas, business and communication skills are a must. And of course, as in so many vocational areas, basic job competencies such as the ability to show up on time, to manage interpersonal differences, and to interact effectively with other employees, are a must.

Resources

AT&T, 195 Broadway, New York, NY 10007

The AT&T InfoQuest Center, 550 Madison Avenue, New York, NY 10022 (2122) 605-5140

Bell Laboratories, 101 JFK Parkway, Shorthills, NJ 07078

General Electric Co., 3135 Easton Ave., Fairfield, CT 06341

ITT World Communications Inc., 67 Broad St., New York, NY 10004

RCA News & Information, Commercial Communications Systems, Government Systems, Route 38, Bldg. 206-1, Cherry Hill, NJ 08358

Telephone Pioneers of America, 195 Broadway, New York, NY 10007

TransCanada Telephone System, 220 Laurier Avenue West, Ottawa, Ontario K1P 5Z9 (613) 237-6540

United States Independent Telephone Assoc., 1801 K St., NW, Washington, DC 20036

Western Union Corporation, One Lake St., Upple Saddle River, NJ 07458

Suggested Reading

The Birth and Babyhood of the Telephone. **Bell Laboratories,** 101 JFK Parkway, Shorthills, NJ 07078

Discovering Technology Communication, Harcourt Brace Jovanovich, Orlando, San Diego, Chicago, Dallas, 1986

"How the Telephone Works," AT&T Public Relations Office, 10 S. Canal St., Chicago, IL 60606

Pushbutton Fantasies. V. Mosco, Ablex Publishing Corporation, Norwood, NJ, 1982

Signals: The Telephone and Beyond. J.R. Pierce, W.H. Freeman & Co, San Francisco, 1981

How the Telephone Works

What are some terms associated with telephones and telecommunications?

apparatus-- the telephone itself
bell-- calls someone to the telephone
carbon chamber-- where voice is turned into electrical impulses
conductor-- wire and cable leading from phone to telephone company
dial tone-- indicates phone equipment is ready for a call
dial-- sends out electrical code to find another phone
diaphragm-- circular piece of very thin aluminum
power source-- the telephone company building
receiver-- converts electrical impulses back into sound
switch-- opens and closes the telephone circuit
transmitter-- the diaphragm and carbon chamber together

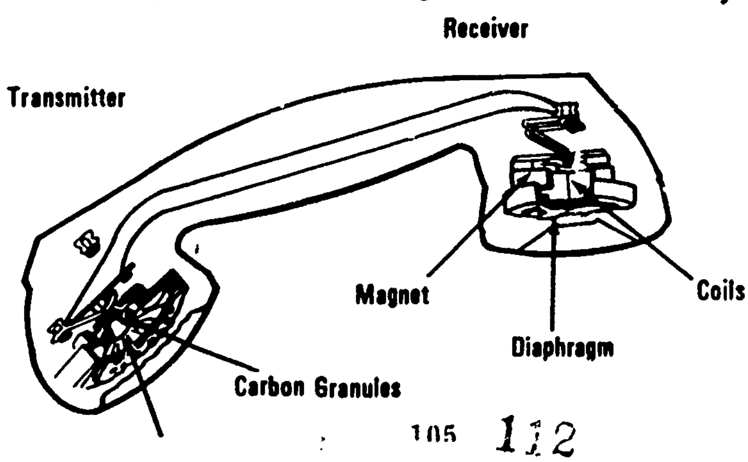
How does a telephone work?

Well, you need a number to dial and a strong index finger. (Ha, ha!) But as Jones and Robb state in **DISCOVERING TECHNOLOGY: COMMUNICATIONS:**

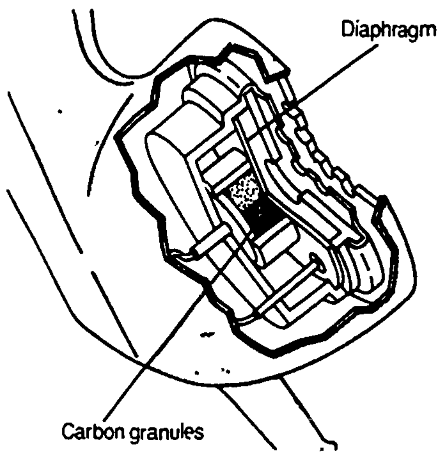
"Telephones are familar devices used to send and receive messages over long distances. A telephone does this by converting sound into electrical current. The electrical current is then relayed through wires to another telephone. The receiving telephone converts the electrical current back into sound.

"Today, the world's total telephone system includes over 425 million telephones. There are over 160 million telephones in the United States. This telephone system gets larger every day. Telephones can now transmit a private call with the same technology used to broadcast radio programs. This means cars, boats, and airplanes can become part of this vast communication system.

"Most telephones can be divided into three elements: a *mouthpiece*, an *earpiece*, and a *connecting mechanism*. In a simple telephone, the mouhtpiece and earpiece are combined into one component, called the receiver. The connecting mechanism is located in the body of the telephone. It is the "dial" portion of the telephone. In learning how a telephone works, it is best to study the mouthpiece, earpiece, and connecting mechanism individually.



"**Mouthpiece.** The mouthpiece converts sounds into electrical currents. Inside the mouthpiece is a thin, flexible sheet of metal called a *diapharagm*. When you talk into the mouthpiece, the sound waves you produce vibrate the diaphragm. The diaphragm vibrates at various speeds, depending on the varying scunds in your voice.



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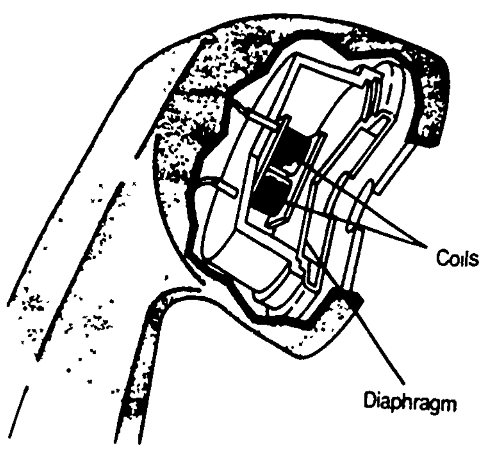
"The center of the diaphragm is connected to a small box filled with grains of carbon. When the diaphragm vibrates, it applies pressure to the carbon grains, causing an electrical current to flow through them. The pressure applied to the carbon grains changes with the vibrations of the diaphragm. When the grains are pressed close together, more current flows because the carbon grains conduct electricity better this way. When the carbon grains are not pressed as closely, less current flows. This action converts the vibrating movements of the diaphragm into a changing electrical current. The current from the box of carbon grains is then routed through telephone wires to another telephone.

"**Earpiece.** The earpiece receives the incoming electrical current and converts it back into sound. Inside the earpiece is a diaphragm similar to the one in the mouthpiece. Below the diaphragm is an electromagnet made of a wire coiled around a piece of iron. The incoming current passes through the coiled wire, which in turn magnetizes the piece of iron.



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"The magnetized iron pulls on the diaphragm. The pull of the electromagnet varies with the strength of the incoming current from the other telephone's mouthpiece. The changes in magnetic pull cause the diaphragm to vibrate. In this way the diaphragm in the earpiece duplicates the vibrations of the diaphragm in the mouthpiece. By duplicating the vibrations, the earpiece diaphragm recreates the sound waves that originally vibrated the mouthpiece diaphragm.

"**Connecting Mechanism.** Before you can talk to someone on a telephone, the two telephones must be connected. The connecting mechanism is the part of the telephone that tells the telephone company which telephone to connect to yours. You select the telephone you wish to be connected with my dialing or pushing a sequence of numbers. Each telephone has its own number. No two numbers are the same.

"When you are using a telephone that has a dial, the dial returns to its starting position after you dial each number. As the dial returns. an electrical switch inside the telephone connects and then breaks an electrical circuit. The switch connects once for the number 1, twice for the number 2, and so on. When the switch makes these connections, electrical pulses travel through the lines to the telephone company. There, the electrical pulses activate automatic equipment that connects your telephone to the desired telephone.

"Push-button telephones use individual musical tones to identify the numbers. Each tone makes a particular electrical signal that activates the switching equipment." [1]

The message is then received by the receiver.

So, do I need to know some things about sound?

Of course you do. You don't want to go around thinking that everything just magically happens by itself. Dissect the butterfly. See how it works. Then you may invent something as equally important yourself someday.

"The sounds we hear are really vibrations of air. When a person speaks, his or her voice sets the air in motion. These air waves--or vibrations--are really what we hear. Sound vibrations are "waves of pressure in the air. At the high point of the waves, the air is compressed, as it is when a bicycle pump is depressed--the air becomes *more* dense than normal. At the low point of the wave, the air is *less* dense. Talking or singing sets up a complicated pattern of waves, in which the air changes from denser to thinner and back again hundreds or even thousands of times a second.

"The telephone converts the sound pattern into a matching electrical pattern. At the other end of the line, the telephone reverses the process. It changes the electrical pattern back to a matching sound pattern. The telephone accomplishes this magic by means of *transducers*." [2]

Did the inventor of the telephone really accomplish that much?

Did people like shouting between buildings to each other? Did they like flashing messages from mountain top to mountain top with mirrors? Did they like whispering messages to barefoot runners who plied stone paths in the Andes mountains? Do you realize what it was like before Alexander Graham Bell barked those now famous words "Mr. Watson, come here, I want you." into his crude device in 1876?

You have to remember that before Bell's invention, communications were transmitted by *telegraph*. Telegraph allows the transmission and reception of messages over long distances, yes. But the telegraph requires the use of code--Morse Code--and skilled operators both to encode the message and to decipher it. Those skilled operators had to be paid. Additionally, all the encoding and deciphering took time. No more than twenty words per minute could be transmitted by telegraph. Telephones expanded that capacity to up to two hundred words per minute! Bell's invention was an immediate sensation, and his initial income from the device actually came from lectures in which he showed off the device. The company which Bell founded, AT&T, later became the largest company in the entire world. Now that's some success story.

CITY HALL, LAWRENCE, MASS.

Monday Evening, May 28

THE MIRACLE

TELE HONE

WONDERFUL P **DISCOVERY**

TELE HONE

OF THE AGE

Prof. A. Graham Bell, assisted by Mr. Frederic A. Gower, will give an exhibition of his wonderful and miraculous discovery The Telephone, before the people of Lawrence as above, when Boston and Lawrence will be connected via the Western Union Telegraph and vocal and instrumental music and conversation will be transmitted a distance of 27 miles and received by the audience in the City Hall.

Prof. Bell will give an explanatory lecture with this marvellous exhibition.

Cards of Admission, 35 cents
Reserved Seats, 50 cents

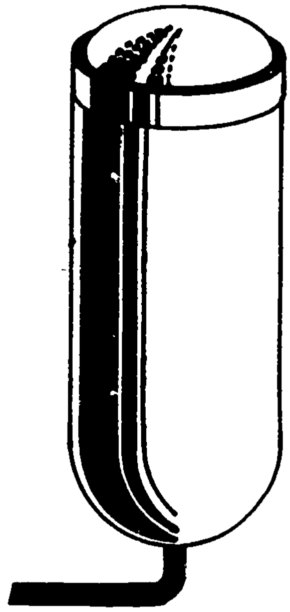
Sale of seats at Stratton's will open at 9 o'clock.

How does a microphone work?

You talk into it and magically everyone hears. Just ask Mick Jagger (of the Rolling Stones). Or Run DNC or any other rock musician you may happen to listen to. Microphones, like so many of our new-fangled gadgets, are often taken for granted.

Actually, when sound waves enter a microphone, they set in motion a chain of events culminating in the apparent re-creation of the sound on a radio or television receiver. Microphones are usually classified by internal structure, pickup or polar pattern and intended use. There are several different types of microphones:

Ribbon or Velocity Microphones. This microphone contains a metallic ribbon suspended between the poles of a permanent magnet. The ribbon moves when sound waves strike it, generating voltage which is immediately relayed to the audio console.



Dynamic or Pressure Microphones. This microphone contains a lightweight molded diaphragm attached to a small wire coil suspended in a magnetic field. Sound waves striking the diaphragm are relayed to the coil and the movement of the coil within the magnetic field transforms physical energy into electrical impulses. This microphone is more rugged than other types and can be used outdoors with less noise pickup from wind.

Condenser Microphones. Condenser microphones are commonly seen in professional recording studios or at stereo FM stations. The condenser microphone has a diaphragm, but instead of a coiled wire, it has an electrode involved. The electrode responds to minute movements of the diaphragm.

Pickup Pattern. The pickup pattern of a microphone is the shape of the area around where it picks up sounds. Microphones can pick up sounds from outside this area, but the quality is usually not good. For best results, the voice or musician should be within the pickup pattern. If you are *off mic,* that is outside the range of the pickup pattern, your voice may be picked up, but not with *fidelity* or clarity. Pickup pattern are classified as:

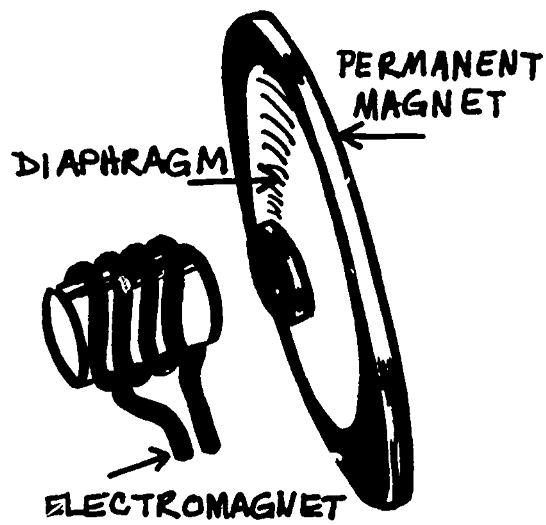
1. **unidirectional**--only one side of the mic is "live"
2. **bidirectional**--two sides of the microphone are live
3. **cardioid**--the pattern is unidirectional and heart shaped
4. **omnidirectional** (or nondirectional)--the mic is live in all directions
5. **muiltidirectional** (polydirectional)--two or more patterns can be adjusted

<u>Does the voice cause changes in electrical impulses in the phone?</u>

Of course it does. As AT&T relates: "When you speak directly into the mouthpiece, soundwaves or vibrations pass through the holes and strike the diaphragm, causing it to vibrate in the identical pattern of vibrations as the words you are speaking. This, in turn, causes the small dome on the underside of the diaphragm to vibrate in the carbon chamber which is part of the electrical circuit. Each vibration causes the dome to compress the grains of charcoal. When the charcoal grans are closer together due to compression, more current flows through the circuit; as the pressure is lessened, the grains have breater space between them, thus reducing the amount of current flowing through the circuit. It is at this critical point that speech is converted from sound waves or vibrations into electrical imipulses or variations. The electrical variations are in fact sound waves in electrical form which are free to flow to the party you're speaking with, where the receiver will convert the electrical variations back to their audible forms." 3

How does the receiver convert the transmitted current to audio-frequency?

The receiver converts electrical impulses or variations into audible sound so they can be heard as words.



"The receiver consists of three basic parts. First, there is the *diaphragm*. The diaphram is different from the one in the transmitter in that it performs as a speaker. It too is fixed to a circular frame; however this frame is made of permanently magnetized iron. Under the diaphragm there is an electromagnet which is simply a cylinder of soft metal with a thin wire wound around it forming a coil.

"Surrounding the magnetic iron diaphragm frame on the under side of the diaphragm is a disc-shaped permanent magnet. This permanent magnet provides a constant pull on the diaphragm's outer ring (called the *armature*.)" 4

What is the function of the diapharam in the sender and the receiver?

"When the varying electrical currents from the transmitter of one telephone flow into the coil of the receiver of another, the coil forms an electromagnetic field which aids or opposes the *permanent magnet*. Magnetic forces in the receiver are alternately increased or decreased, depending on the direction in which the alternating current is flowing. This variation in magnetic pull causes the flexible armature to move in and out. The *diaphragm* moves in and out at the same rate and, in turn, pulls and pushes the air, setting the air into vibration at the same rate. This air vibration is the "voice" you hear in your telephone receiver.

"At the transmitter end of the telephone, sound waves cause vibrations in an electrical current. This varying current is sent out in a pattern that fluctuates in strength, similar to the sound waves. The receiver converts the electrical waves into sound waves by putting air in motion in a pattern that is similar to the electrical pattern.

"Actually the voice that you hear on the telephone really is not our caller's voice. It is a *reproduction* of that voice, a reconstruction of the tone and "personality" of his or her voice." 5

Can I sketch a typical telephone circuit?

Got a pencil? Got a pad of paper? To draw a typical telephone circuit, you need to be able to draw a complete *electric circuit.* A telephone circuit is simply an electric circuit.

"There are four basic ingredients to an electric circuit:

"A **POWER SOURCE** to set the electrons in motion--such as a battery or generator--much as a pump sets a stream of water in motion.

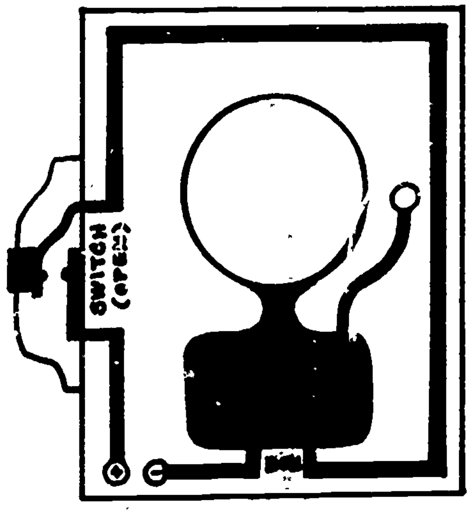
"An **ELECTRICAL APPARATUS**--such as a motor, a stove, a TV set or a telephone--to be operated by the electrons.

"A **CONDUCTOR** which provides a continuous "pipe" through which the electron stream can flow from power source to apparatus and back to the power source. Electrons will not flow easily in materials such as wood or brick--only through "good conductors" of electricity, such as copper.

"A **SWITCH** to complete the circuit and to turn the stream of electrons on and off, much as a faucet turns the water on and off.

"These four ingredients working together make up a simple circuit. More complicated circuits may have many pieces of apparatus working together, and hundreds or even thousands of switches. But an electrical circuit--whether simple or complex--must include all four elements.

To sketch a telephone circuit, you might start by sketching just a simple electrical circuit.



"Like the bulb, the telephone operates as part of an electrical circuit. The *power souce* is in the telephone company building. The *conductor* is in the wire and cable that lead from your telephone to the telephone building. The *apparatus* is the telephone itself. The *switch* is right in the telephone.

"The switch that closes and opens the telephone circuit is operated by the *"plunger"* beneath the telephone handset. With the handset resting in its cradle, the plunger is pressed down--the circuit is broken. Lifting the handset releases the plunger and a spring operates the *switch*. The circuit is now complete. It brings you the *dial tone* which tells you that the telephone equipment is ready to handle your call.

The telephone also contains two other important units. The *bell* is operated by electric current to call someone to the telephone. The *dial* (or push buttons), when operated, sends a kind of "electrical code" to search out and find the other telephone you're dialing." 4

How are telephone electrical impulses transmitted?

There are several means of telephone *transmission*.

"Originally, telephone calls were transmitted only by metal wire. And, for many calls today, wire is still an important transmission means. Telephone wires are still seen on poles. But they are also buried underground--bundled together in a heavy, well-protected *cable*. There are also cables laid under lakes and rivers. And there are telephone cables on ocean bottoms, carrying calls between continents.

"But many long-distance telephone messages make only part of their journey by wire or cable. They may be carried part of the way through the air on radio waves...to cross great land areas and great expanses of water.

"Radio relay systems employ radio waves of high frequency called *microwaves*." These waves are predominantly used over straight "line of sight" paths from tower to tower so they are not blocked by the earth's curvature.

"Short wave radio signals bounce back and forth between the *ionosphere* and earth and are used for radiotelephone calls to many parts of the world.

"Communications satellites receive and rebroadcast microwave messages that penetrate the ionosphere. In effect a communications satellite is a tower in space.

"Beams of light carrying a wide range of telecommunications services--once a dream of the future--are now practical realities and are also joining the other methods of transmission." 6

Okay, now where are the jobs in the phone industry?

Today the telephone industry is involved in more than just manufacture and oversight of phones. Telephone companies manufacture, market, and sell services equipment for telecommunications networks. Whew! Those are big words. But many factors have come together to make telecommunications one of the fastest-changing, fastest growing industries around. Some of the companies are so big that it seems that company could employ almost any job you can name. But technology is the name of the game, and those with technical training and and overall understanding of telecommunications have the inside track.

So how can I contrast acoustical information transmission with that of other energy sources?

It would be a bias and an understatement indeed to say that a telephone is an "acoustical information device." The telephone is an electrical device which may employ mechanical forms of transmission (such as wire), radio waves (from your home portable phone to microwaves), or fiber optical forms of transmission. Telephones are right in the midst of the integration of various forms of transmitting and receiving information.

*1 From **DISCOVERING TECHNOLOGY: COMMUNICATION** by Ronald E. Jones and Janet L. Robb, copyright (c) 1986 by Harcourt Brace Jovanovich, Inc. Reprinted by permission of the author, pp. 243-244.*

2 How the Telephone Works, PE 204, AT&T, 6/79, p. 11.

3 Ibid., p. 11.

4 Ibid., pp. 2-5.

5 Ibid., p. 16.

6 Ibid., p. 16.

Principles of Light and Sound Transmission

Teacher Page

Competency: Identify the principles of light and sound transmission

Tasks: Describe the nature of light and sound
Describe implications of satellite communications
Describe how a communications satellite functions
Explain the concept of orbit-stationary orbit
Explain how a ham radio works
Explain ways of transmitting microwaves
Describe how radar, lasers and fiber optics work
(A) Explain two ways signals are sent by light
(A) Control a device using light rays
(A) Transmit light through a fiber
(A) Explain how fiber optics is used in telephone communications
(A) Contrast the advantages and disadvantages of fiber optics in communication
(A) Construct a project using fiber optics
(A) List industries utilizing fiber optics

Introduction

With the integration of sound and light transmission via fiber optics, light is fast becoming sound and sound, light. Rapid developments in superconductivity using ceramics at temperatures approaching room temperature may dramatically alter the way communications are sent and received. Additionally, home computers and telephones are becoming increasingly integrated. A knowledge of the basic physics of light and sound will allow students the flexibility to keep up with such changes. Students can follow a particular issue, such as superconductivity --the more specific, the better--and report on its impacts or impending impacts on the field of communications. A number of experiments are available. Students can use fiber optics in experiments. Students can create a bulletin board display concerning principles of light or sound. They can list words on the board which relate to principles of light and sound, like *spectrum, sound barrier, prism, band, hologram, pulse, photon, etc.*, pick one, and give a brief explanation of that phenomenon. Students can explain Einstein's theory of relativity and how it relates to principles of sound and light.

Overview

Jobs involving "principles of light and sound" might include junior high or high school physics, math, or science teaching. Students might apply such principles as they work in other fields or as they order or purchase improvements for their homes or cars. Sometimes students are resistant to studying such "abstract" principles. Perhaps it would be best for students to start with concrete experiments and then discover what precipitates the outcome. It seems that few who end up doing basic research in sound and light knew when they were young that was what they would be doing. Basic interest in the field needs cultivation. Great strides in the understanding of sound and light have been made in the 20th century, and with the prospect of superconductivity, even greater strides are possible. Students need to cultivate their interests. A strong background in such principles blended with a strong basic education and some technical training will greatly assist in eventual employment.

Resources

American Institute of Physics, 935 E. 45th St., New York, NY 10017

"The AT&T INFOQUEST Cent Secondary School Curriculum Guide," New York City Board of Education, Divisi.. of Curriculum and Instruction, New York, NY, 1986

Eastman Kodak Company, Educational Markets Services, Rochester, NY 14650. Publication VR-11: Visual Learning Materials

Planetary Society, 65 N. Catalina, Pasadena, CA 91106

Suggested Reading

Discovering Technology Communication, Teachers Manual and Activity Guide, Harcourt, Brace, Jovanovich, Chicago, IL, 1986

Exploring Technology, Activity Manaul, Davis Publications, Inc., Worcester, MA, 1980

People Create Technology, Activity Manual, Davis Publications, Inc., Worcester, MA 1980

"Popular Science," Times Mirror Magazines, Inc., Subscription Dept. Boulder, CO 80322, current subscription price $13.94

Systems of Technology-Laboratory Activities in Visual Communications, University of Texas at Austin, 1985

Technology Activities--Idea Book #1, International Technology Education Association, Reston, VA, 1986

Principles of Light and Sound Transmission

Exactly what are light and sound?

Light might be thought of as a stream of incredibly small particles called *photons*. Light might also be thought of as a wave of energy. Photons travel extremely fast--at 186,000 miles/second in a vacuum. This speed is constant. Photons can travel through air, glass, plastics, or other media. They can bounce or reflect off or pass through various surfaces such as mirror, lenses, and prisms. [1]

Wavelength	Uses
Radio Waves	communication
Microwaves	radar, cooking, communication, spectroscopy
Infrared (heat)	cooking, photography, medicine, any use of heat
Light	visible light
Laser light	communication
Ultraviolet radiaion	flourescent tubes, suntanning, germicidal applications
X-Rays	X-Ray photos, diagnosis and treatment, engineering radiographs
Gamma Rays	Nuclear radiation (extremely dangerous) [2]

Chart A

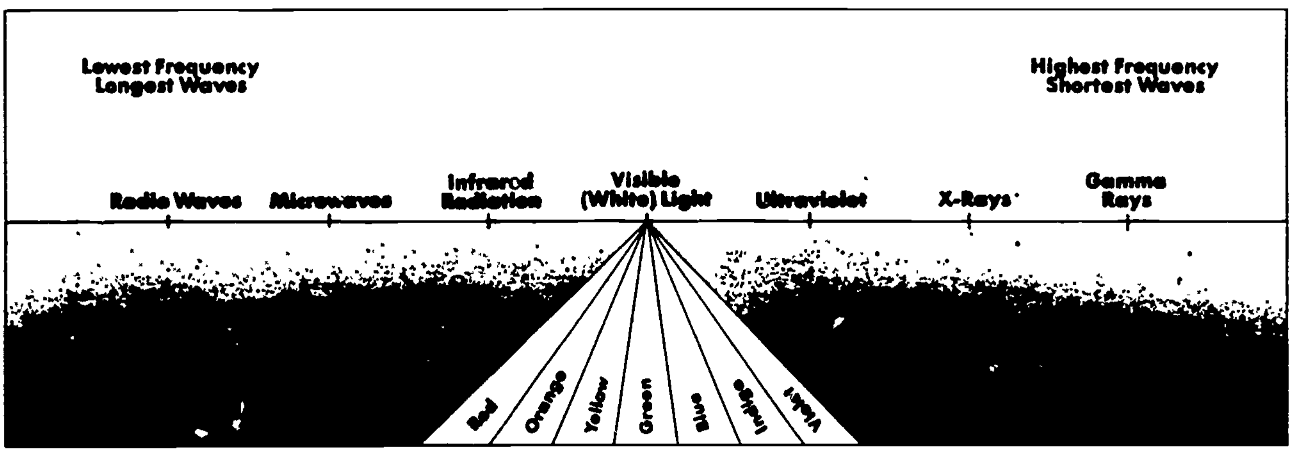
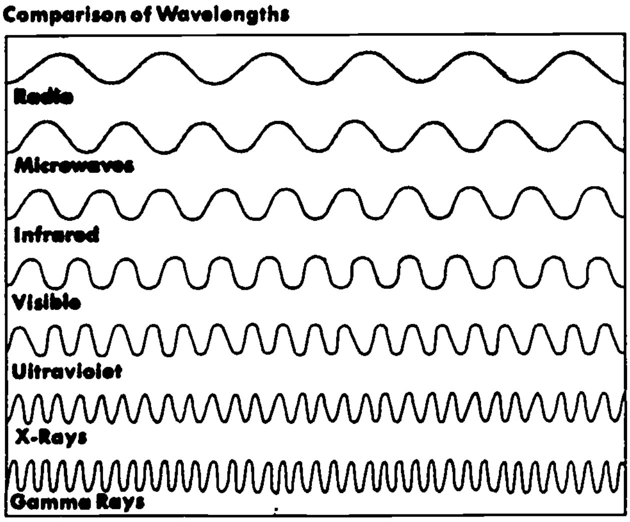


Chart B
Comparison of Wavelengths



How have satellite communications changed things?

It depends on how far back you want to go. It was not very long ago that mail was delivered by dogsled to rural interior Alaska. With the arrival of bush planes in the late '20's and '30's, when the weather was good, a person could receive a letter from Fairbanks in a matter of days. But that letter may have taken a week or a month or more just to get to Fairbanks. Satellite communications allows someone in New York or Paris or Melbourne to telephone someone in that village instantaneously. Instantaneously! What an incredible breakthrough! If you're a history buff, perhaps you know that the Battle of New Orleans in the War of 1812 was fought *after the war was over.* Soldiers on both sides didn't know they had to reason to fight. Satellite communication has not only improved our abilities to become informed, it has radically changed the amount of time needed to recieve that information.

How does a communications satellite function?

A message originates in a television, radio or other studio. That message is fed to an *uplink dish* that beams the signal up to the orbiting satellite. As the Utah Department of Education states, the satellite in turn beams the message back down to Earth where a *downlink* system--a satellite dish--receives it. The downlink signal is very weak, about as strong as a CB radio signal. The intensity of the signal drops as it radiates outward from the central point at which it is beamed. The pattern a satellite signal makes on the earth's surface is known as a *footprint.* The satellite acts as a relay device or a *retransmitter.*

What is orbit-stationary orbit?

A satellite in orbit can have a great advantage. Line-of-sight transmission is valuable, but if the satellite is orbiting the earth, obviously the thing must go around the *other* side to return overhead. What to do? Well, if a satellite is placed in *orbit-stationary orbit,* it will orbit the earth at the same speed at which the earth turns. Thus, a orbit-stationary orbit satellite remains directly overhead.

A slight change slated in the way satellites are positioned in respect to the earth is expected to reduce substanially the fuel needed to keep them in the correct orbital slot. If so, new satellites may last considerably longer than current models, and replacements will not have to be sent up as often.

How does a ham radio work?

There is no particular significance to the word "HAM." A HAM radio operator is a person who uses a home radio for international transmissions. The first HAM was Guglielmo Marconi, the person who invented radio. There are more than 1 1/2 million HAM radio operators around the world, some half a million of them are in the U.S. HAM operators are amateur radio operators, meaning they operate their radios as individuals. Amateurs are granted use of certain frequency bands in the radio spectrum. HAM radios broadcast at a certain *wavelength* and *frequency.* Amateur bands are often referrred to by approximate wavelength rather than frequency. The amateur community won frequency allocations at 10.1 and 24.5 MHz during the 1979 World Administrative Radio Conference.

HAM radio waves travel to their destinations in three ways: directly, along the ground, or refracted or bent back to the earth by the *ionosphere.* The ionosphere is a layer of charged particles in the earth's atmosphere. The study of how radio waves travel from one point to another is the science of *propagation.*

In the late 70's fiber optic systems first commercially carried voices. A lightwave cable will soon carry thousands of telephone calls beneath the Atlantic Ocean.

Today's fiber optics systems carry up to 24,000 conversations simultaneously at 1.7 gigabits per second, fast enough to transmit the entire Encyclopedia Britannica in two seconds.

How is sound transmitted by light?

In lightwave communications, information is transmitted as "pulses" of highly focused light from tiny lasers and light-emitting sources no bigger than grains of salt. The light pulses are carried over "lightguides"--hair-thin fibers of glass so transparent that if sea water were as clear, you'd be able to see the bottom of the deepest oceans. At the other end of the light path, other tiny devices called *photodetectors* convert the light pulses to electrical impulses that can be processed by conventional techniques.

The advantages of fiber optic comunications are numerous. In conventional copper transmission systems, digital pulses can travel for only about a mile before they need to be regenerated by electronic terminals called *repeaters*. In current fiber optic systems, light pulses can travel along lightguides for several miles before regeneration is needed. In one experiment, light pulses traveled through more than 100 miles of fiber without amplification.

Why use fiber optics in communication?

Lightguide cables are only a fraction the diameter and weight of conventional copper cables. Fiber optic cables can often be installed in the same ducts as existing copper cables, thus avoiding costly new construction. Fiber optic cables don't conduct electricity, so electrical interference from power lines and other sources won't interfere.

In 1987 fiber cable networks were under construction under the Atlantic Ocean. This network will handle many communications transmissions as well or better than satellites do. "Trans-Atlantic message traffic doubles every 3 years. The first trans-Atlantic cables were made of copper and could carry 36 conversations. The most recent (TAT-8) is a fiber optic cable capable of carrying 40,000 conversations. Every foot of the old copper cable weighed 2 pounds. A foot of the fiber optic cable weighs little more than half a pound and is only 3/4 of an inch thick. One hair-thin fiber optic lightguide can carry 6,000 conversations, four times the capacity of the copper cable it repaces. In an experiment two thousand million bits per second were sent 130 kilometers on a single fiber without amplification. That pulse rate could transmit the entire text of the 30-volume **Encyclopedia Britanica** in less than a second." [5]

[1] *From "The AT&T INFOQUEST Center Secondary School Curriculum Guide, New York City Board of Education, Division of Curriculum and Instruction, New York, New York, 1986, p. 25.*

[2] ***Ibid.**, p. 31.*

[3] ***TUNE N THE WORLD WITH HAM RADIO**, The American Radio Relay League, Newington, CT 06111, 1986,*

[4] ***The AT&T INFOQUEST Center Secondary School Curriculum Guide**, p. 35.*

[5] ***Ibid.**, p. 31.*

Uses of Citizens Band and Amateur Radios

Teacher Page

Competency: Identify uses of citizens band and amateur radios

Tasks: Define terms associated with citizens band and amateur radios
Contrast radio transmitters and receivers
Explain uses of CB channels
Name basic requirements for ham operators
Identify regulations governing the use of CB and ham radios
Discuss the issue of privacy and censorship in communications
(A) Send voice and code messages by walkie-talkies

Introduction

As many a sourdough knows, amateur radio had--and still has--a place in the formation of Alaska. Because of its great distances, lack of roads, and small population, Alaska and amateur radio have a very parallel history. Students can contact those who utilize HAM radios. Students can study and complete FCC licensing in the classroom. A school would be a good place to set up HAM equipment. Knowledge of Morse Code may benefit the student in other areas of his/her life. Ready materials are available from the American Radio Relay League. A local HAM could offer a demonstration in the classroom.

Overview

There might be more employment than one can imagine in amateur and ham radios. One is not paid to operate such radios--usually--but with the so many amateur radios and those on fishing boats and at work sites around, there is plenty of work for those able to repair radios. Nearly every sizeable community in the state has someone who is able to work on radios, whether to install them or to troubleshoot their installation in boats, planes or in homes. Overall knowledge of amateur radio, as well as in electronics, is helpful.

Resources

American Radio Relay League, 225 Main St., Newington, CT 06111

Anchorage Amateur Radio Club, P.O. Box 101987, Anchorage, AK 99510-1987

Association of North American Radio Clubs, 1500 Bunbury Dr., Whittier, CA 90601

Federal Communications Commission, Washington, DC 20554

Federal Communications Commission, Field Operations Bureau, 6721 West Raspberry Road, Anchorage, AK 99502

International Radio and Television Society, 420 N. Lexington Ave., New York, NY 10170

Land Mobile Communications Council, 1712 N. St., NW, Washington, DC 20036

National Association of Business and Educational Radio, 1330 New Hampshire Avenue, NW, Washington, DC 20036

Radio Emergency Action Citizens Teams (REACT), 75 E. Wacker Dr., Chicago, IL 60601

Special Industrial Radio Service Association, Inc., 1700 N. Moore Street, Suite 910, Rosslyn, VA 22209

Suggested Reading

The ARRL Antenna Book. The American Radio Relay League, Newington, CT

The ARRL Operating Manual. The American Radio Relay League, Newington, CT

Archie's HAM RADIO Adventure. (comic book), ARRL, Newington, CT, 1986

The ARRL Training Program 1986 Official Novice Instructor's Guide. ARRL, Newington, CT

Beginners TRRY Handbook. RTTY Journal, Cardiff-By-The-Sea, CA

Electronic Communications. Shrader, McGraw-Hill, New York, NY

Exploring Electronics. by Gerrish, Goodheart/Willcox, South Holland, IN

First Steps in Radio. DeMaw, Doug, ARRL, Newington, CT

FM and Repeaters. Kearnam, ARRL, Newington, CT

Practical Antennas. Myers, SCELBI Publications, Elmwood, CT

Radio Amateurs Handbook. ARRL, Newington, CT

Radio Frequency Interference. ARRL, Newington, CT

Radio Handbook. Orr Howard Sams & Co., Indianapolis, IN

Solid State Basic. DeMaw & Rusgrove, ARRL, Newington, CT

Tune in the World. American Radio Relay League, Newington, CT

Weather Satellite Handbook. Taggart, 73 Publications, Peterbough, NH

Films, Videos, Slides, Tape Recordings

VT-5, Moving Up to Amateur Radio (11 min., color, VHS, U-Matic). A good general introduction to Amateur Radio. Available from American Radio Relay League, Newington, CT. (Also available as 16mm film F-99.)

SC-4--The First Thirty Years of Amateur Radio. [97 slides, 1 hr.]

T-9 (Tape Recording)--**World of Amateur Radio.** [35 min.] An introduction to Amateur Radio that can be used the first meeting of a licensing class.

T-12--Titantic Story. [1 hour] The sinking of the luxury liner Titantic as remembered by an amateur radio operator.

Uses of Citizens Band and Amateur Radios

What are some terms associated with citizens band and amateur radios?

Antenna--a device made from wire or metal tubing, and used to receive or transmit radio waves.

Bandwidth--the range of frequencies in the radio spectrum that a radio transmission occupies.

CQ--the general call when requesting a conversation with anyone.

CW--a term used by amateurs as a synonym for Morse code communication. It is derived from the fact that Morse code signals are usually produced by interrupting the continuous-wave signal from a transmitter to form the dots and dashes. Also called A1A emission.

Dash--the long sound used in Morse code, pronounced "dah" when verbally sounding Morse code characters.

Direct waves--radio waves that travel directly from a transmitting antenna to a receiving antenna. Also called "line-of-sight" comunications.

Dot--the short sound used in Morse code, pronounced "dit" when verbally sounding Morse code characters, if the dot comes at the end of the character. If the dot comes at the beginning or in the middle of the character, it is pronounced as "di."

Feed line--the wires or cable used to connect your transmitter and receiver to an antenna.

Frequency bands--a group of frequencies where amateur communications are authorized.

Ground connection--a connection made to the earth for electrical safety.

Ham--a person licensed by the Federal Communications Commission (FCC) to be an Amateur Radio Operator.

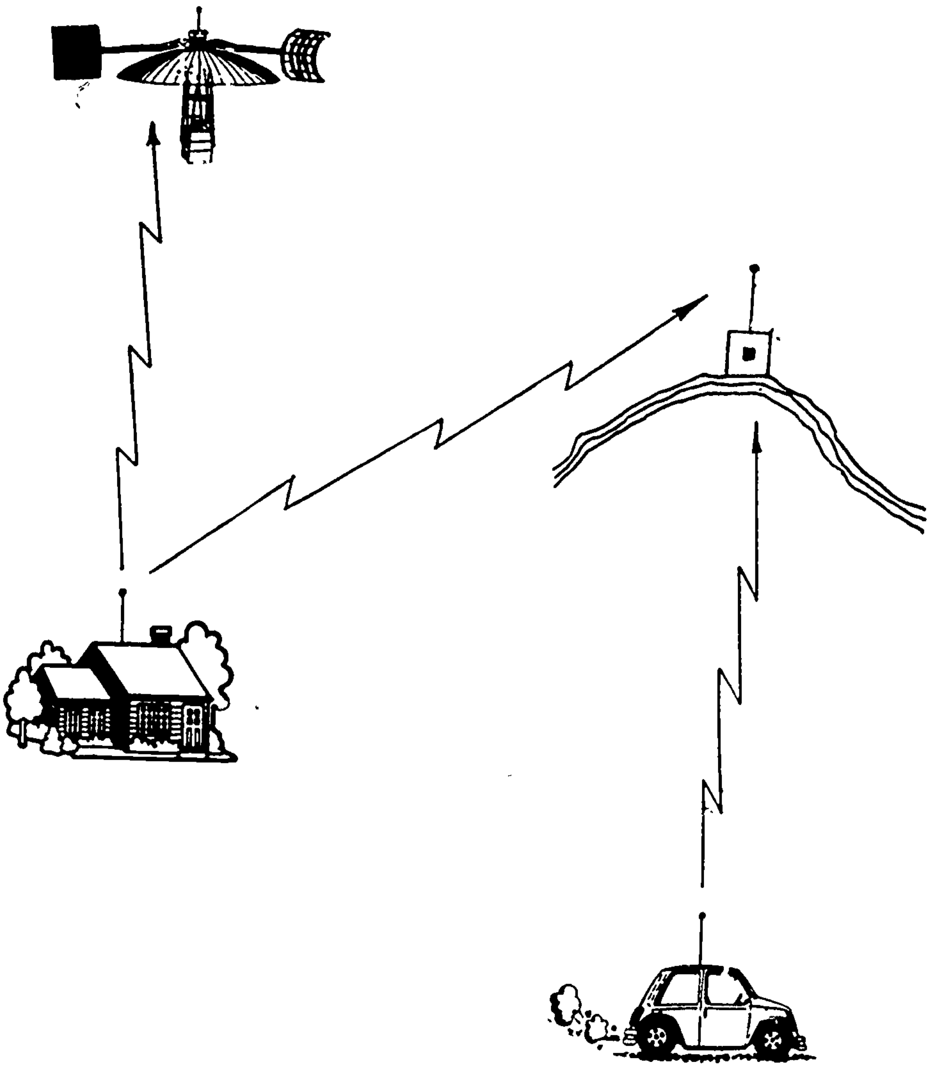
Radio frequency (RF)--the range of frequencies (usually taken as frequencies higher than the audio frequencies, or above 20 kilohertz) that can be radiated through space in the form of electromagnetic radiation.

Repeater--an automatic relay station that picks up a signal from a small transceiver and re-transmits much more strongly from a high antenna. Repeaters can be "linked" to allow someone to talk hundreds or even thousands of miles from a small hand-held radio.

Rig--the radio equipment used by a Ham to communicate with other hams. The rig consists of a reciever and a transmitter. Modern rigs have the receiver and transmitter in the same unit.

Skip--radio waves that are bent back to earth by the ionosphere.

Traffic Net--an on-the-air meeting of amateurs, for the purpose of relaying messages. 1



What is the difference between a radio transmitter and a radio receiver?

A wave is energy which travels through a substance by vibration. Like the rings on a pond from a thrown pebble, waves move out from their source. In much the same way *radio waves* move out from their sources. These waves are a form of *electromagnetic energy*. These waves are created as an electrical current moves through a *conductor* such as copper wire. 2

The *transmitter* is something which sends, and the *receiver* is something which receives. When someone speaks into a microphone or when a record is played on the disk jockey's turntable, those sound signals are converted into electrical current which changes in various patterns. The patterns of changing current are called an *audio signal*. 3

A *transmitter* is a piece of equipment which strengthens the incoming audio signal so that it can be transmitted through the air by a *transmitting antenna*. Surely you've seen transmitting antennas. These transmitting antennas are usually tall towers. They have red lights on top and sometimes have flashing white lights up their sides.

After a radio signal is sent, some distance away the signal induces a voltae in a receiving antenna. That voltage goes from the receiving antenna into a *receiver*, and the receiver converts the radio frequency energy into an audio frequency signal, which you hear from a loudspeaker.

What are some uses of CB channels?

Hey, what's your handle, good buddy? Uh, 10-4 back door. Put the pedal to the metal and let 'er roar...

Recognize any of that lingo? If you do, then you have at least heard of the CB craze of the 1970's. It was during that time that what had been a useful tool for truckers and those in vessels, and some with ranches and other operations became popularized in song and with everyday citizen users (and some could say, abusers). Citizens band constitutes just what the term implies--radio bands reserved for citizens. Some use the bands for commerce, others as an intercom. Many fishing vessels not only carry a VHF (very-high frequency) radio for more official communications, but they also carry a Citizen's Band radio for more informal talk. While many citizens band channels are cluttered with informal chatter, the federal laws governing broadcasting apply to citizens band stations as well.

What are basic requirements for ham operators?

Do you know any ham radio operators? Ham operators use radios which allow them to talk to other ham operators in virtually any part of the world. There are classes of ham licenses:

Amateur Operator Licenses 4

Class	Code Test	Written Examination	Privileges
Novice	5 WPM (Element 1A)	Elementary theory and regulations. (Element 2)	Telegraphy in 3700-3750 (5167.5 kHz Alaska only, emergency communications using single sideband), 7100-7150, 21, 100-21,20-0 and 28,100-28,200 kHz. 200-watts PEP output maximum
Technician	5 WPM (Element 1A)	Elementary theory and regulations, general theory and regulations (Elements 2 and 3)	All amateur privileges above 50.0 MHz plus Novice privileges.

Class	Code Test	Written Examination	Privileges
General	13 WPM (Element 1B)	Elementary theory and regulations, general theory and regulations (Elements 2 and 3)	All amateur privileges except Advanced and Amateur Extra Class. 1500 Watts PEP output maximum.
Advanced	13 WPM (Element 1B)	General theory and regulations, plus intermediate theory (Elements 2,3 and 4A)	All amateur privileges except those reserved for Amateur Extra Class. 1500-watts PEP output maximum.
Amateur Extra	20 WPM (Element 1C)	General theory and regulations, intermediate theory, plus advanced techniques (Elements 2, 3, 4A and 4B)	All amateur privileges. 1500-watts PEP output maximum.

A licenses radio amateur will be required to pass only those elements that are not included in the examination for the amateur license currently held. In other words, if you hold a Novice license, you need not take another 5-WPM code test to qualify for a Technician class license.

You might have an interest in joining an Amateur Radio Club. Perhaps there is such a club in your area. If not, contact Amateur Radio Relay League.

What are the regulations governing the use of CB and ham radios?

CB and ham radios are regulated by the Federal Communications Commission (FCC). These radios fall under the areas of private convenience or amateur communication.

Radio operators are required by law to identify their station. They identify their station with call signs. Call signs identify the *nationality* of the station; they identify the *type* of station; and they identify the *individual* station. As the FCC states, "Radio call signs, in effect, are the 'license plates' that identify communication traffic on the radio highways." The operator must identify the station every 10 minutes or less during a contact and at the end of a contact.

The Communications Act bans transmission obscene, indecent, or profane language or of false or deceptive signals. As the American Radio Relay League relates: "codes or ciphers may not be used to obscure the meaning of transmissions. *Malicious* (intentional) *interference* to other communications is prohibited, and so is transmitting *false or deceptive signals*, such as a distress call when no emergency exists." 5

The AARL further states: "an amateur station may not be used for monetary gain. [The operator] must not accept payment in any form the for use of [his or her] station at any time.

If an operator receives an official notice from the FCC informing him or her that they have violated a regulation, the operator must respond in writing within 10 days to the FCC office that issued the notice.

Are radio communications private, and should they be?

Perhaps you live in a part of Alaska where the telephone is transmitted by radio. Do certain people dial at a certain frequency at a certain time? In other words, do they eavesdrop on conversations? Eavesdropping is, of course, one of humankind's oldest hobbies, but in a nation founded on the right to privacy, it hardly seems ethical. In fact, it is unethical. But then again, how would you like to be trapped in a burning house to discover in one corner a radio transmitter. Would you hope for someone to be *monitoring* your transmission at that time? Of course you would. Privacy of the airwaves is a debatable issue, as you can see. In fact, in many parts of Alaska, some radio channels become almost a newspaper of the air, with people sending personal messages over AM radio or *single side band* channels. Do you live in such a community?

Ham radio operators talk with other ham operators all over the world. They often exchange information about each other's equipment or their home towns.

What are some uses of walkie-talkies?

Walkie-talkies have obvious uses in the military. In fact, walkie-talkies were first popularized there. But today you don't have to go far to find a "walkie-talkie." Today's versions of hand-held radios are in fact just that--hand-held radios. These small versions of VHF (Very -High Frequency) radios have been, through the wonders of miniaturization, reduced in size so that they are very easily held in one hand. As such, these 1 to 5-watt radios can be clipped to a policeman's belt, can accompany a kayaker, or can be air-dropped to a party in need of rescue. Though *single side band radios*, those which send and receive messages which bounce off the ionosphere (upper atmosphere), have gotten to portable size, such radios require stretching 100 feet or so of copper wire to receive. Who could walk around tagging 100 feet of wire?

Small hand-held radios allow industrial workers to talk with workers on the other side of the industrial plant; walkie-talkies let park rangers in the field concur humpback whale sightings; walkie-talkies allow police officers in Anchorage to quickly communicate with headquarters when investigating felonies. Walkie-talkies lend kayakers at sea or mountain climbers high on a peak in the Alaska Range a margin of safety, a way to communicate with an aircraft or, line of sight, with a ground station.

1 *Tune in the World with Ham Radio*, *American Radio Relay League, 1986, p. 2-11.*

2 *From* ***DISCOVERING TECHNOLOGY: COMMUNICATION*** *by Ronald E. Jones and Janet L. Robb, copyright (c) 1986 by Harcourt Brace Jovanovich, Inc. Reprinted by permission of the author, pp. 235-236.*

3 ***Ibid****, p. 235.*

4 *Tune in the World with Ham Radio, p. 2-5.*

5 ***Ibid****, p. 2-11.*

High Technology

CAD
(Computer-Aided Drafting)
Teacher Page

Competency: Understand Computer-Aided Drafting (CAD)

Tasks: Define CAD terms, principles and techniques
Explain the components of a CAD system
Explain basic two and three dimensional coordinates in the Cartesian system
Describe functions of a CAD software package

Introduction

Most industrial education teachers know something about computer-assisted drafting. But not all schools have "taken the plunge" of incorporating CAD into the curriculum. CAD need not replace the traditional drafting program, as traditionally the drafter works from an engineer's, architect's, or designer's rough sketches. A problem may arise in grading students' work in a traditional manner, as with CAD, the quality of many of the products may be similar. Although this is an advantage in industry, it is a challenge for the teacher. Students can, with CAD equipment, follow the format of the drafting lab. Students can start with single-view drawings. Such drawings foster good work habits and tool usage. Students can then proceed to three views, sections, and pictorials. Students need to solve problems on their own, using textbooks and CAD user manuals as resources. Several excellent CAD programs are available for Apple computers. Many standard CAD programs work on the IBM PC. An Apple Macintosh computer and a program such as *Macdraw* offers an excellent introduction to CAD ways of thinking. The industry standard (as of 1987) is the IBM-PC/XT/AT, though Macintosh is making strong inroads.

Overview

Computer-aided drafting and computer graphics are dramatically changing the way people work. Fields such as architecture, engineering, manufacturing, printing and scientific research are being redefined. Great potential for growth is seen in this field. William Burns of the State University of New York College at Buffalo sees up to 100,000 new openings within five years! But computer-assisted drafting will probably not be replacing manual drafting altogether in the forseeable future. Some workers correct computer-assisted drafting printouts using manual tools, as it is sometimes not cost-effective to enter the CAD data base to correct a drawing every time a mistake is found. Careers related to CAD might include drafter, architect, aerospace designer, computer programmer, or computer operator.

Resources

American Institute for Design and Drafting, 102 North Elm Place, Suite F, Broken Arrow, OK 74012

National Association of Trade & Technical Schools, 2021 K Street, NW, Washington, DC 20006

National Computer Graphics Association, 2722 Merrilee Drive, Suite 200, Fairfax, VA 22031 (703) 698-9600

Suggested Reading

The CAD/CAM Workbook, D.L. Goetsch, South Western Publishing, Cincinnatti, OH, 1983

CAE Computer Aided Engineering, 111 Chester Ave., Penton Plaza, Cleveland, OH 44114 Penton-IPC (216)579-6333

Computer Design, Maclean-Hunter Publishing Corporation, 300 W. Adams Street, Chicago, IL 60606, current subscription price $25.00

Stepping Into CAD, Mark Merickel, New Riders Publishing, P.O. Box 4846 Thousand Oaks, CA 91360. AutoCAD microcomputer program

CAD
(Computer-Aided Drafting)

What Is CAD?

In the future, when people look back on our times, they might remember it as the time when computer graphics came of age. *Computer-aided drafting* (CAD) is using computer graphics capabilities to draft plans or drawings for manufacturing or other purposes. After being drafted on the computer, the drawing can then be made into *hard copy* using either a computer printer or a *plotter*. The drawing can be electronically stored, be placed on microfilm, or used to guide automatic industrial machinery.

Traditional drafting methods involved bulky drafting tools such as T squarès, pencils, paper, drawing boards, dividers, and other tools. The quality of the drawing is based largely on the drafter's skill. Using CAD allows the drafter to begin drafting very quickly and to get rid of bulky tools. The computer is consistent in its work and has good quality control. The computer makes it very easy to change the arrangement of a drawing and to correct a mistake.

Architects develop floor, elevation, heating, plumbing, and electrical plans for the construction of new homes or buildings using CAD technology. The automobile industry uses CAD technology to design longer-lasting tires, smaller and more efficient engines, stronger car bodies, and designs for steering and suspension.

What makes up a CAD system?

Obviously for computer-aided drafting, you're going to need a computer. You're also going to need some way to print out the creations the computer generates. Some CAD systems are *dedicated,* meaning the computer upon which they are generated is built only for CAD. Other CAD software is available for nearly any popular computer. A *workstation,* where *input* is created, might consist of a personal computer. That *PC* would be well-equipped to have a *hard disk* of 10 or more megabytes. A megabyte is 1012 kilobytes. Having a large memory and capacity for information means that complex drawings can be stored. Drawings can take up a lot of a computer's memory.

Typically a CAD system must have input devices such as a keyboard and/or *digitizer* equipped with a *stylus* or *puck*, the computer itself, a display screen (monitor), and a plotter. The digitizer sometimes called a "koala pad," is an electronic drawing board. A CAD system can use a standard computer screen or one with *high resolution*. Resolution defines how sharp the images are on the computer screen. That resolution is determined by the *pixels* or pinpoints of light on the screen and by the resolution of the graphics card inside the computer directing the monitor. CAD systems use *plotters,* which are printers with drivers to move pens and paper in relative X and Y axis movements to produce *hard copies*. The pen moves back and forth in the X direction, and the paper moves in the Y direction.

How do we use basic two and three dimensional coordinates in the Cartesian system?

The digitizer (or "koala pad") on the CAD system directs X and Y positions on the cursor on the computer screen. A digitizer may have either a *stylus* or a *puck*. A stylus is like a pencil with a wire attached. A puck works like a computer *mouse*. The stylus allows the draftsperson to use finger muscles to control the stylus. Most draftspersons have less control using the puck because the puck is controlled by the arm muscles rather than those of the finger.

CAD operates by assigning coordinate values to positions on the drawing area of the screen. CAD may assign polar coordinates (distance and angle). Coordinates may also be assigned relative to the last coordinate position given.

What are functions of a CAD software package?

A CAD software package determines how the computer is to operate for drafting purposes. There are two ways to train using CAD software. You could use the actual package which is used in industry, thus learning skills directly applicable to the workplace, or you could use a less sophisticated, less expensive, or tutorial package which allows you to learn the basic principles of CAD.

1 *"**Computer-Aided Design (CAD)**", from Industrial Education Magazine, September, 1986, pp. 10-11.*

2 *Adapted from "**CAD, Computer Aided Drafting, Student Information**" The Utah Office of Education, Vocational Program Division, October, 1986.*

CAM
Teacher Page

Competency: Understand Computer-Aided Manufacturing (CAM)

Tasks: Define automation
Define CAM terms, principles, and techniques
Identify parts of a numerical control system
Contrast numerical control (NC) systems with computer numerical control (CNC) systems
Identify terms related to CNC systems
Discuss interfaces between CAD and CAM systems

Introduction

For the past century, automation, has seemed the wave of the future. The future, the future. Everyone talks of the future. Students need to discuss and debate impacts of the future. Has automation really improved our lives? It's a question worth asking.

Completing activities with computer-aided manufacturing may be difficult at your school. A penchant for manufacturing may be difficult in Alaska at all. The question of the place of manufacturing in the Great Land is also worth debating. Have students take sides with those in favor of increased manufacturing debating those against. As a supplier of natural resources with very little manufacturing, Alaska is in a unique position.

Overview

In computer-aided manufacturing, it is anticipated that there will be a great need for electronic and mechanical service persons, programmers, and machine operators. New workers will be needed and existing workers will be trained. In nearly all manufacturing companies there is high demand for NC and CNC trained personnel. This demand will sharply increase in the future. In the face of unemployment, many jobs in computer-assisted manufacturing go begging. Much traditional manufacturing is now automated and computer-controlled. Skilled people are needed to operate and maintain such equipment.

Resources

Association for Computing Machinery, 11 W. 42nd St., New York, NY 10036

Suggested Reading

The CAD/CAM Workbook, D.L. Goetsch, South Western Publishing, Cincinnatti, OH, 1983

CAM, Computer Aided Manufacturing, The Utah State Office of Education, Salt Lake City, UT, 1985

General Industry and Technology, Bennett & McKnight, Peoria, IL, 1986

Preparing for High Technology, 30 Steps to Implementation, The National Center for Research in Vocational Education, Research and Development Series No. 232, NCRVE, 1960 Kenny Road, Columbus, OH 43210, 1983

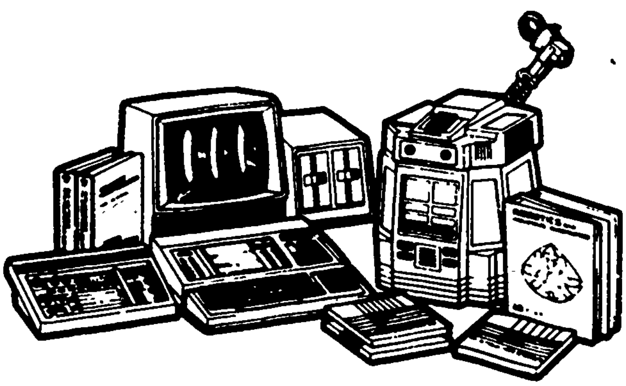
Production Technology, Bennett & McKnight, Peoria, IL, 1986

Understanding Automation Systems, Robert F. Farwell and Neil M. Schmitt, Texas Instruments, available through Howard W. Sams and Company, 4300 W. 62nd St., P.O. Box 7080, Indianapolis, IN 46206

CAM
(Computer-Aided Manufacturing)

How is automation changing the manufacturing workplace?

The computer is finding innumerable applications in the workplace. The computer is virtually changing the face of manufacturing. Currently major applications of the computer in manufacturing include computer analysis and control, numerical control, and computerized interface for automated factories. Computers are used in *scheduling and routing.* The computer assists in achieving a proper balance of input and output in a factory. What previously was done with paper or pencil or in the manager's head is now done electronically. [1] Computer programs are written indicating maximum limits for materials to be used in manufacturing. The computer can call up more materials when they are needed. Likewise, when limitations, locations, and capabilities are all programmed into the computer, the machine can aid in routing. Uses of computers in manufacturing range from huge main frame models to small desk-top units.



Computer-Aided Manufacturing helps answer the following questions:

1. If a product can be made at more than one plant location, how much manufacturing should occur at each plant?

2. If products can be shipped from more than one plant or warehouse, which plant or warehouse should service which customers?

3. When and how often should materials be ordered from suppliers to keep inventory levels at a minimum without creating production line shortages of materials?

4. To meet finished goods manufacturing requirements, how many machine hours should be scheduled for the next week/month? How many labor hours? How many shifts? Is overtime necessary? [1]

Age-old questions of manufacturing are now being answered by a machine!

What is CAM?

CAM is *computer-aided manufacturing*. If something is manufactured and it is computer-aided, it is a CAM operation. The computer is being found in many areas of the workplace. Computers might control the robots which weld automobiles or the automatic fryers which fry potato chips.

What is a numerical control system?

Numerical control (NC) is a form of programmable automation. Numerical control manufacturing processes are controlled by numbers, letters, or symbols. [1] Different sets of numbers and symbols are used for a different job. When the job changes, the numbers and/or symbols change. It is much easier to write new numbers or symbols than to change manufacturing equipment. NC equipment is used in all areas of manufacturing, although its primary application is related to metal. Today, up to 15% of all machines in manufacturing are NC, including drills, mills, lathes, grinders, presses, and welders. NC is used in manufacturing operations in which:

1. Workparts are being produced in various sizes;

2. Workparts are being produced in small to medium-sized batches; and

3. A sequence of similar processing steps is required to complete the workpiece. [1]

NC systems consist of a *program* of instructions, a *controller* unit and a *machine tool*. The program of instructions is the detailed step-by-step set of instructions which tell the machine what to do. It is coded in numerical or symbolic form on some type of *input medium* (this medium could be a punched tape) which will be interpreted by the *controller unit*. The controller unit consists of electromechanical hardware that reads and interprets the program of instructions and converts it into mechanical actions and motions at the machine.[1] For an analogy, think of a player piano. What is written on the paper roll is the *program*. The paper roll itself is the *input medium* and the player part of the piano is the *controller unit*. The piano itself is the *machine tool*. And what does the piano manufacture but music! Presto! Ragtime! In CAM manufacturing, large parts of the manufacturing process might be CAM controlled.

Numerical control is used in manufacturing, generally through the following process:

1. The working drawing of the workpart must be interpreted in terms of processes to be used;
2. Actual dimensions and specifications are taken from the drawing and handwritten into a program;
3. The programmer types the program from the initial hand-written program;
4. A punched tape (perhaps many feet long) is prepared by hand from the typed program;
5. The tape is checked/verified by running it back through the printer and receiving a program printout which is checked for any errors; and,
6. The job is produced on an NC machine under tape control and modified if needed prior to use in manufacturing. [1]

There are advantages and disadvantages of numerical control:

1. Design changes are relatively easy. Holes can be added, moved, or omitted simply by changing the tape.
2. Quality control is simplified since the tape will produce the same accuracies part after part as long as the cutters and machinery are maintained.
3. There is reduced scrap as a result of better quality control.
4. There are reduced space requirements because the tape is smaller than jugs/fixtures which were formerly used.
5. NC equipment is generally three to six times the cost of conventional manual equipment. However, many processes are often put in what are called "machining centers" with one new NC machine replacing several former processes, thus making NC an attractive investment.
6. New people must be trained, including electronic and mechanical service persons, programmers and machine operators. However, most existing workers can be retrained. With the advent of NC the operator's role is less difficult. Often the worker needs only to put a workpiece on the machine table and start the machine (tape). But the NC operator may now be responsible for more than one machine or an entire "machining center." With NC, the operator is nearly eliminated in the conventional sense of "running a machine." The NC can simply run the machine process.
7. Extremely careful planning of cutting tools and processes, usually coordinated with drafting, is necessary if small details are to be built into the component.
8. NC machines do not cut any faster than conventional tools. Metal (and other) materials can only be removed at a given rate and cutters will prematurely be destroyed if speeds and feeds are excessive. However, NC processes are more consistent since they do not fatigue, have family or interpersonal problems, and do not come in late for work.
9. People will often resist changes such as NC since they see this type of change as a threat to their job security. People probably will not be put out of work as such; they simply need to retrain. [1]

How do numerical control (NC) systems contrast with computer numerical control (CNC) systems?

Automated machining began many years ago with the introduction of *tracer lathes*. The operator of the tracer lathe followed a pattern, which was attached to the lathe to produce the product. Following the development of the tracer lathe, Mohn Pearson and the Massachusetts Institute of Technology developed the first numerically controlled (NC) machine tool in 1952. This machine tool was made for the production of particularly complicated workpieces. Just a few years ago, NC machines were extremely costly and few manufacturers invested in this technology. The development of microprocessors, however, has caused a great increase in the use of NC technology. Microprocessors have made the use of NC technology affordable. Today, the cost of a control unit with much larger capacity might cost just a fraction of what it cost in 1968. [1]

With *computer numerical control (cnc) systems,* there is no longer a need for a person to punch cards or tapes. The information can be entered directly into the computer which can store the information in a number of ways, generate the program, interpret the information, and operate the machine tool.

How does CNC work?

"Control units have progressed from bulky tube types of the 1950's to the microprocessor -based computerized numerical control (CNC) units of today. The computer, through the evolution of Numerical Control... makes it possible to create versatile systems capable of producing different parts and automatically adapting to different mixes and variations of part types and lot sizes. In addition, the computer can sense the operating conditions of various machines through CNC feedback and initiate corrective action if needed.

"CNC machines fit well into a manufacturing system's concept as they are primarily used in the mid-volume production range and are capable of many operating tasks in a computer-aided manufacturing environment.

"Current and future developments for CNC revolve around computer solfware. Computer software traditionally lags computer hardware by several years. Computer technology has accelerated so rapidly that software has fallen even further behind. It will take some time for factory management systems to be developed, from a software point of view, that will take full advantage of the increased computer capability.

Computer Aided Manufacturing/Computerized Numerical Control

"Computer-aided manufacturing typically uses machining centers consisting of a single (sometimes two) machining tool equipped with automatic tool changers and capable of performing a wide range of operations on a common workpiece. Typical operations performed at a CAM machining center might include milling, facing, slotting, boring, drilling and tapping on the same workpiece. Often the computer controls the tooling which is "called up", the sequencing of operations, durations of cuts, application of cutting fluid, sensing tool wear, measuring for quality and so on.

"Direct savings are provided to the manufacturer with CAM because of the increased productivity and reduced in-process inventory costs. For this reason, CAM operation is sometimes referred to as computerized numerical control (CNC). NC tapes are related for purposes of performing various operations. When the NC tape is completed, it can be controlled via the computer at a single processing or machining center with a single tool (which can be manually changed by the operator) or with a multiple tool machine."

How do CAD and CAM systems interface?

Interface, in computer jargon, means to tie together. As the State of Utah relates, "Computer -aided manufacturing (CAM) consists of using the computer to control various factors related to processing components being produced. Many of the inputs generated as part of the CAD data base typically can be used to produce a numerical control tape which can be cycled via the computer to control processing centers to produce the component generated earlier in CAD. Identified as generative programming, this CAD-CAM relationship is increasingly being used in industry to identify material to be machined, to select tooling to be used, to aid in determining fabrication steps, and to sequence the tool paths.

"At a basic level CAD-CAM interfacing provides a sophisticated system for combining design and manufacturing functions to increase efficiency. Essentially CAD-CAM systems use CAD -generated data bases to perform CAM operations, thus gaining design and manufacturing functions with a single effort. In fact, many manufacturing operations are increasingly relying on CAD data to be used to program their numerical control tapes used for various shop floor operations. When design, manufacture, and control functions are combined, it can approach being a computerized factory. Theoretically, an automated factory could be operated by an individual at a graphic terminal, developing a competent design, feeding the design into NC equipment and monitoring and controlling with various scheduling, routing, inventory, and other programs. While it may be possible to have computerized people-less factories in the future, currently people are very much a part of the manufacturing process.

"When many systems are computerized in the continuous production setting, consistent work speeds, tool wear, materials flow, tooling changing time, quality levels, and other factors can result in higher productivity. The computerized factory system has tighter control throughout, providing more predictable production circumstances and results. Many systems throughout the world are currently using computerized robots and materials handling systems as part of the computerized factory. In these systems master control schedules are generated based on known production capabilities in the factory. The master schedule will then control materials and/or components called out of inventory stocks and their routing to various appropriate machining or assembly centers.

"Often the load/unlaod function is computerized from the inventory point completely through the point of finished product, completing the computerized factory.

In terms of manufacturing automation, remember:

1. <u>Automation Is Expensive</u>

Automation is capital intensive. It costs money to buy equipment. To make automation pay for itself, the machines must produce a large volume of products.

2. <u>Automation Means New Jobs</u>

New jobs will be created to service the new equipment. Programmers, electronic technicians, computer managers and others will be needed. Some more traditional, labor-intensive jobs may be lost due to automation.

3. <u>Automation Means Working Smarter</u>

The automated workplaces of the future will require those with strong cognitive skills. Workers must be well rounded both in traditional production content as well as math and science, among other areas. Most automated workplaces will require training beyond high school. They may require a B.S. degree.

4. <u>Automation Requires Skills</u>

Automation widens the gap between skilled and unskilled workers. Those without the skills or knowledge or without the willingness to learn new skills will be relegated to the ever-shrinking unskilled tasks.

5. <u>Automation Means More Responsibility</u>

Automation raises the skill level of the employee to that of supervisory level. The automation worker will quite likely be responsible for some extremely expensive equipment.

6. <u>Automation Makes Everybody Managers</u>

The automated factory requires more and better trained workers. The better trained, highly skilled people will demand the respect of management since the equipment <u>cannot</u> function without the skilled people." [3]

[1] *From "CAM, Computer Aided Manufacturing," compiled by Jerry P. Balistreri, The Utah Office of Education, Vocational Program Division, July, 1985.*

[2] ***Ibid.***

[3] ***Ibid.***

Computers
Teacher Page

Competency: Understand computer technology

Tasks: Identify terms and principles associated with computers
Explain how a microcomputer works
Explain uses of computers in offices, schools, and business operations

Introduction

Innumerable possibilites exist for activities involving computers. One student may trace recent computer innovations mentioned in periodicals. Another student may follow the history of the computer from Leibniz to Wozniak. And then there are the programmers. An inherent comprehension of electronic circuitry and pure and simple logic results from writing computer programs.

Overview

Possibly no field has drawn such nebuluous attention as "computers." Recent degree programs in the field or in "data processing" have sometimes become instantly obsolete with the introduction of new technology. Experts in computer technology now often suggest that students not bother learning to program, as the real jobs in computers involve using already-developed programs. Yet, someone must develop those program for people to use them. A solid overview of all aspects of the machines, with easy access to more involved information seems best.

Resources

American Telephone and Telegraph, Public Relations Office, 10 S. Canal St., Chicago, IL 60606

Apple Computer, Inc., 20525 Mariani Avenue, Cupertino, CA 95014 (408) 996-1010

IBM Public Relations Office, Old Orchard Road, Armonk, NY 10504

National Computer Graphics Association, 2722 Merrilee Drive, Suite 200, Fairfax, VA 22031 (703) 698-9600

Suggested Reading

Computer Basics, Time-Life Books, Alexandria, Virginia, Reader Information, Time-Life Books, 541 North Fairbanks Court, Chicago, IL 60611

Exploring Careers as a Computer Technician, Rosen Publishing Inc., 29 E. 21st St., New York, NY 10010

Getting Into Computers, Ballantine Books, Random House, New York, NY

Introduction to Computers, A.R. Kindred, Prentice-Hall, Englewood Cliffs, NJ, 1976

The Personal Computer Book, McWilliams, Peter A., Quantum Press/Doubleday, First Revised Edition, 1984

Films/Filmstrips

"**A Computer Glossary,**" 10 min. Free loan, Intruduces basic ideas and terms associated with data processing and computers. Modern Talking Picture Service, 1658 Carmen Drive, Elk Grove Village, IL 60007.

Computer Awareness, $135.00. This series of four filmstrips with cassettes introduces the student to how computers work, how they are used, languages, and simple programming methods. The filmstrips also prepare students to work with the programs' optional microcomputer disks which are available at an additional cost. Society for Visual Education, Dept. LC, 1345 Diversey Pkwy., Chicago, IL 60614.

IBM Film Library, 4705-F Bakers Ferry Road, SW, Atlanta, GA 30336.

"**The Information Machine,**" 10 min. Free loand. An animated film about the development of the computer and the nature of data processing. Modern Talking Picture Service, 1658 Carmen Drive, Elk Grove Village, IL 60007.

Computers

Just what are computers?

You don't have to know a lot about computers to use them. Maybe you've seen first-graders pecking out words on a computer keyboard at school. You can use a vacuum cleaner without knowing just how it works, and you can use a computer without being a computer scientist, or a computer technician. You just use them and when you're done, you turn them off. But of course you may want to know more.

To understand computers fully, you need to understand a little bit of their history. They haven't been with us so long. In fact, having them in every classroom and in many homes is a very recent phenomenon.

Some say Britain's prehistoric *Stonehenge* was a type of computer. Prehistoric people could work out their calendar from the position of the shadows on the stones. Very simply put, a computer is something which *sorts information.*

The first computer was the *abacus*. Maybe you played with an abacus in elementary school. An abacus is still used in parts of the world for government or private business. The abacus was first used over 5,000 years ago. The next breakthrough in the development of computers was the French scientist Pascal's development, in 1642, of an "arithmetic machine." (Perhaps you've heard of a high-level computer language called "Pascal".)

In 1694 the German mathematician Leibniz brought out a machine designed to add, subtract, multiply, divide, and extract square roots. It did not work. But Leibniz broke mathematical problems into steps. Where Pascal used ten symbols--*the decimal system*--in each mathematical problem (0,1,2,3,4,5,6,7,8, and 9), Leibniz used two--*the binary system*--(0 and 1). A machine works well with absolutes--off or on, black or white, up or down, in or out. The binary system works especially well with machines. Numbers in the decimal system can be created using binary symbols. In binary, as in decimal systems, the number 0 is zero. But in binary, the number 1 might be thought of as a *place holder*. In the binary system there are two digits and the system is based on twos.

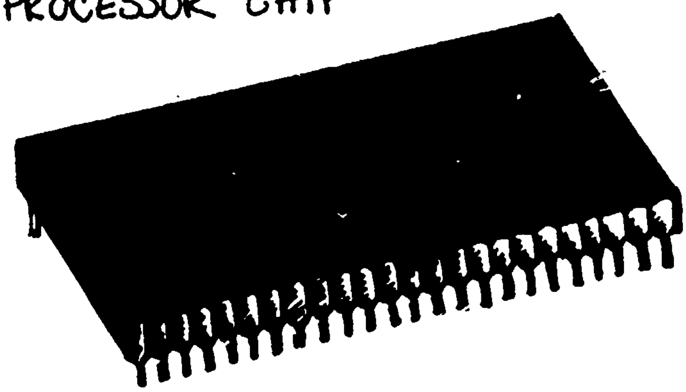
So how would you write the numbers **one, five, ten, twelve, fourteen,** *and* **fifteen?**
Here they are written both in decimal and binary:

Decimal					**Binary**					
Number	**Tens**	**Ones**			**Eights**	**Fours**	**Twos**	**Ones**		
One		1	=	1				1	=	1
Five		5	=	5		1	0	1	=	101
Ten	1	0	=	10	1	0	1	0	=	1010
Twelve	1	2	=	12	1	1	0	0	=	1100
Fourteen	1	4	=	14	1	1	1	0	=	1110
Fifteen	1	5	=	15	1	1	1	1	=	1111

The binary numbers may look a little odd, but that's because we typically don't use the number 1100 to write the number twelve. But because an electronic switch typically works in two positions--*off and on*--binary is the perfect digital notation for computers. The switch is either *off* or *on*. That's it! So all numbers, letters, pictures, anything which can be *digitalized*. (drawn or written from a series of digits or small points of light) can be processed and/or reproduced on the computer. That's how a computer can come up with your picture. That's how a computer can complete mathematics. A computer represents the alphabet with binary code. An accepted standard for representing letters and symbols with binary is the *American Standard Code for Information Interchange--ASCII*. In ASCII, the capital letter "A" is represented by 01000001, the capital letter "Z" by 01011010. You can imagine how many ones and zeros a computer has to whiz through just to print a sentence! How about a paragraph? How about a novel? 01001000 01000101 01001100 01010000! (That spells HELP!) You can see that those little information processors can compute information that would be hopelessly tedious for people.

A computer contains a mass of *silicon chips*. Silicon comes from ordinary sand. Electric current passes through the chips in a series of pulses which form a code. That code ends up representing numbers, letters, or colors. In binary code, the digit "1" stands for pulse and "0" stands for "no pulse." Through a series of pulses and no pulses, the computer is able to complete its work.

MICROPROCESSOR CHIP



How does a mirocomputer work?

The stream of pulses travelling through the computer *circuits* is controlled by the *transistors* switching on and off, sending pulses on around the circuit or holding them back. These transistor switches are also called *gates*. Each gate in the computer circuits contains two points called *terminals*. Whether or not such *terminals* send pulses on or not depends on the pulses the gate receives. There are three types of gates: one called an **AND** gate, one called an **OR** gate, and one called a **NOR** gate. An **AND** gate only sends a pulse on when it receives a pulse at both of its terminals. An **OR** gate only sends on a pulse when it receives one at either or both of its terminals. A **NOR** gate sends a pulse on if neither of its terminals receives a pulse. Thousands of gates are arranged in circuits to create patterns of pulses which allow the computer to operate.

A microcomputer has specific architecture. That architecture involves a system board containing the *central processing unit (CPU)*. Every instruction given the computer (input) must be examined and acted on by the CPU. The computer contains a quartz crystal clock which coordinates the responses of the computer's circuits. The system board also includes *ports* for connecting input and output attachments and microchips for Read-Only Memory (ROM) and Random-Access Memory (RAM). RAM stores information only while the computer is turned on.

So what exactly is the function of computers in offices, schools, and businesses?

You've certainly seen plenty of computer terminals in school offices, airport terminals, even at home. As super information processors, computers have an ever-increasing impact on all of our lives. Your digital watch actually contains a micro-processor. The watch might be thought of as a computer. Computers are found in millions of homes, being used for word processing tasks, for budgeting, for games, even for shopping. The machines can be put to innumerable uses, wherever information or numbers need to be explained, stored, or computed.

Jobs in High Technology
Teacher Page

Competency: Identify jobs in high technology

Tasks: Describe jobs in:

a. computers
b. robotics
c. CAD
d. CAM
e. satellite technology
f. laser technology
g. photovoltaic technology

Introduction

Considerable attention is going into the ways technology is changing the workplace. Not only has the automated office emerged as computers have entered all phases of employment, but whole new fields--such as desktop publishing--have emerged as a result. A student needs a strong background in technology and principles of technology to compete for jobs which require increasing complex skills.

A curriculum which aims toward employment in manufacturing might feature machine shop, metals, drafting, CAD, CAM, robotics, and computers. But do not ignore basic skills. Students need a sound overview of high technology rather than specific skills in one or two areas.

Overview

Increasing use of computers will mean that many workers will need skills in computer science. Some workers will program, but most will simply use the equipment. Traditional manual occupations, excepting those in the service field (such as custodian) will continue to decline. There will be openings in equipment repair. Students will need a sound foundation in electronics and hydraulics as well as integration of technological systems. Students will need competency in reading, writing, arithmetic, problem-solving and computer literacy. Employers will look for employees with "invisible skills" such as self-discipline, reliability, adaptability, and knowing how to learn. They will need employees who anticipate change in the workplace and who are ready to adapt to those changes.

Resources

Alcoa Aluminum, Public Relations Department, 1501 Alcoa Building, Pittsburg, PA 15219

General Motors Corporation, Public Relations Department, Detroit, MI 48202

National Computer Graphics Association, 2722 Merrilee Drive, Suite 200, Fairfax, VA 22031 (703) 698-9600

Suggested Reading

General Industry and Technology, Bennett & McKnight, Peoria, IL, 1986

"Operator Roles in Robotics," Robotics Age 6, John Lyman and Azad M. Madni, (January 1984): 39-41

People Create Technology, D.J. Jambro, Delmar Publishing Co, Albany, NY, 1982

Production Technology, Bennett & McKnight, Peoria, IL, 1986

Resources in Technology, Davis Publications, Inc., M. Printers Bldg., Worcester, MA 01608. A series of documents developed for the I.E. Service, Virginia Department of Education for classroom duplication

Technology for Tomorrow, South Wester, Cincinnatti, OH, 1985

Jobs in High Technology

What kind of job am I going to find in computers?

Even though there is very little manufacturing in Alaska, there are still innumerable openings in the field of computers. The machines, in fact, have found their way into so many nooks and crannies of all of our lives, that saying you "work with computers" has become a meaningless phrase. That's like saying "well I work doing something." Computers influence nearly everyone who lives in our western society. They have made quite an impact.

You might divide work in the field of computers in two, in the same way computers interact with information: input and output. You might be one of those who directs what computers do; you might be a computer technician who fixes or customizes computers. Work in this area is changing. Where an electrical technician of the past would perhaps have dug into the circuitry of appliances, computer microchip circuitry is microscopic. The work of such a technician today might involve determining the problem by testing the machine (some computer programs are available which do the testing), and then replacing entire systems of circuitry. With the millions of machines in homes and businesses, and even though the machines have few moving parts and usually function reliably, the business of troubleshooting and repairing the machines is thriving--even in Alaska. Some in this same category of work help design the data processing systems which allow the machines to perform in certain ways. Such people are *data processors.* Data processors help design, adapt, or customize computer software so that it satisfies the user's needs. Imagine the miracle of a person in a remote portable location calling up pages of information about someone else (police do it all the time). Someone has to design a way that all of that information becomes available, is stored accessibly, and is in order.

You might instead be simply a user of computers. Most people will fall in this category. Just as you don't need to know exactly how an automobile works in order to drive one, you don't have to be able to program a computer in order to use a computer program. What you do need to be able to do, however, is know how to type (though "hunt and peck" works for some) and use a ten-key pad. And, you need to know or to be able to learn, the ins and outs of certain software. Somebody else does the developing of software for you. Use of computers is headed this direction--away from individual programming and towards use of packaged, commercial programs. To be able to use computer software, you just need to know some basic concepts.

Computer software is sometimes complex and using that software requires an inquisitive, adventurous nature. Those who use complex software must not be afraid of exploring its capabilities. Programs developed by such software giants as *Microsoft* and *Lotus* not only equip a computer user to create documents, compile data, or plan construction, but also make it easier to operate other software systems. As computer systems become more *user friendly* (easier for the newcomer to use), the focus will shift to creative use of the machines, not just simple familiarity. Your job in computers will probably involve *using* the machines. While some workers will be involved in programming and computer science, most will only need to know how to use the keyboard or a digitizer, read the monitor, or interpret a printout.

Careers related to computers include data processor, computer repair, service, installation person, word processor, accountant, systems analyst, planner, business person, home economist, airlines reservation agent, computer sales person, and, many others. That's a lot of people!

What kind of job am I going to find in robotics?

Robots today are replacing direct laborers. Perhaps you have seen pictures of robots welding autos together on auto assembly lines. Perhaps you have seen pictures of robots spray-painting the vehicles. Wherever repetitive, dangerous, or mundane tasks are being done by hand, a robot many be able to do them. Human workers need regular pay, need personnel policies, job counseling, and benefits. Robots need none of the above. But robots do need one thing. They need maintenance. And that's where people come in.

It is estimated that fewer than 10,000 robots are currently in use in American industry. That number is expected to swell ten-fold in the years to come. The Japanese have pioneered the technology; their manufacturing successes are renowned. But as Steve Hsiung of the University of North Dakota relates: "robots can only improve productivity and product quality when implemented by trained professionals." Workers *are needed* to implement and maintain the equipment. Your job might be as a robotics repairperson, a specialist in hydraulics (robots lift great weights hydraulically), or a robot technician. A robot technician might help perfect the motions the robot follows in its *working envelope* (its area of reach) so that the robot performs the most efficient movements in the least amount of time. What you need for such work is a working understanding of the robotic literacy--the terms and concepts which underlie robotics.

Since Alaska currently has little manufacturing per se, robots may seem abstract and futuristic to Alaskan workers. But robotics has innumerable applications. In many cases machines can work more safely and efficiently than hand-laboring humans. Robots may have an increasing role in fish, mineral, and timber processing. Alaska may develop some light manufacturing which involves robots. You may find a job in the lower '48. Robots are an increasingly important feature of the industrial scene, and it pays to know what is new.

What kind of job am I going to find in CAD?

With any computer-assisted work, the jobs involve being able to use the computer. You might concern yourself with the most commonly used computer and software program in the kind of drafting you are interested in, but replicating exactly what you are going to do when you have a job is not all-important. Concepts of CAD are similar on most machines.

In manufacturing, CAD, coupled with CAM, takes a computer drawing and turns the dimensioning and tolerances into a readable format that a machine tool uses for the post processing. It is unlikely, however, that Alaska will become a manufacturer or provider of machine parts in the near future. CAD, however, has a formidible place outside of manufacturing. During the Alaskan construction boom of the 1970's and early 80's, designers and architects blossomed in the Great Land. CAD has a place for designers, planners, and draftspersons. As computer software moves more towards overall project planning and simulation, those who can use software which integrates graphics, graphing, word processing, layout, and CAD, will have an employable edge.

Careers related to computer-aided drafting include mechanical, electrical, and residential drafter, architect, aerospace designer, computer programmer, and computer operator.

What kind of job am I going to find in CAM?

Single, manually-operated machines are not cost efficient today. Parts made manually on a metal lathe and in milling machines are expensive in terms of human labor. Numerical control allows a machine to produce a family of parts and to control critical tolerances. Highly skilled lathe operators who formerly operated a machine manually may now be numerically controlled machine operators who set up the lathe or milling machine. They may oversee the operations of a number of machines that are controlled by a computer. Familarization with particular equipment may not be as important as a good well-rounded knowledge of all aspects of such operations, an ability to communicate, some fundamental skills, and a good attitude.

Careers related to Computer Aided Manufacturing include manufacturing technician, engineer (mechanical, aerospace, and architectural), machinist, and computer programmer.

What kind of job am I going to find in laser technology?

Laser technology is making great inroads into many aspects of contemporary life. Low-level laser beams scan product labels at the grocery store; laser beams detect someone approaching an automatic door; laser beams fuse damaged corneas in eye surgery. Your job involving laser technology may involve *using* lasers rather than building or repairing them. A sound background in laser principles will assist you.

Related careers include those in construction, manufacturing, communications, medicine, and the military. Careers related to laser communication include video equipment sales and service; laser manufacturing; repair, service, and installation of laser printers; laser engineers, holographers, and laser technician.

What kind of job am I going to find in satellite technology?

Satellites are neither manufactured nor launched from Alaska. Such work in high technology is done elsewhere in the U.S. But as the premier space nation on earth, the U.S. has a major role in satellite development and utilization. The U.S. is at the forefront. Alaska, with its sparse population and wide open spaces, needs and uses considerable satellite technology in broadcasting and communications. Countless homes have satellite dishes. Satellite-supplied cable television graces many an Alaskan home. Satellite dishes set up in rural villages beam and receive telephone messages. Satellites inform and relay information to Alaska's many military installations and watch stations. Jobs in communication, with the military, with state and local government, or with a cable television company might call for a background in satellite technology. Alaska relies heavily on the devices.

Alaska is currently a consumer of technology, not a developer. Manufacture and design of satellite technology is pursued and will continue to be pursued Outside. But Alaska is a heavy user of satellite technology. Satellite technology provides television and telephones to rural areas, provides eyes and ears to the important defense network, and links together villages and towns. Those who can purchase, operate, repair, and oversee such equipment will be in demand.

What kind of job am I going to find in photovoltaic technology?

Photovoltaic technology is not completely foreign to Alaska, even though the state has long periods of darkness. But the state has corresponding long periods of sun, and with the remoteness of many Alaskan locations, photovoltaic technology will have a role in the state's energy use. The U.S. is well seated in the development of solar technology, but very little if any of that development takes place in Alaska. Working in photovoltaic technology in Alaska would involve advising and assisting others with solar projects.

The energy field seems ever-changing. Modern industrial society is a society based on consumption of energy. The welfare of economies and nations rides on energy prices and availablity. Photovoltaic technology offers a degree of energy independence anywhere the sun shines. Alaska utilizes some photovoltaic technology; remote sites sometimes benefit from on-site power generation. Some transmitters on the trans-Alaska pipeline are charged and recharged by solar cells. However, Alaska has long periods of darkness. Photovoltaic technology can supplement power generated by other sources or replace those other sources during periods of long light. Since the state does not manufacture such devices, jobs in photovoltaic technology will probably involve ordering, installing, and servicing such equipment.

Careers related to photovoltaics include solar researcher, solar unit designer, solar cell manufacturer, electrician, construction draftsperson, solar collector installer, and satellite manufacturer.

A recent report titled "High School and the Changing workplace: An Employer's View" prepared by the panel on Secondary Education for the Changing Workplace, a committee of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine, came up with, among other findings, the following: [1]

- Young people today will face great changes in technology during the 40-year work careers. Change will be gradual and steady.
- High school graduates will need to understand and adapt to that change.
- A sound *fundamental* education will help those graduates adapt.
- Students need to have a functional command of spoken and written English.
- Students need to be able to analyze and solve problems logically.
- Students need knowledge of math at least through elementary algebra.
- Students need to know the scientific method and basic principles of physics, chemistry, biology, and computers.
- Students need to be able to deal constructively with others.
- Students need good work habits.
- Students need to understand the American and other economic systems.

1 *Adapted from **Skills for Lifelong Careers,*** William E. Burns Ed.D. State University of New York at Buffalo, from Industrial Education Magazine, March, 1986 pp. 8-10. Used with permission.

Laser Technology
Teacher Page

Competency: Use laser technology

Tasks: Explain laser terms, principles, and techniques
- Follow safety procedures
- Explain the various ratings of lasers
- Explain characteristics of laser beams
- Illustrate the spreading of the laser beam
- Split a laser beam
- Change the direction of the laser beam
- Discuss fiber optics
- Use the laser to transmit a signal (such as a voice signal)
- Use a polarizer to vary the intensity of the laser beam

Introduction

Your school may or may not have a laser. Hopefully, you have one. If you do, the activities listed here require a Helium-Neon laser. The school can order one of several such laser kits. These kits offer considerable hands-on experience and demonstrate the fundamentals of laser technology. Students can investigate applications of laser technology by visiting a supermarket to see the laser-scanner check out stand in use. A student report could explain how the scanner reads product labels. An ophthalmologist familiar with laser eye surgery could explain to the class how such technology has changed his or her medical practice. Visitors from industry who use lasers in cutting, welding, or heating can explain the use of the technology in their professions. The use of laser technology in surveying the military and law enforcement can be explored. Students can report on or inspect such uses as an individual or class project.

Overview

Lasers are creating a need for more computer programmers and numerical-control tool programers. Laser technology is supplanting occupations such as drill press operators, heat treaters, machine tool operators, sheet metal workers and welders. But the use of lasers will create new jobs as well. Included in these new areas of employment are jobs as fiber optics engineers, ring laser gyro engineers, gyro-optics technicians, laserists, industrial laser process technicians, laser beam machine operators, laser beam color scanner operators, and others. Engineers and physical scientists make up about 20 percent of the workforce in the development and building of laser equipment. This is ten times higher than in most other industries, and reflects the newness of this field and the wide range of applications being developed. As laser usage increases, more engineers with specialities in communications, design, electrics, optics, and processing will be needed to develop new systems. Demand is also expected to be created for sales engineers who can exhibit, display, and explain equipment; for optical engineers to research and develop optical components; for fiber optics engineers to build efficient light communications systems; and for safety engineers to protect workers and users from injuries. Also expected is a need for more physicists and chemists to perform more research and development on optics and light-emitting properties of molecules, and on other particles.

Engineering and science technicians acocunt for over ten percent of the workforce in most laser manufacturing companies, as compared with one percent in other industrial manufacturers. A strong demand for these technicians is expected, especially for workers with skills in electrical, mechanical, and optical engineering technologies. A new occupation called laser electro-optical technician has emerged to meet this demand. These workers assemble and test, service and maintain laser equipment.

Laser printers should decrease in cost in the next few years. Their use will probably cause a significant decline in printing-related occupations, lessening the need for compositors, engravers, typesetters, photoengravers, and printing equipment repairers. [1]

Resources

Center for Occupational Research and Development, 601 C Lake Air Drive, Waco, TX 76710 (for information about careers for laser technicians)

Laser Institute of America, 5151 Monroe Street, Suite 118 West, Toledo, OH 43623

Metrologic Instruments Inc., 143 Harding Avenue, P.O. Box 307, Bellmawr, NJ 08031-0307

Suggested Reading

Course 1 Introduction to Lasers, Center for Occupational Research and Development, Inc., 4800 Lakewood Dr., Waso, TX 76710

Lasers, the Light Fantastic, Clayton Hallmark, Blue Ridge Summit, PA: TAB Books, 1979

Lasers, Raintree Publishers, Milwaukee, WI, 1981

Films and Filmstrips

"Introduction to Holography," 17 min. Order # 8276, $11.00 Uses actual expoeriments and animation to explain basic principles of holography. Shows solme holograms. Discusses usefulness of holography as a scientific tool and as an artistic medium. Bureau of Audio Visual Instruction, University of Wisconsin-Extension, Box 2093, Madison, WI 57301.

"Lasers Unlimited," AT&T, Bell System, Mountain Avenue, Murray Hill, NJ 07974.

[1] From "A Career in Laser Technology," by William E. Burns, reprinted from Industrial Education, April, 1986, p. 9.

Laser Technology

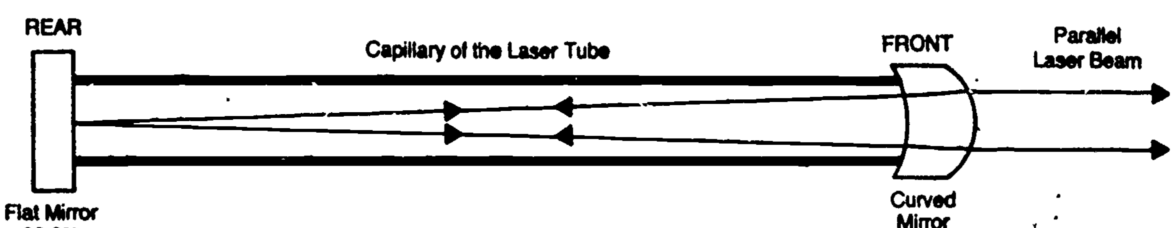
What are lasers?

Lasers are devices which produce a tremendously hot, narrow beam of light. They are used to cut metal, print catalogs, drill holes, and produce holographs (three-dimensional images). They are also used to perform eye and ear microsurgery, to transmit information, and for many other tasks.

Lasers were invented in 1960 in California. However, the principal of using a light source to produce heat is similar to using the rays of the sun passing through a magnifying glass. Archimedes used a "burning glass" in 212 B.C. to produce a hot, narrow beam of light to set fire to Roman ships beseiging Syracuse (Sicily).

Laser means **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation (energy). A laser produces light in which all light waves are in phase with each other. The result is a hotter, more intense light.

A laser consists of a device containing a crystal, gas or other lasing substance in which atoms (photons) stimulated by focused light waves are amplified and concentrated, and then emitted in a very intense, narrow beam. A photon is the energy of light. Photons do not have mass or charge, but possess momentum.



Semi-confocal Mirror Arrangement

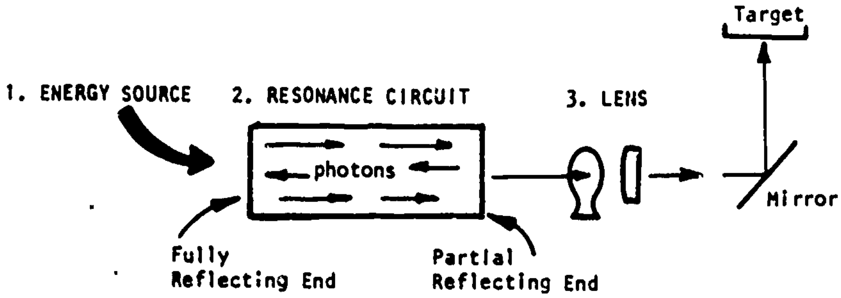
What are the different parts of lasers?

Lasers consist of:

1. *A source of energy.* This might be light, an electric current, another laser, or battery cell.

2. *A resonance circuit.* This is a cell or device that contains a crystal, gas, or other "lasing" substance which acts as a medium . One end of the device partially reflects light waves while the other end fully reflects light waves. When stimulated by the energy source, the lasing substance inside the device absorbs the energy and releases it as a stream of photons. The photons vibrate back and forth between the ends of the reflecting surfaces, concentrating them into single phase waves, which continue to absorb energy and amplify.

When concentrated, the photons are raised to higher energy levels. At a predetermined level, the photons can pass through the partially reflecting end of the resonance device as a narrow beam in intense, single phase light.



3. Optical elements. The highly amplified light beam then passes through optical elements such as a lens, mirror, or combinations of lenses and mirrors. These elements can change, modify, or alter the size, shape and other characteristics of the laser beam. They also direct the laser beam to its target.

What are the different types of lasers?

Lasers are characterized by the the active medium used in the laser. Lasers are generally classified into three types:

1. Gas Lasers These might include gases such as helium-cadmium, helium-neon, argon, carbon-dioxide, or krypton.
2. Solid Lasers These might include solids such as rubies, semi conductors, neodymium, or erbium.
3. Liquid Lasers These might include liquid dyes, household detergent, or water vapor.[2]

Are lasers dangerous?

Lasers vary in power. Some have an output of only a few thousandths of a watt. Much more powerful lasers are used to burn, cut, and drill.

A laser could damage your eyes. **Never look directly into the laser beam or stare at its bright reflections.** The federal government classifies lasers according to their power levels and specifies safety features for each level. Demonstration lasers are Class II. These lasers require a yellow "**CAUTION**" label with the warning "Do not stare into beam." The laser should be plugged into a grounded outlet. [2]

Laser Safety Rules

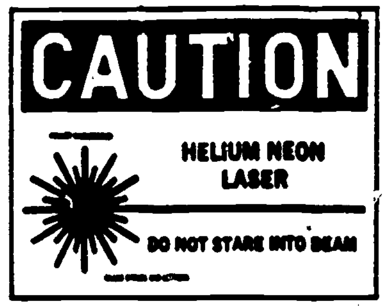
1. Never look into the laser beam.
2. Never direct the laser beam into another person's or an animal's eyes.
3. Only use the laser with the instructor's permission.
4. Only use the laser after having adequate prior instruction.
5. Use the laser only for the purpose for which it is intended.
6. Turn the laser off when through.
7. Do not look at mirror-like relfections of the beam.
8. Post appropriate caution sign. [2]

How are lasers rated?

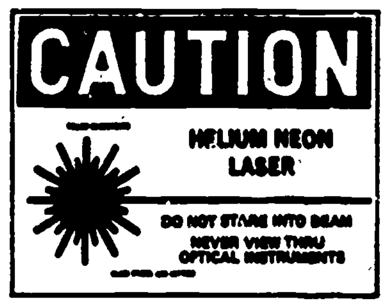
Lasers are classified into four major groups based on the output power of its beam. The power or strength of the laser beam is measured in milli watts (m W).

Class I lasers have such a low-powered beam that they cannot cause damage to anyone or anything. People can look all day directly into a Class I laser without damage to their eyes. Examples of Class I lasers include supermarket checkout scanning systems and video disk readers.

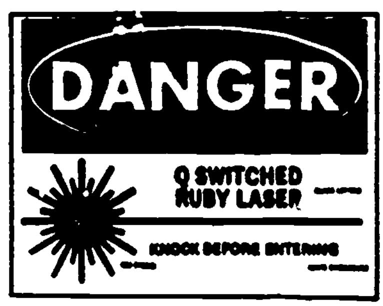
Class II lasers have a visible beam with a power rating not exceeding 1mW (one thousandth of a watt). Common demonstration lasers are Class II lasers. They have a yellow "**Caution**" sign on them saying not to stare directly into the beam.



Class III lasers have a total power output up to a maximum of 5mW. **Class IIIa** beams are visible. **Class IIIb** beams are invisible. These lasers can damage the eye.



Class IV lasers exceed 5mW output. Even a scattered reflection of the beam can cause serious eye damage. The beam can cause serious skin damage. Class IV lasers are used to cut or weld metals. They are usually enclosed in a protective cabinet. [2]

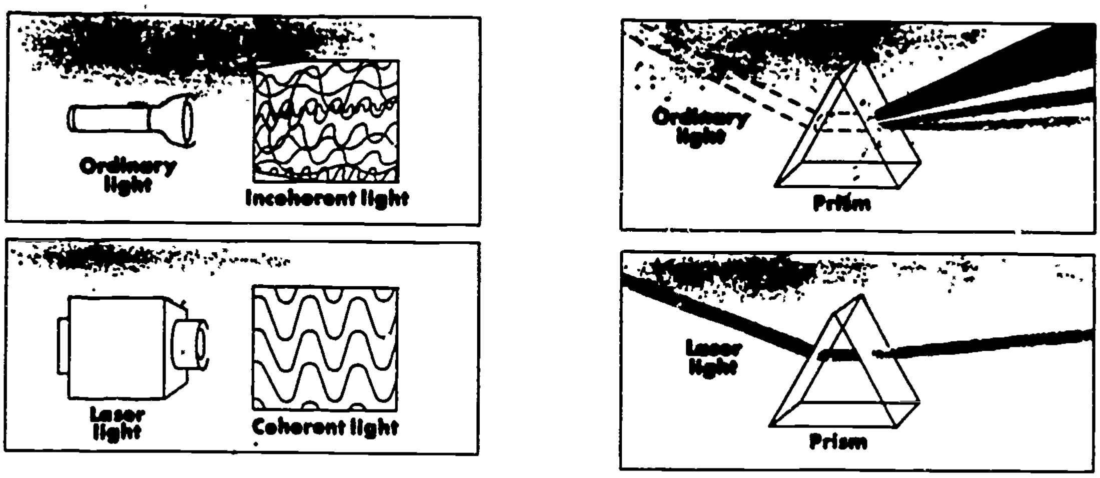


What are characteristics of laser beams?

Lasers produce a beam of *coherent light. Coherent light* differs from light as we know it in its:

directionality
intensity
monachromaticity
coherence

The light waves in ordinary light do not start and stop at one given point in time. They are all jumbled. Light as we commonly see it is caused by electrons dropping down from a high energy state to a low energy state *randomly*.



In coherent light, all of the light energy waves start and stop in step at the same time. They aresaid to be in *phase*.

The extreme intensity (brightness) of the laser beam is due to the fact that all of the laser energy is confined to the very small diameter of the laser beam. While the average power of the beam is relatively low, all of this energy is confined within a very small area. In addition, all of the emitted light is at a single frequency (wavelength); being at a single frequency also contributes to the high intensity of the laser beam.

The *coherence* of the laser beam is a result of the selection feedback system established by the two end mirrors on the laser tube. This effect may be likened to a very selective electrical filter whose output is a very pure electrical sine wave signal (without harmonics or distortion).

The *monochromatic* (single) color of the laser beam is a result of the selective feedback provided by the laser tube end mirrors and also the narrow frequency bandpass of the amplifier (excited helium and neon atoms). These factors result in the purity of the emitted laser beam being better than one part in 10^{15} (ten to the fifteenth).

Light is a form of electromagnetic energy. Originally the term "light" included only the visible frequencies. About 1800, however, the British-German astronomer, W. Herschel placed a thermometer just beyound the blue portion of the spectrum produced by a prism using sunlight and found its temperature was raised. Later, invisible light was found on the other side of the visible spectrum. Thus it was that frequencies outside the visible range were lumped with the visible frequencies under the term *light*.

Later, when X-rays, radio waves, and other discoveries were made, light was found to be part of a spectrum of electromagnetic radiations. The distinction between the various radiations is primarily energy which is proportional to frequency. Light is considered to be that portion of the electromagnetic spectrum having wavelengths between 100 and 10,000 *nanometers* (a nanometer is 10^{-9}--ten to the minus ninth--meters, or one *billionth* of a meter). 2

Wavelength			
0.00001	Cosmic Rays		
0.0001			
0.001	Gamma Rays		
0.01			
0.1			
1	X-Rays	400 nm	Violet
10	Ultraviolet		
100	VISIBLE	500 nm	Blue
1000	Infrared		Green
10000		600 nm	Yellow
.01 cm	Millimeter waves		Orange
.1		700 nm	Red
1			
10	Microwaves		
100	TV and FM		
1000	Shortwave		
10000	AM Broadcast		

Electromagnetic Spectrum
Reprinted courtesy Utah Office of Education

How are lasers used?

Lasers are used in manufacturing. Lasers are used for transforming and changing cloth, leather, metals, rubber, and plastic. Lasers are now used in metalworking for drilling, cutting, annealing (tempering or hardening), and welding. They are very precise and can make holes of nearly perfect shape and configuration, even with square corners! Many lasers are controlled by *computer numerical control (CNC)* machines. Thus, lasers are creating a need for more computer programmers and numerical-control tool programers.

Lasers are used in medicine. Lasers are used in thousands of eye operations yearly. They are also used for inner ear surgery, to treat skin problems, remove growths on vocal cords, for brain surgery, and for many other uses. About one-half of all hospitals will soon be equipped with lasers.

Lasers are used in communication. Lasers can carry information. Because they are high in frequency, beams of laser light passing through the pui.st of glass can transmit much more data than wire or sound (radio) waves, and the quality is better. Lasers can transmit voice and television signals. Unlike radio waves, laser beams spread out very little as they travel. Laser beams could be used to clearly communicate with spacecraft. Some laser beams carry information through cables of glass fibers. Some computers use lasers in their calculating and memory units. Audiodisc players use lasers to improve sound quality. Photographs can be stored on laser discs. A single disc can hold up to 10,000 photographs! [1] Laser printers use laser scanning devices co bined with memory units to produce easily readable text. This publication was printed on a laser printer!

Lasers are used in the military. Lasers are used to measure distances to and from objects. They guide machines and weapons. Lasers themselves have great potential as weapons.

Lasers are used in scientific research. Lasers can function as extremely accurate measuring devices. They may be used to create hot gases called *plasmas*. Plasmas may help scientists learn to control nuclear fusion, a kind of nuclear reaction. Lasers could help solve energy needs. [2]

Lasers have other uses. Laser radar is used to measure pollution in the atmosphere; lasers are used to create holograms, using a lensless photographic method to produce three-dimensional images, and lasers are even used for those wild light displays at rock concerts! [1]

What kinds of jobs are available in laser technology?

There will actually be less growth in some occupations as a result of laser automation. These occupations include drill press operators, heat treaters, machine tool operators, sheet metal workers and welders. But the use of lasers will create new jobs as well. Included in these new areas of employment are jobs as fiber optics engineers, ring laser gyro engineers, gyro-optics technicians, laserists, industrial laser process technicians, laser beam machine operators, laser beam color scanner operators, and others. 1

1 From "A Career in Laser Technology," by William E. Burns, from Industrial Education, April, 1986, p. 9.

2 From "Laser Technology," compiled by Jerry P. Balistreri, The Utah Office of Education, Vocational Program Division, July, 1985.

Photovoltaics
Teacher Page

Competency: Use photovoltaic technology

Tasks: Identify photovoltaic terms
Explain the principles of photovoltaics
Determine the output parameters of a photovoltaic converter
Identify characteristics of silicon cells
Measure the efficiency of a photovoltaic converter

Introduction

Photovoltaics is receiving usuable energy from the sun.

Students can compare the effects of light on a solar cell by observing the difference in the total power output by attaching the solar cell to a small electric motor. The student can monitor the speed of the motor as it changes when light comes in contact with the solar cell. Light can be provided by a light bulb if the sun is not shining.

You can perform simple experiments with just a photo cell, electric motor, and light source.

Overview

With temperamental sunlight, Alaska is a temperamental place to find work in photovoltaics. But power requirements at remote controlling stations and switching units along with 'round the clock sun in the summer, make photovoltaic technology cost-efficient in many situations. Some solar-operated sensors exist along the Trans-Alaska pipeline. Though of course Alaska is unique in its offerings, a student specializing in photovoltaics might work someplace in the United States as a solar researcher, solar unit designer, solar cell manufacturer, electrician, or in satellite manufacturing. However, a strong background in photovoltaics will improve the student's overview of high technology.

Resources

Alaska Energy Education Series, Vocational Education Library, Office of Adult and Vocational Education, Alaska Department of Education, Box F, Juneau, AK 99811

Energy Sciences Inc., 16728 Oakmont Avenue, Gaithersburg, MD 20877 (301)948-0202

IASCO Industrial Arts Supply Co., 5724 West 36th Street, Minnesota, MN 55416-2594 (612)920-7393

National Center for Appropriate Technology

Radio Shack, Tandy, Inc., Fort Worth, TX

Solar Energy Research Institute, 1617 Cole Boulevard, Golden, CO 80401

Photovoltaics

What are photovoltaics?

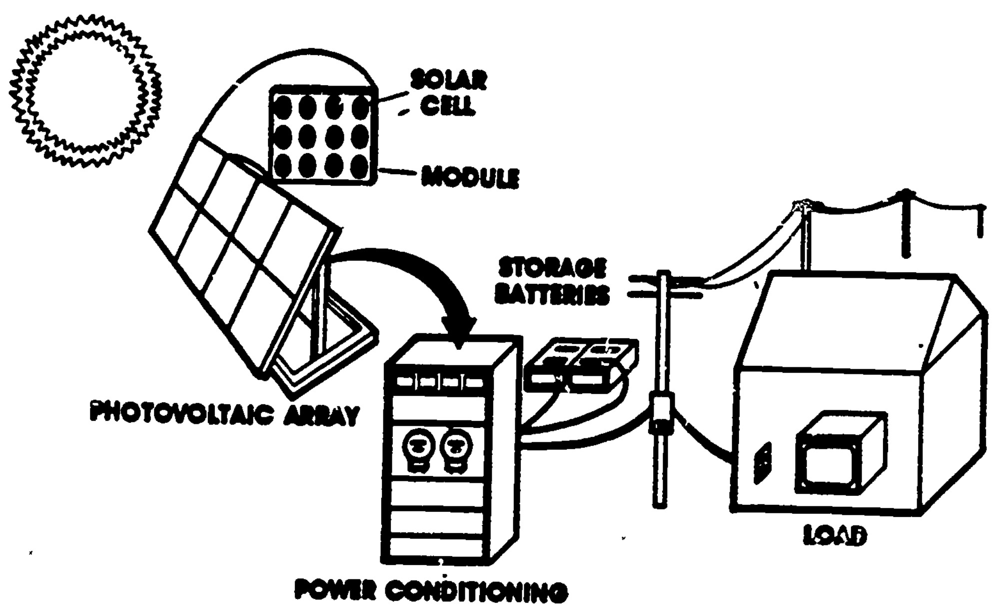
Photovoltaics are using power cells to generate energy from the sun. They generate direct current (DC) from sunlight. Currently solar cells are too expensive for widespread use, but they are cost-effective in areas where other more conventional forms of generating electricity are not possible. There is some question as to the feasibility of using photovoltaics for power generation in Alaska, with its long season of darkness. However, Alaska also has its long period of sunlight in the summer. The long hours of the midnight sun combined with large areas of cloudless skies, give Alaska photovoltaic potential.

"People have known for 100 years that light can generate electricity, but generating light from electricity could not be done with any useful efficiency until the development of semi-conductors in the 1950's.

"The first practical photovoltaic systems, developed for the space program, provided dependable electricity in space vehicles. It seemed logical that a process that worked well in space would be applied to our ever-growing energy needs back on Earth--if only the cost could be reduced. Today, a national effort is concentrating on bringing the cost down. 1

How does a solar cell work?

"A solar cell is made by joining two very thin layers of semiconductor material. Each layer has been prepared by adding different materials to the major constituent, silicon, to give one layer a negative electrical bias (n-bias, an excess of electrons) and one layer a positive electrical bias (p-bias). Terminals of an external electrical circuit are attached to the front and back of the cell. Sunlight knocks electrons loose from some of the silicon atoms, leaving "holes" in the atomic structure. Because of the n-bias and p-bias of the cell, the free electrons move into the n-layer, leaving holes in the p-layer. In essence, this creates voltage in the cell, and a current can be drawn through the external circuit. If a load, such as a d.c. electric motor, is placed in the circuit, it will be operated by the current.



1 ...inted courtesy Utah Office of Education"

What are some principles of photovoltaics?

"The basis of photovoltaic power systems is solar cells that generate direct current electricity directly from sunlight. A whole technology is evolving to enable us to use photovoltaic power systems cheaply and efficiently in all areas. As this technology is improved, a great deal of the electricity to serve our many needs can be provided by an inexhaustible resource, the sun. 1

What are some terms which relate to photovoltaics?

1. **Converter** - A device which converts one form of energy, or power, to another form of energy, or power
2. **Current - Amperes, or Amps** - A measure of the intensity of flow of electrical charge
3. **Diode** - A semiconductor device, usually made of silicon, which permits charge flow in one direction only
4. **Input** - That energy, or power, which enters a device, converter, or system
5. **Insolation** - MW/cm2, milliwatt per squre centimeter - The radiation striking or falling on unit area of a surface
6. **Light** - Radiated energy which travels in the form of waves; may include ultraviolet light, visible light and/or infrared wavelengths
7. **Load** - That which is powered by a voltage source, e.g., a light bulb
8. **Milli** - Prefix meaning 1/1000 of the base unit, e.g., milliwatt
9. **Output** - That energy, power, voltage, or current which comes out of a device, converter, or system
10. **Photovoltaic Cell** (sometimes called solar cell) - A device specifically made to convert light energy into electrical energy; light (photo) striking its sensitive surface causes a voltage (voltaic) across its terminals
11. **Photovoltaic Module** - A group of photovoltaic cells connected together so as to intercept more light, and therefore, provide more electrical output
12. **Power - Watts or Milliwatts** - The rate at which electrical energy is transformed, stored, or used
13. **Radiation** - Energy which travels in the form of waves
14. **Resistance - Ohms** - A measure of opposition to electrical charge flow
15. **Silicon** - A material which is used as the beginning or parent material to make photovoltaic cells, diodes, and other electrical/electronic devices

16. **Solar Electric Generator System** - A system mainly composed of one or more photovoltaic modules, a regulator one or more storage batteries, and a load

17. **Solar Energy** - Energy which comes from the sun

18. **Storage System** - One or more rechargeable batteries which store the photovoltaic converter's output in the form of chemical energy

19. **Voltage - Volts** - A measure of the "force" which causes electrical charge flow

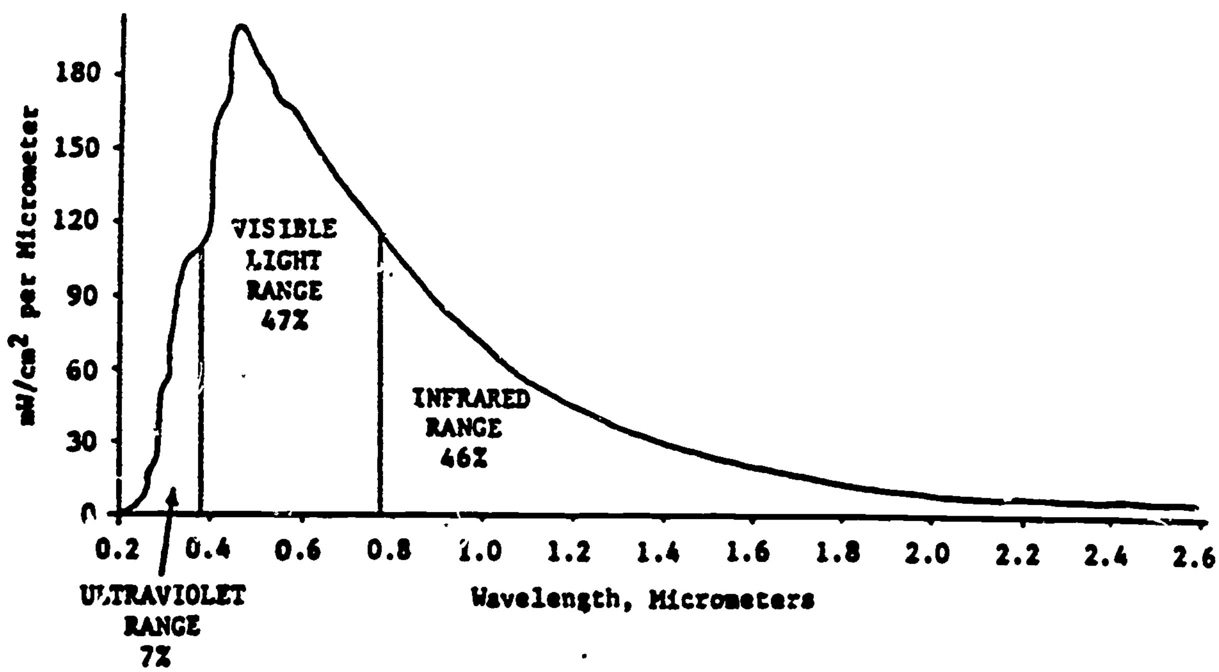
20. **Wavelength - Micrometers** - The length of one complete wave, as in radiation or light energy

"Most all photovoltaic (solar) cells of today are made using silicon as the base or parent material. A very thin circular wafer is cut from an N-type silicon ingot, which forms the basic structure of the cell.

<u>What are some output parameters of a photovoltaic converter?</u>

<u>Solar Radiation Spectrum</u>

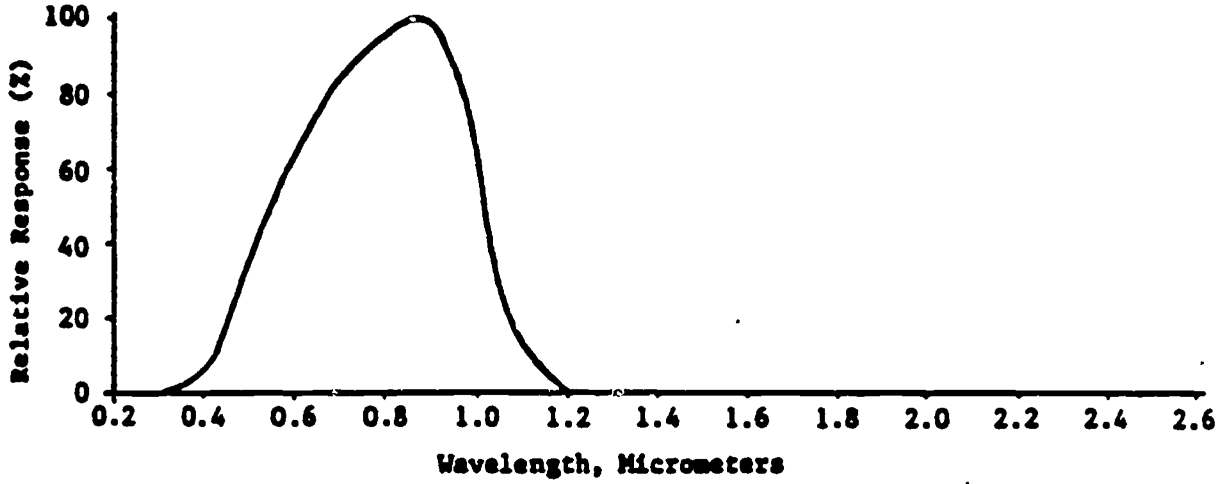
"The wavelength spectrum of radiation which can reach the earth's surface on a bright sunny day is composed of three regions. This graph indicates the distribution of the total available energy, with 7% being in the ultraviolet, 46% in the visible light, and 47% in the infrared region of the total spectrum. A knowledge of this distribution is helpful when studying and using any photovoltaic converter. Ideally, a solar electric generator system should be capable of responding to or using as much as possible of this total spectrum as input energy.



"reprinted courtesy Utah Office of Education"

Silicon Cells' Spectrum Response

"At present silicon cells are the most-used type of converter for solar electric systems. One important reason for this is that silicon cells respond to a fairly wide region of the total available solar radiation which reaches the earth's surface. This graph shows that the silicon cell's output is maximum (100% of that possible) at a wavelength of about 0.875 micrometer. By comparing this wavelength with the graph above, we observe that this maximum output occurs near the boundary of the visible light and infrared regions.



"reprinted courtesy Utah Office of Education"

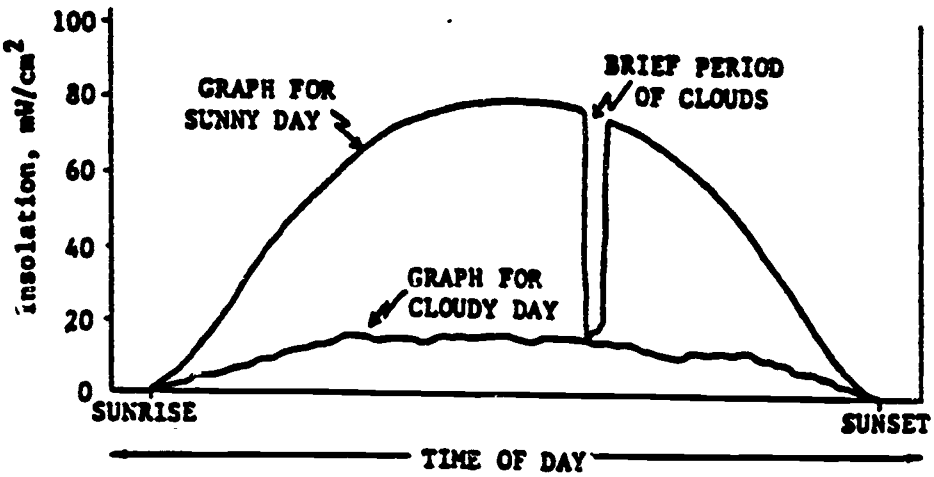
"Further comparison of the curves graphed shows that the silicon cell's response decreases to near zero at the shorter wavelength and at the visible light region. At the longer wavelengths, the silicon cell's output nears zero at about 1.15 micrometers, which is near the center of the 46% infrared range area. Thus, we see that silicon cells can respond to a fairly large portion of the solar radiation reaching the earth.

"Research is currently being conducted by scientists and industries toward development of more effective photovoltaic converter materials. A variety of materials show good promise in this regard. However, until the newer materials can be proven effective and mass produced at competitive cost, silicon cells will continue to be dominant in the photovoltaic converter field.

Other Response Factors

"Several other factors can act toward determining the output of a silicon photovoltaic converter, or solar electric generator system.

"On a bright sunny day the *insolation* (insolation is the radiation striking or falling on a unit area of a surface) on the cells of the converter will be primarily beam radiation and consist of the full spectrum of solar radiation. However, during a cloudy day this insolation may be reduced to a much lower level, and will be primarily diffused radiation.



"reprinted courtesy Utah Office of Education"

"The time of day also affects the level of available insolation. The amount of change throughout the day is greater for the sunny day. Also, both curves reach maximum at midday.

"Another factor affecting available insolation is the time of year. In the Northern Hemisphere the available insolation is highest during the summer and lower (to non-existant) during the winter months. This throughout-the-year change in insolation is due to the changing altitude angle (angular height above horizontal) of the sun. [1]

What are characteristics of silicon cells?

"Solar cells work on the principle of unbalanced electrons. Most solar cells on the market today are thin circular wafers made up of silicon with a small quantity of phosphorous that produces a negative charge. The positive charge is made up of boron. When these two materials work together, they produce an imbalance in electrons. The unbalanced electrons will balance themselves and give off the excess amounts in the form of electricity. When the solar cell is placed in light, the unbalanced electrons will start to produce free electricity. The solar cells do not run on heat from the sun; they use light. Higher concentrations of light will produce higher amounts of electricity.

"Photovoltaic technology is still in the development stages. The challenge for industry is to produce a more efficient cell at a much lower cost than we have at the present time. At the present time solar cells are not practical for homeowners to start producing their own electricity, but it will be part of our future in residential and commercial construction. Solar cells have been used widely in the U.S. space industry. Solar cells restore energy in satellite systems, and they powered the moon rover. Solar cells are used in remote areas for electric fences to control livestock, and they operate communication systems. They are also used to pump water in areas where power lines are too costly to install."

What is the efficiency of a photovoltaic converter?

"The efficiency of any energy of power converter is the ratio of its output to its input. Efficiency is usually expressed as a percentage. Therefore, working with units of power, this can be represented as % Power Conversion Efficiency = P_o X 100/P_i.

"Remember that output power P_o is the product of the voltage across the load V_{RL} and the output current flow through the load I_o. Also, the input power P_i received by the photovoltaic converter is the product of the insolation I_a striking the converter and the total area A of the converter's cells. Thus, the above equation can be written as:

% Power Conversion Efficiency = V_{RL} X I_o X 100/I_a X A.

Efficiency Factors

"Several factors can effect the efficiency of a photovoltaic converter, including:

1. The value of load resistance R_L effects efficiency. Maximum possible efficiency occurs when $R_L = R_i$, the converter's internal resistance.

2. The level of insolation I_a affects efficiency. This insolation, in turn is effected by:

    a) The amount of water vapor, or pollution, in the atmosphere
    b) The presence of thin, or thick, clouds in the sky
    c) The time of day
    d) The time of year
    e) Any change in the tilt angle or other orientation of the converter itself

Expected Efficiency

"The present state-of-the-art of mass producing silicon photovoltaic cells limits their conversion efficiency. Typically, efficiencies of 12% to 15% are common. Precision laboratory manufactured and tested cells have produced efficiencies up to 20%, but such values would require ideal conditions in commercially available modules.

"Experimental research being conducted by scientists and those in industry using materials other than silicon show promise for higher efficiencies. However, until these experimental materials are available in commercially available converters, silicon will remain the dominant photovoltaic material." [1]

1 From "Photovoltaic Technology," compiled by Jerry P. Balistreri, The Utah Office of Education, Vocational Program Division, July, 1985.

Robot Technology
Teacher Page

Competency: Understand robotic technology

Tasks: Identify robotics terms and principles
Explain robotics safety practices
Identify uses for low, medium, and high technology robots
Explain the coordinate system defining a robot's movements
Identify robot parts and features
Discuss maintenance of robotic systems
Explain several robot end-effectors
Sketch out the "working envelope" for a robot
Describe robotic "pick and place", "point-to-point", "continuous path" operations and their applications
Discuss robotics' social and economic impacts

Introduction

Today a number of robot kits are available. Look in industrial education magazines. Ideally, students should construct such robots themselves. According to a survey by Steve C. Hsiung of the University of North Dakota, a sequential order of learning activities to introduce robotic automation includes:

1. "Introduction to the Coordinate System

2. Introduction to Types of Robotic Actuators, Safety and Maintenace in Robots

3. Manipulating the End-Effectors and Actions in the Working Envelope Space

4. Using the Teach Pendant for Programming, Saving, and Loading

5. Introduce the Robotic Programming Language(s)

6. The Pick-and-Place (PNP) Operations of a Robot

7. The Point-to-Point (PTP) Operations of a Robot

8. Interfacing of the Robot Through Two Conveyers and One Moving Table into a Work Cell

9. Sensor Control in Robotics Applications

10. Future Applications of Robots

By writing to Mr. Hsiung, you can obtain copies of the activities he uses, for the simple cost of their duplication. The address is in the **Resources** section.

Overview

Employment possibilities are excellent for those with training in robotics. Robot repair people, electrical, hydraulic, and mechanical technicians are in demand. There are needs for computer programmers, materials handlers, parts replacers, machinists, and others. Robotics is a growing field. As the microprocessor industry grows in the U.S., more and more manufacturing functions are being performed by robots. [1]

According to Steve Hsiung of the University of North Dakota, approximately 7,000 industrial robots are in use in the U.S. today. That number will swell to 75,000 to 100,000 in the near future. . The equipment will require trained professionals able to operate and maintain industrial robots. An industrial education program needs to help students acquire an understanding of robotic literacy.

Resources

American Institute of Industrial Engineers, 25 Technology Park, Norcross, GA 30092

Department of Industrial Technology, University of North Dakota, Grand Forks, ND 58202

ESHED ROBOTEC, INC., 45 Wall Street, Princeton, NJ 08530 (609) 683-4884

Rhino Robots, Inc., Champaign, IL

Suggested Reading

Fundamentals of Robotics Theory and Applications, Reston Publishing Company, Reston, VA, 1984

Handbook of Advanced Robotics, **First Edition,** Stafford, Edward L. Jr., Lab Books, Incl, Blue Ridge Summit, PA, 1983

Here Come the Robots, Milton, Joyce, Hastings House, NY, 1981

Hitachi's Robot Hand, Nakano, Yoshiyuki, "Robotics Age," July, 1984

Industrial Robotics Handbook, Hunt, Daniel V., Industrial Press, 1983

"Operator Roles in Robotics," Robotics Age 6, John Lyman and Azad M. Madni, (January 1984): 39-41

"Robotic: Using Technology to Teach New Technology." ***T.H.E. Journal 12,*** Karen C. Cohen and Carol D. Meyer, (September 1984): 88-92

The Robot Book, Malone, Robert, Harcourt Brace Javanovic, NY, 1978

Robotics: Past, Present, and Future, Knight, David C., William Morrow and Company, NY, 1983

Robots A to Z. Metos, Thomas H., Julian Messner, NY, 1980

Robots: Fact, Fiction, and Prediction. Reichardt, Jasia, Penguin Books LTD., NY, 1978

Robots in Practice. Engelberger, Joseph F., A.M.A.C.O.M.--A Division of American Management Association, copyright 1980

Robots. Henson, Hilary, Warwick Press, NY, 1982

Robots: Reel to Real. Krasnoff, Barbara, Arco Publishing, Inc., NY, 1982

Understanding Robots. Compton, Michael M., Sherman Oaks, CA, Alfred Publishing Co., Inc., copyright 1980

Working Robots. D'Ignazio, Fred, Elsevier/Nelson Books, NY, 1982

1 From "Technology, Life and Careers," Clive Jensen, Project Director, The Utah Office of Education, Vocational Program Division, Summer, 1986.

Robot Technology

What is robotics?

The thought of robots has both fascinated and frightened people for decades. Look at sci-fi movies from the 1950's and you'll see the sinister qualities attributed to robots. Who could forget *Hal*, the computer gone wild in **2001, A Space Odyssey**; or *R2D2* in Star Wars? Robots were already a part of our culture even before they were a part of our culture! It was almost as if people were afraid that if machines got too intelligent we would find ourselves surrounded.

The invasion has already begun. Robots *are* all around us, or at least they're going to be. Robotics is one of the fastest advancing areas of manufacturing today. What is the definition of a robot? The dictionary says that a robot is a "human-like mechanical device capable of performing human tasks." It also says that a robot is a human who works like a machine or a machine which works automatically. Know any robot-like people?

One might divide robots into three types: *low-technology robots, medium- technology robots,* and *high-technology robots*. You might try and guess which one is the most technologically complex. *Low technology robots* are restricted in their movement, are controlled by logic systems, and are regulated by adjustable stops. *Medium-technology robots* have a human-like arm design. *High technology robots* typically have six axes of human-like arm movement, are microprocessor controlled, and are often interfaced with external sensors.

Are robots dangerous?

Robots are programmable machines. They do what they are programmed to do. Robots, as industrial machines *can* be dangerous. They're not dangerous in that they can take over the world--they're dangerous in that they can take off your hand or foot if you don't work safely around them.

What are some uses for robots?

Robots are particularly useful for jobs that people don't like to do, or for jobs that are not safe for people to do. You might think of the Voyageur interplanetary probe as a robot. The machine was programmed for a job it completed on its own.

How does the coordinate system define a robot's movements?

"There are four dominant coordinate systems used in the designing of industrial robots. The first type is rectilinear and incorporates strictly linear X,Y and Z movements, which can be viewed in Figure 1-a. The second system is termed cylindrical due to its revolving base but linear vertical and horizontal movements, as shown in Figure 1-b. The third system is based on polar or spherical coordinates. See Figure 2-a. The fourth, most human-like, is termed revolute or anthropomorphic. It consists of a revolving base, shoulder, elbow, and wrist movements, as shown in Figure 2 b.

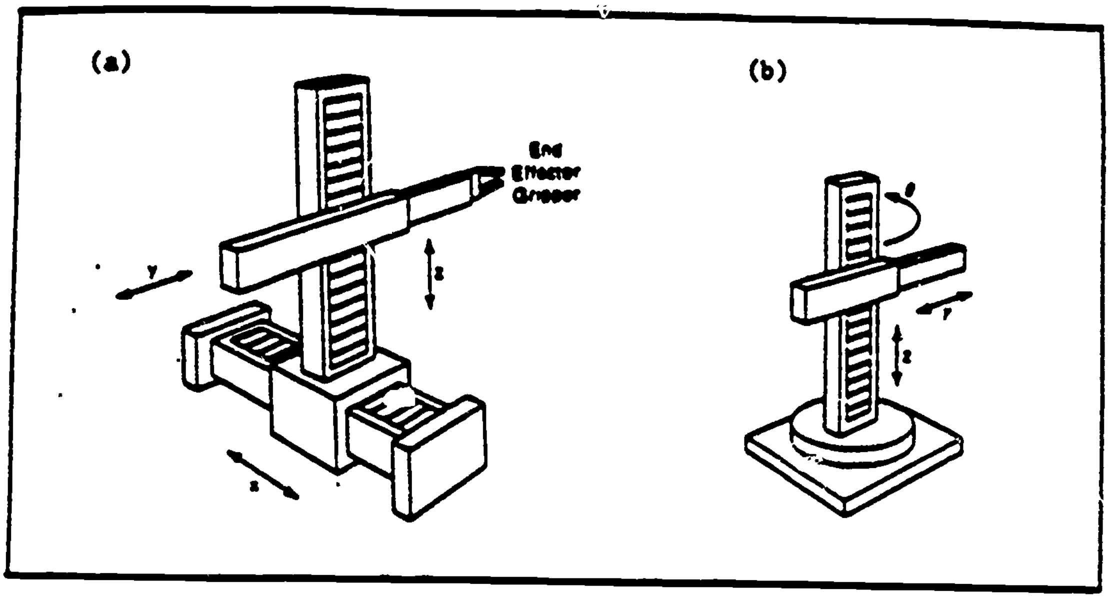


Figure 1. Coordinate Systems: (a) Rectilinear, (b) Cylindrical.

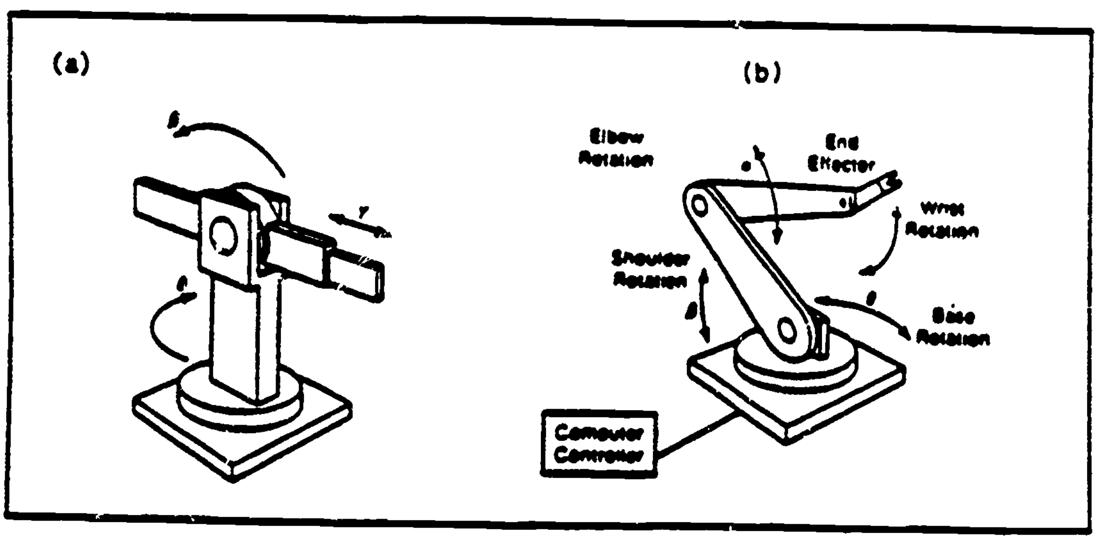


Figure 2. Coordinate Systems: (a) Spherical, (b) Anthropomorphic.

Source: Richard C. Dorf, Robotics and Automated Manufacturing (Reston: Reston Publisning Co., 1983), pp. 52,55.

"On the basis of their motion, there are three geometric shapes and an unlimited configuration. The rectilinear motion produces a square or cube, the cylindrical motion produces a cylinder, the polar a sphere, and the revolute can duplicate any of these motions and much more.

The following terms apply to robots' different coordinate systems:

Coordinate System--A method of defining the directions and dimensions of the space through which a robot's end-effector can move

Rectilinear Coordinates--The movements are linear (straight line), one in each of the three planes X, Y, and Z.

Cylindrical Coordinates--The movement in two planes is linear (straight line) and in the third it is rotational.

Spherical Coordinates--The movement in one plane is linear (straight line), whicle in the other two planes it is rotational.

Anthropomorphic, or Revolute, Coordinates--All movements are rotational. Anthropomorphic means resembling human shape or characteristics. It describes the ability of a robot arm to move in a fashion similar to the human arm.

Degrees of Freedom--The total number of different movements, about axes, through which the robot can function. It is equal to the number of axes built into the robot." 2

What are some robot parts and features?

Well, let's see...you've got your antennae and you've got your ray gun. But really, there are parts similar to all robots.

Basic parts of the robot include:

Base--The robot part which is fastened to the table or floor. The base contains the *waist axis* or rotation.

Torso or Shoulder Assembly--The robot part which contains the *bicep flex axis* of rotation.

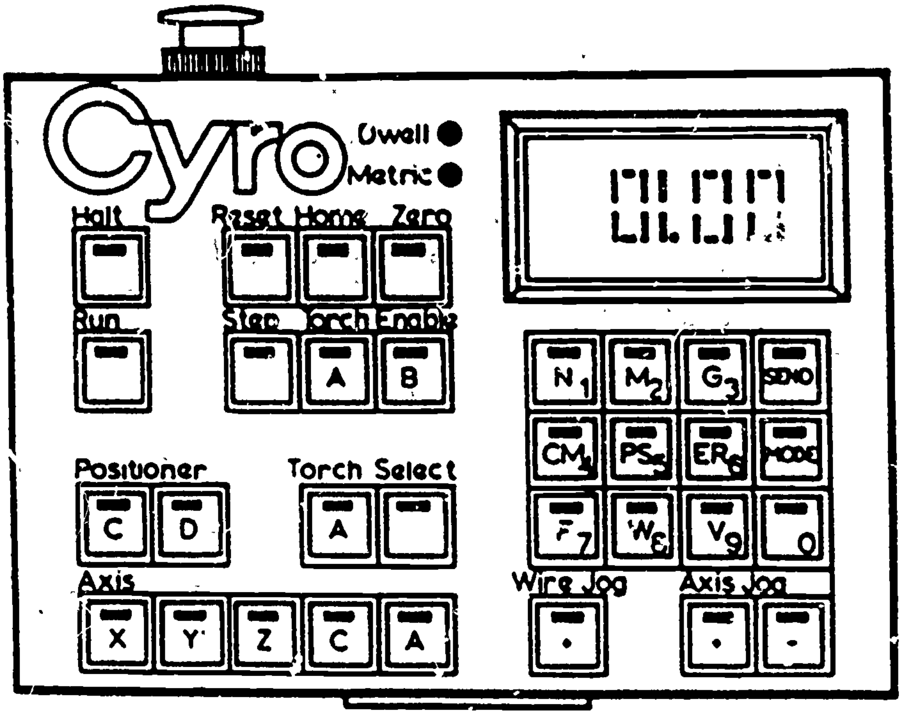
Bicep, or Upper Arm--The *bicep* constitutes part of the extension capability of the robot. Its length is from the bicep axis to the elbow axis.

Forearm--Another part of the extension capability of the robot. Its length is from the *elbow axis* to the wrist axis.

End-Effector--This part is often referred to as the "business end" of the robot. It flexes about the *wrist flex axis.*

Controller--This part contains controlling and motor drive circuitry for the robot. The controller forms the major link between the teach pendant and the robot.

Teach Pendant--A hand-held computer, usually attached to the robot controller, with which the opeator can guide the robot through a series of points or in a motion pattern. Typically, a teach pendant can also be used to record the robot's moves for subsequent automatic actions by the robot. This device permits a human to teach a machine. Some teach pendants have provisions whereby the program of moves stored in the teach pendant's memory can be *uploaded* to a host computer. Uploading is used when one wishes to save a previously teach-pendant developed program on disk. A program saved on disk can be used later to run the robot from the computer or, in some cases, can be *downloaded* into the teach pendants' memory for modification via editing.



Robot Actuators--An actuator is a motor or transducer that converts electrical, hydraulic, or pneumatic energy to effect movements of a robot's segments. Motors can be electrical, hydraulic, or pneumatic. They have rotary motion as their output. However, if translational (back and forth) movement is needed, the usual practice is to use hydraulic or pneumatic cylinders with pistons. Each different actuator has distinct advantages and disadvantages:

Electric Actuators

Advantages	**Disadvantages**
Fast and accurate	Require gear trains
Can apply sophisticated controls	Gear backlash limits precision
Easily available and relatively cheap	Electric arcing a problem
Simple to use	Power limit

Hydraulic Actuators

Advantages	**Disadvantages**
Large lift capacity	Systems are expensive
Moderate speed	Systems pollute workspace with fluids and noise
Joints can be held motionless	Not suitable for high speeds
Offers accurate control	

Pneumatic Actuators

Advantages	Disadvantages
Relatively inexpensive	Air is less compressible
High speed	Noise pollution
No polluting fluids	Leakage of air a problem
Can be used in laboratory work	Air filtering and drying needed
	Maintenance and construction costly 3

Do robots require much maintenance?

With such complicated machines, maintenance and troubleshooting is very important. In fact, mainteance and troubleshooting can determine a large part of the effectiveness of the robot. Get to know the following terms and concepts:

"**Maintenance Schedule**--A recorded account of all servicing, repairs, and other maintenance performed on a robot. Such a record is important toward determining the cost of upkeep, the maintenance to be anticipated in the future, and any possible improvements regarding the robot or its use.

"**Payback Period**--The time, typically in years, that is required for the savings attained by using a robot to equal its original cost. Other costs such as interest and inflation are not taken into account in this definition.

"**Payload Handling Capabilities**--The payload of a robot basically concerns the mass or weight which the robot can grasp, lift, or handle safely. This payload can be determined by the reach, speed, acceleration/deceleration with which the robot must handle the load. These, in turn, can affect the reliability and life of the robot.

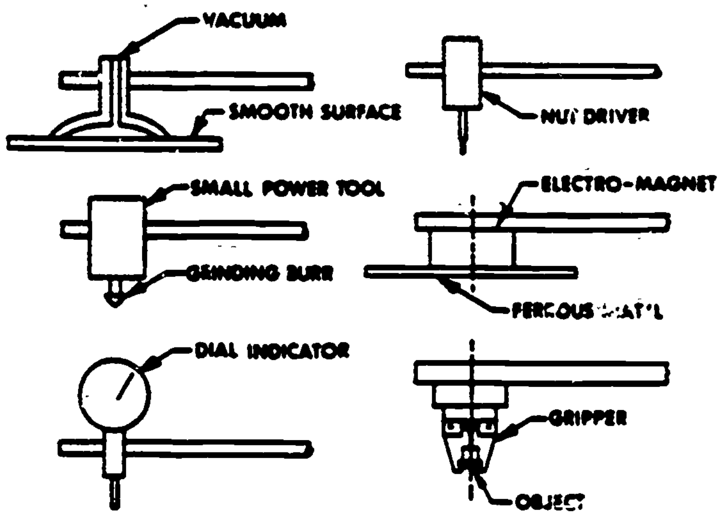
"**Sensors**--The type and number of sensors needed for a robotics installation depends upon the individual application. Sensors may be used to determine (sense) the presence/absence of parts which the robot is to handle, the position, direction, speed of parts and of the robot itself, and/or a wide variety of other conditions. Their calibration, adjustment and maintenance can greatly affect the robot's performance.

Those who maintain robot equipment may perform the following tasks:

1. Checking for proper positioning of limit switches and other sensors
2. Checking for wear in joints and other linkages
3. Adjusting cables, belts, and/or chain drive tension
4. Cleaning and lubricating robot parts
5. Checking electrical cables and connections
6. Checking hydraulic or pneumatic hoses and connections
7. Measuring/determining the accuracy and repeatability of end-effector positioning
8. Checking the security of keys, set screws, and other fasteners" 4

What are robot "end-effectors"?

"The *end effector* is the business end of a robot. And end-effector may be defined as any actuator, gripper, or mechanical device which is attached at the wrist joint of a robot for the purpose of picking up, moving, or positioning an object. The object, or *payload*, could be any of many things such as a workpiece to be machined, a part to be assembled, or the wire which comes out of the nozzle of a wire-feed welder. The end-effector is what handles that object.

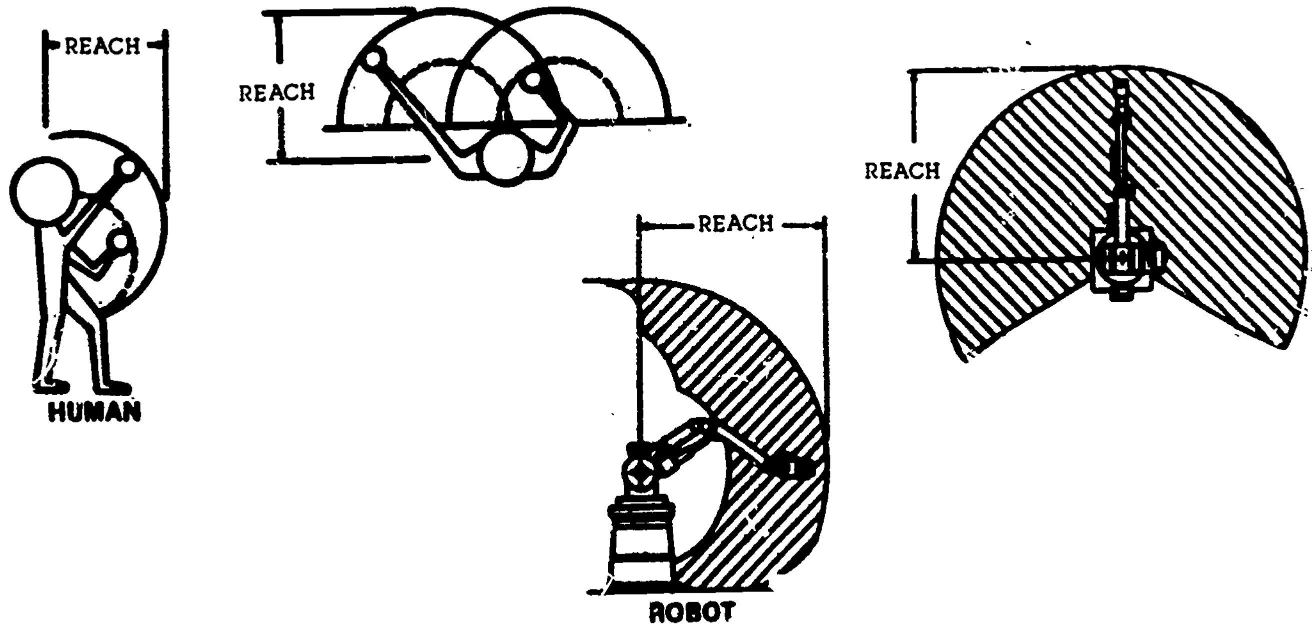


"The design and manufacture of end-effectors is a somewhat specialized area within the field of robotics. Robots perform a wide variety of tasks. A robot used to insert and remove parts from a lathe may require a differently shaped end effector for each type of part machined on that lathe. The end-effectors must be easily interchangeable for the different parts completed on that lathe.

"The design of end-effectors is as varied as the robot applications themselves... They may be pneumatically (vacuum), electrically, or mechanically driven. Also, they may operate as a power tool, measuring device, or some sort of gripper. The gripping-type end effector is the most often used because it can be made to be able to grasp a wide variety of shapes and sizes of objects.

"Grippers can usually be classified as two-finger or three finger, and each can be made to grasp an object internally (hollow object) or externally. The three-finger gripper is often used where the object is circular or spherical and where the object must be centered between the fingers.

What is the "working envelope" for a robot?



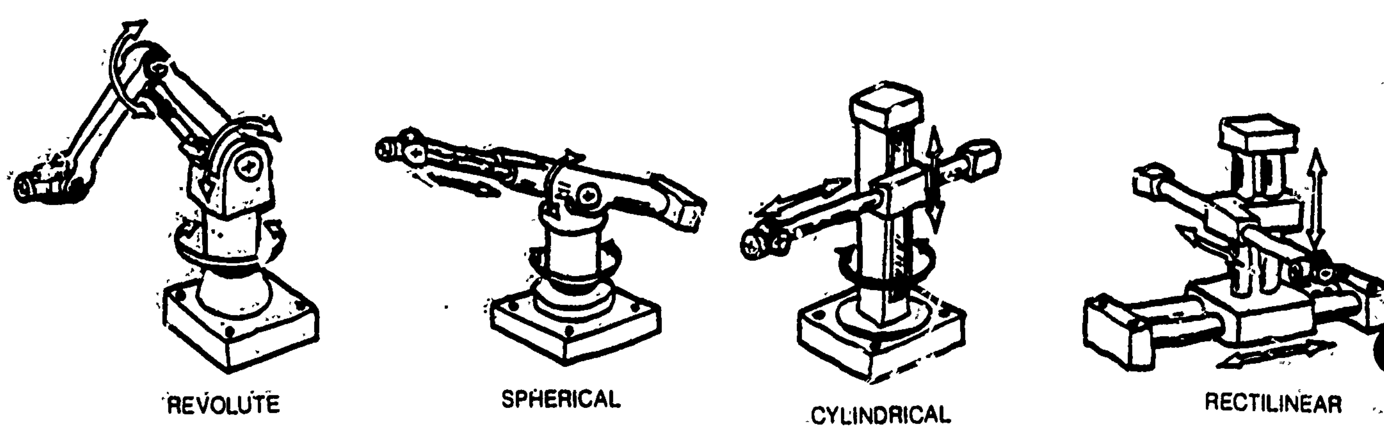
The *working envelope* of a robot is the three dimensional space within which the end-effector of the robot can be positioned. Each of the four coordinate-system categories produces a differently-shaped working envelope. These four shapes include:

Rectilinear Coordinate System--A rectangular box (X,Y, and Z axes) envelope

Cylindrical Coordinate System--A cylinder-shaped envelope

Spherical Coordinate System--A partial sphere-shaped envelope

Revolute (Anthropomorphic) Coordinate System--Also produces a partial sphere-shaped envelope, but one that is far more intricate than that of the spherical coordinate system robot



Common terms associated with robot working envelopes include:

__Swing__--The *angle* through which the waist will rotate.

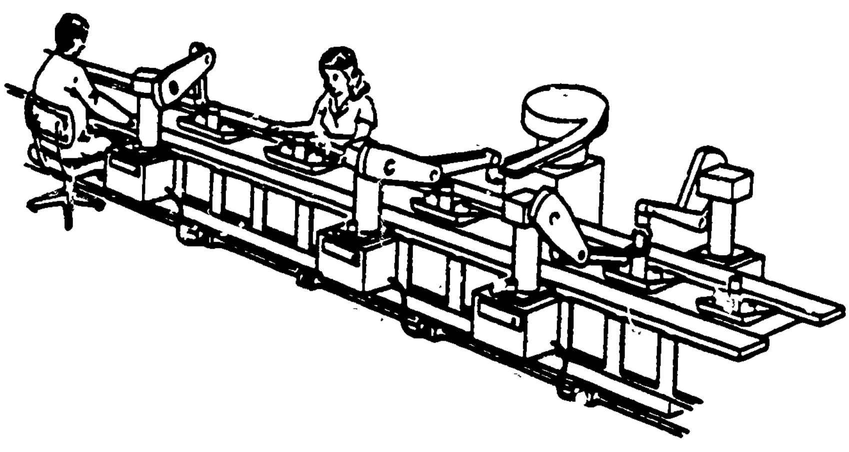
__Vertical Stroke__--In the spherical robot this is the *vertical plane* (up and down) *angle* through which the end-effector can move.

__Horizontal Stroke__--The in and out distance through which the arm can move the end-effector. This movement is caused by extension and retraction of a *linear* actuator, such as a hydraulic cylinder-piston.

__Vertical Reach__--The up and down distance through which the arm can move the end-effector. This distance is affected by horizontal stroke. Thus, the vertical reach is expressed as the *maximum* up and down angle. [5]

What are some different kinds of robot operations?

The *work cell* of a robot involves the area in which the robot performs tasks or with other machines within a factory. The related machines can include a wide variety of possibilities. The robot must be able to reach most of the elements surrounding it. Robots can perform tasks along an assembly line.



What are some social and economic impacts of robots?

Robots give some people the creeps. But then again, some people give robots the creeps. Considerable attention has been focused on mechanical workers in the workplace, not only because they send shivers up the spines of those who fear technology, but also because robots stand at the forefront of a technological revolution. The Japanese have made extensive use of robots in manufacturing. Robots can not only perform mundane and repetitive tasks, they can be programmed to complete more complex tasks as well. Though the initial cost of installing or designing robots may be very high, often the machines pay for themselves within a relatively short period of time. Robots do not need a coffee break and they do not need to sleep at night. They do not organize into unions and they do not strike for greater wages. Robots often increase efficiency. Increased efficiency results in lower costs which mean greater savings. Robots have very much contributed to the Japanese economic miracle. U.S. auto and other manufacturers have scrambled to catch up with these industrial innovations. Robots allow developed nations with high wages to compete not only with other developed nations using robots, but also with less-developed nations which have cheap labor. The great savings robots can provide has sizeable economic impact.

[1] *From "Laser Technology," compiled by Jerry P. Balistreri, The Utah Office of Education, Vocational Program Division, July, 1985.*

[2] ***Ibid.***

[3] ***Ibid.***

[4] ***Ibid.***

Satellites
Teacher Page

Competency: Understand satellite technology

Tasks: Explain satellite terms, principles, and technology
Review the history of satellite technology
Explain laws governing satellite communications
Explain the significance of the Clarke belt
Describe the function of satellite system components including home satellite dishes

Introduction

Satellites may be one of the more interesting areas for students, though it's tough to provide hands on experience. Satellites are manufactured and launched into orbit far from Alaska. But satellites touch many parts of our lives. Awareness of how satellites have changed things for all of us is in order. Students can build a model of a satellite. They can communicate with a company which uses satellites--such as Alascom or RCA.

Overview

Much of which occurs in industry in Alaska and elsewhere in the world depends as much on economics and politics as it does technology. Obviously the explosion of the space shuttle Challenger and the ensuing slowdown in the U.S. space industry coupled with the buildup of satellite technology in other industrialized countries makes the skies open to all. Applying satellite technology in making personal, management, and technical decisions might be the ticket to employment in this field. The student who has a strong familarity with satellite technology is a student who can make wise decisions about its use. For Alaska, satellite technology plays a prominent role in telecommunications. The state is linked together socially and defended militarily through the use of satellite technology.

Resources

AT&T Bell Laboratories, 101 J.F. Kennedy Pkwy, Short Hills, NJ 07078

European Space Agency/Information Retrieval Service, Via Galileo Galilei, C.P. 64, 00044 Frascati, Italy (06) 94011

Federal Communications Commission, Satellite Radio Branch, Washington, DC 20554

International Telecommunications Satellite Organization (INTELSAT), 3400 International Drive NW, Washington, DC 20008 (202) 944-6800

Modern Satellite Network, 43 Rockefeller Center, New York, NY 10020

Motorola Communications and Electronics, Inc., Public Relations Office, 1309 E. Algonquin Rd., Schaumberg, IL 60194

NASA Headquarters, Public Information, Washington, DC 20546

NASA Lewis Research Center, Office of Education Programs, 21000 Brook Park Road, Cleveland, OH 44135

RCA News & Information, Commercial Communications Systems, Government Systems, Route 38, Bldg. 206-1, Cherry Hill, NJ 08358

Space Education Assocation, 746 Turnpike Road, Elizabethtown, PA 17022

Suggested Reading

Build a Personal Earth Statio for Worldwide Satellite TV Reception, Tab Books, Inc.Blue Ridge Summit, PA, 1982

Trackers of the Skies, E. Nelson Hayes, Smithsonian Institution Publication 4708, Washington, DC, 1967

The Versatile Satellite, Richard W. Porter, Oxford University Press, Walton Street, Oxford OX2 6DP, England, U.K., 1977

Satellites

Exactly what are satellites for, what do they do, and how do they work?

How did satellites impact your life today? Did you listen to a morning radio broadcast which came to you by satellite? Did you talk on the phone with someone in a distant city and have your voice relayed by satellite? Have you ever looked up on a clear night and identified a "moving star" as a satellite? They're all around us--literally!

Satellites have many functions. Some carry cameras which beam photos of weather back to earth stations. Others have military uses, taking pictures of facilities and airstrips. Still others process telephone calls and television stations, relaying information to other points on the earth. Obviously something straight up offers the advantage of line-of-sight transmission. With satellites there is little in the way between the earth station and the satellite hovering overhead.

Satellites work from a power source. It is difficult to send a repairperson or refuel the devices, so satellites must have either a self-recharging power source or one which lasts a long time. Many satellites benefit from *photovoltaic* technology, via solar power cells. The power cells replenish batteries which the satellite carries. Some satellites contain small cannisters of gas which can be discharged like small rocket engines to alter the satellite's orientation. Still other satellites contain nuclear fuel. These satellites are politically controversial, as virtually all satellites are eventually pulled back more closely into the earth's gravitational field and fall. Having nuclear fuel fall down from the sky is hardly anybody's idea of a good time.

The U.S. space shuttle launched, refueled, repaired, and brought back satellites. The space shuttle Challenger blew up in 1987 sidetracking the program. Other countries are jumping into the business of launching and servicing satellites, as are private U.S. companies. Satellites serve a number of communications and surveilliance uses.

Does satellite technology have a long history?

No. The Soviet satellite, *Sputnik* was the first human-made object set into earth orbit. The year was 1957, and the Soviet achievement set off a furor in the United States which led into the space race of the 1960's, culminating in the 1969 U.S. man on the moon achievement. Sputnik also caused massive American review and revision of science and math programs. In fact, the whole satellite issue is at a turning point as of the publication of this handbook (1987). The explosion of the space shuttle Challenger in January of 1986 led to President Reagan's decision in August, 1986 that future shuttle flights would have few commercial payloads. An international field of contenders has rushed to fill the void. McDonnell Douglas corporation and Martin Marietta Aerospace of the United States are rushing production of satellite-carrying rockets. The China Great Wall Industry Corporation has aggressively marketed its "Long March-3" booster service. The Soviets are marketing their mighty "Proton" rockets, and the Japanese have recently blasted right into the "satellite carrier for hire" business with their new NIPPON rockets.

What are the laws governing satellite communications?

The Federal Communications Commission regulates satellite communcation. Section 605 of the Communications Act of 1934 states that no one shall be authorized to duplicate or retransmit for profit or entertainment and transmission other than for personal use. In 1970 the FCC developed the, 22 FCC 2d 86(1970), rules and regulations. These rules guide the domestic owners of satellite equipment in their actions. Since that time amendments have been made to the original rules and regulations to insure proper use of domestic statellite facilities.

President Reagan signed a third significant bill into law in October of 1984. This bill completely legalized satellite dishes for home owners. [1]

What is the significance of the Clarke Belt?

If satellites orbit the earth at the same rate that the earth turns on its axis, they remain stationary above a certain spot on earth. This orbit is called *"geosynchronous orbit."* They hover 22,300 miles over the equator, and can always be found at a specific location in the sky. For retransmission of straight-line television signals, keeping satellites in the same place overhead is very useful. This band of satellites, 22,300 miles above the equator is called the Clarke Belt, in honor of science fiction writer Arthur C. Clarke. Clarke first proposed in 1945 that satellites could be maintained in such a fashion. Even in the vastness of space such a ring at such an altitude could eventually fill up. In fact, estimates are that the Clarke Belt will be full of satellites by the 21st century. [1]

What are the functions of some satellite system components, including home satellite dishes?

Maybe your family has a satellite dish. Maybe you know somebody else who has one. If you have enjoyed programs "collected" by a satellite dish, did you really know how they got to you? If you really had lofty fantasies, you could stretch up there and take a look at the other end--the satellite end--of things.

As described in Utah Department of Education's "Satellite Technology"

> "Television satellites vary in design, but they all have the same basic parts. Westar 4, for example, is 7.1 feet wide, 21.6 feet long, and weighed 1,260 pounds at the start of its orbital life. (Some 300 pounds of propellant will be consumed during Westar 4's 10-year span.) Westar 4 has control and propulsion systems that can be manipulated from Earth should it stray from its orbit, and it is equipped with solar panels that produce 935 watts of electrical power to operate all its systems. But what makes Westar 4 a boon to television viewers are its 24 *transponders* or relay systems, which are similar to the channels on your television set. (Some of the first *birds* --slang for satellites--have only 12 transponders.)
>
> "Each transponder carries up to 2,400 one-way voice circuits or one color television program. Broadcast companies such as Home Box Office or the major television networks lease a transponder from the satellite owner--for example, RCA and Western Union own the Satcom and Westar series, respectively, while Anik birds are the property of the Canadian government to service each affiliate station or subscribing cable system simultaneously by blanketing the nation with a signal.

"Without satellites, television programmers would have to be connected with each afficliate on separate earthbound microwave system at a staggering expense.

"With a dish, you bypass this network of middlemen so that you can choose from all the satellite programming available--more than 100 services--whereas cable subscribers can only watch what is offered on their cable services. And unless a dish owner chooses to subscribe to a scrambled service that charges a subscription fee, a dish owner pays no monthly charges to see what's on the satellites." [1]

1 From "Satellite Technology" compiled by Jerry P. Balistreri, The Utah Office of Education, Vocational Program Division, July, 1985.

Forestry and Logging

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Forestry and Logging

Overview

Although employment levels in the logging industry fluctuate with the world economy, forestry employment levels should remain relatively steady in the years to come.

Like most fields, forestry requires both professional and technical workers. The first category includes foresters, biologists, biochemists, biometricians, hydrologists, geologists, soil scientists, cartographers, economists, public administrators, engineers, architects, landscape architects, recreation managers, and surveyors. Almost all of these disciplines rely on a large number of technicians to perform much of the actual field and laboratory work.

Sub-fields such as fire control, fish and wildlife protection, visitor information, public safety, and maintenance offer most of the entry-level opportunities.

As in logging itself, a continual shortage of skilled Alaskans (both technician and professional) has forced government and industry to import workers from the lower 48 states. Although technicians are professionals in the sense that they get paid for their work, the pay of technicians sometimes reflects the fact that they generally have less academic training than the so-called "professionals." Both technical and professional level jobs present many personal challenges and make for very rewarding careers.

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Role of Forest Products

Competency: Identify the Role of Forest Products in Modern Society

Tasks: Recount the history of the U.S. forest industry
Describe the importance of the forest industry to Alaska's economy
Recount the history of Alaska's forests
List forest products

What is the American timber industry's history?

Although native Americans used forest products for clothing, shelter, weapons, and boats, the North American timber industry, per se, did not start until the arrival of Europeans. The Pilgrims soon recognized the value of the tall straight pine trees which covered much of coastal New England. In 1626, Plymouth Colony passed ordinances regulating timber cutting on colony lands. In Pennsylvania (Penn's woods), William Penn decreed in 1861, that for every five acres of land cleared, one must be left forested.

From the outset, trees played a prominent role in American history. England's dominance as the world's great naval power had much to do with her stout oak trees. But maintaining a huge fleet required cutting down the largest trees much faster than they could be replaced. The English were understandably delighted to find in the forests of New England what appeared to be an unlimited supply of high quality ship building material. For example, they reserved the largest New England pines suitable for making ship masts by marking them with an arrow-shaped blaze. Later, paper and wood from the New England forests played a role in kindling and winning the American Revolution.

The first 100 years of U.S. history coincided with the golden era of wood. During the 1800's, one Eastern forest after another fell to the axe and plow. The California Gold Rush of 1849 (from which comes the name of the San Francisco '49ers football team) created a huge need for wood in the West. Miners needed wood for tunnel supports, railroad ties, trestles, and sluice boxes. Everyone needed wood for wagons, stagecoaches, railroad cars, fences, houses, and, after 1860, telegraph poles. Trees were transformed into whaling and clipper ships, so named because they kept getting faster, clipping hours, days, and weeks off the record passages from port to port.

In order to entice investors, the government gave any one who wanted to build a transcontinental railroad ownership of land on both sides of the right of way. The land grant consisted of a checkerboard (every other) of square mile parcels for ten miles on each side of the track. The resultant monopolies assured the financial success of the railroad and put thousands of square miles of forests into private ownership.

By the end of the century, there were few forests left in the United States that hadn't felt an axe. In the spirit of the day, the timber industry focused on cutting down in the most economical fashion the most valuable trees. This "cut- and-run" way of business caused great environmental damage. In the wake of logging, rain washed soils from steep hillsides, clogging trout and salmon streams with silt and debris. Sparks from logging trains turned the landscape to ashes.

But as the virgin forests and blank spots on the maps shrunk, as rivers were dammed for water and hydropower, some people began to notice. These people realized that America's forests and wilderness was finite and that the unspoiled wilderness were part of the American identity. They wrote letters to the government about the importance of proper forest management and talked to anyone who would listen.

Although thousands of individuals became involved in this first debate over the future of American's public lands, several names stand out. John Muir, one of the earliest conservationists/preservationists, founded the Sierra Club and led the successful effort to make Yosemite a National Park; Gifford Pinchot, the first head of the U.S. Forest Service; and Aldo Leopold, a forest ranger and wildlife management professor, advocated treating nature as a community to which people belong, rather than as a commodity, and reserving portions of the National Forest system for wilderness.

Indeed, the history of American forestry and conservation have always been closely linked. In 1875, the American Forestry Association was organized. In 1885, the State of New York created the Adirondack Forest Preserve to protect the woods and wildlife surrounding the State's highest peaks. In 1891, passage of the Forest Reserve Act enabled the President to establish forest preserves on public lands. The Forest Management Act of 1897 prescribed how these preserves should be managed. In 1898, Gifford Pinchot was named head of the Division of Forestry (within the Department of Agriculture).

Who was Gifford Pinchot?

Pinchot is credited with being the first American to choose forestry as a career. Since there were no schools of forestry in the U.S., he studied in France and returned to America obsessed with the notion of managing forests as a crop. Before joining the government. he managed railroad-tycoon George W. Vanderbilt's huge private forests in North Carolina.

As the head of the Division of Forestry, Pinchot worked with dozens of agencies on issues regarding forests, watersheds, soils, agriculture, ranching, and mining. At first, he saw these as isolated but related issues. After about ten years, Pinchot realized that these issues were all very closely related. Furthermore, with the help of William J Mcgee, a bright young scientist, he became convinced that all land management issues boiled down to "providing the greatest good for the greatest number of people for the longest period of time." Mcgee convinced Pinchot that "monopoly of natural resources was only less dangerous to the public welfare than their actual destruction." (This conclusion grew from Pinchot's experience that private ownership generally led to destruction of resources; logging practices then current could best be summarized by the expression "cut-and-run.")

Already a good friend of President Theodore Roosevelt, an ardent outdoorsman, Pinchot easily convinced him of the necessity of protecting public lands. Roosevelt eventually transferred forest lands from the Department of the Interior to the Department of Agriculture, thus paving the way for the creation of the present 191 million-acre, 154 forest system.

The present day Forest Service was established in the midst of his tenure, in 1905. When Pinchot became embroiled in controversy in 1910 with the new Secretary of the Interior, Richard A. Ballinger, over the processing of claims for Alaskan coal, President Taft fired him. Pinchot's ideas far outlived his 12 years at the head of the Forest Service and its forerunner. For example, Pinchot was instrumental in adapting "conservancies," the term applied by the British to their royal forest lands in India, to these new principles and the conservation movement they inspired.

Incredible technological advances accompanied the arrival of the 20th century. Aviation, automobiles, telephones, X-rays and other breakthroughs blossomed seemingly overnight. A miracle substance in its own right, wood was not completely left behind. During World War I, it was used for airplane propellers, struts, and structural members. Engineers learned how to laminate several thin layers of wood into large strong sheets and create plywood. Howard Hughes had his engineers build the spruce goose, a flying boat, and the largest airplane that has ever flown, out of plywood. Some of the PBY's (Patrol Bomber Yachts) which harassed the Japanese in Alaska's Aleutian Islands during World War II had plywood hulls. World War II combat ships continued to be made out of wood. For example, PT (Patrol Torpedo) boats were fast maneuverable craft used to attack enemy shipping. On one of these boats, PT 109, served young John Kennedy, who later became the 35th president of the United States. Engineers even figured out how to extrude wood cellulose into a popular silk-like synthetic fabric called rayon.

World War II ended ten years of global economic depression. After the war, America's appetite for forest products, natural resources, recreation, and wilderness increased dramatically. At the same time, many of the private timber lands had been logged. In the face of growing demand and decreasing supply, the National forests were called upon to meet the nation's needs. Created largely for just such a situation, the National Forests contained huge tracts of virgin timber. However, more than ever before, the Forests were expected to supply recreation opportunities, wilderness, and water for domestic consumption and hydroelectric power.

Foresters, industry, and conservationists agreed that something had to be done to balance all these competing interests while protecting the National Forests. The result was the Multiple Use-Sustained Yield Act of 1960. At the time of its passage, few people probably believed that the Act would resolve all the conflicts over land use in the National Forests. But the Act did codify some of the "greatest good for the greatest number for the greatest period of time" principles that Pinchot had espoused more than fifty years earlier. If the Act didn't resolve all the conflicts, at least it helped the Forest Service administer the Forests.

The Forest Service was under pressure from all sides. On the one hand, conservationists advocated the wise use of the National Forests, while preservationists called for setting aside increasingly large tracts of land in wilderness or natural condition; on the other hand, the timber companies, miners, and ranchers with grazing rights on public lands lobbied hard for unrestricted access and minimal use fees. The debate over the best use of National Forest lands continues to the present. Nowhere is it more heated than in Southeast Alaska's Tongass National Forest.

In the meantime, private industry has shown that it has the potential to manage its own forest resources responsibly. "Cut-and-run" companies continue to operate. Many companies, especially those with timberlands capable of growing trees as if they were indeed a crop, operate as if good forest practices were good business practices. In 1951 Weyerhauser, for example, became the first large private company to raise its own seedlings in order to speed the regrowth of logged-over lands.

What does the National Forest Service have to do with the history of logging in Alaska?

Until 1980, the U.S. forest Service owned almost all of the best commercial forest lands in Alaska. At 16 million acres, Tongass National Forest is the largest in the National Forest System. The nation's second largest National Forest, the 5.9 million acre Chugach in Southcentral Alaska also contains valuable commercial timber land.

What was logging like before World War II in Alaska?

At first logging was done on a very small scale--almost entirely for local consumption. Alaska Natives made totems, long houses, boats, weirs (fish traps), harpoons, and clothing from forest products. Starting about 1800, the Russians felled trees for ships, stockades, and cabins in Kodiak, Prince William Sound, Yakutat, and Sitka. With the advent of large-scale gold-mining in Juneau in 1880, the need for locally-sawn lumber increased the rate of logging. The lower slopes of Gastineau channel, for example were stripped of trees for houses, boardwalks, piling, railroad ties, and mine timbers. At the end of the 19th century, huge pilings were driven for salmon traps.

Handloggers, who worked alone or in small crews filling custom orders, fanned out through Southeast Alaska in search of high quality stands on steep slopes close to saltwater. Using pulleys, levers, and the tricks of the trade they muscled the best trees down to the water. Once they made up a raft of logs, they'd take a tow into town.

World War II hastened the change to large-scale, highly mechanized operations. In the wake of the war, the federal government decided to use Southeast Alaska's timber resources to stimulate the region's economy. Since forests in the lower 48 states could supply that part of the country's timber needs with better wood at cheaper prices, a market had to be found for Alaska's wood. The war-ravaged Japanese were willing customers, provided they could do most of the processing.

In the 1950's, the Forest Service divided Tongass national Forest into four sale areas and solicited bids for each. Louisiana Pacific won the right to log that part of the Forest closest to Ketchikan, and Alaska Lumber and Pulp (a Japanese company) won the right to log around Sitka and the Wrangell-Petersburg area. In the face of rising public criticism, a lack of industry enthusiasm, and an apparent shortage of timber, the Forest Service dropped plans for the other two sales which were to have been on Admiralty Island and along the shores of Lynn Canal. Logging under the two existing timber sales will continue for fifty years, past the turn of the century.

The passage of the Alaska Native Claims Settlement Act (ANCSA) (1972) gave Southeast Native corporations the right to select timber lands, thereby placing considerable acreage in private ownership. The Alaska National Interest Lands Conservation Act (ANILCA) (1980) marks the most recent withdrawal of commercial timber lands (about 2.8 million acres) from the National Forest timber base.

Due to poor world market conditions, logging in Southeast Alaska has been sluggish throughout the middle 1980's. In the meantime, the Forest Service has been busily investing in road construction so that when the market rebounds, it will be possible to log large areas quickly.

The Native Corporation experience with logging has been almost wholly unsuccessful from a financial point of view. Although the resultant economic activity has created jobs for corporate shareholders, the native corporations have faced a number of obstacles largely beyond their control. These include global market conditions, high start-up and operating costs, and competition with highly subsidized operations on adjacent National Forest Lands.

How important is the forest industry to Alaska today?

The timber industry is an important part of the economy of many Southeast Alaska communities. In 1986, approximately 2100 people were directly employed in timber-related jobs and another 1000 indirectly employed. Forest management and logging-related work generated approximately $65 million in direct revenues and payroll, and another $14 million in related services. Including the value of fisheries, tourism, and recreation (all of which depend to varying extents on the existence of forests) generates another 7,400 jobs and $150 million. In other words, logging accounts for about one-third of natural resource-derived revenues and income in Southeast Alaska.

The fact that timbering is just one piece of the natural resources economics pie explains why multiple use is so important and also why there are resource management conflicts between various user groups.

Isn't logging important in other parts of Alaska?

Yes, although commercial logging is largely limited to coastal southern Alaska. Other parts of the State with commercial logging activities include Yakutat, Seward, Afognak, Southcentral in general, and Fairbanks. (There is a small forest products industry in Interior Alaska.)

Furthermore, wherever trees grow and people live in Alaska, trees tend to be an important source of heating fuel, cabin logs, and rough-cut dimensional building materials. These trees create jobs, supplement incomes, and support subsistence life-styles.

What common products currently come from trees?

Forest products are generally broken into two categories, primary and secondary. Primary includes pulpwood bolts, sawlogs, veneer logs, poles, and pilings. Secondary products include, sawdust, chips, bark, and cones.

A hundred years ago, only the best parts of the best trees were taken. The rest was left to rot. But the part typically taken, from stump to 4" top contains only 65% of the tree's usable fiber. (Two thirds of the rest is in the stump and roots, the remaining third in the branches.)

Today, thanks in part to modern technology, nearly every part of a tree can be used profitably. The more of each tree's fiber used, the more profitable timber harvesting can be.

The number and variety of products made from trees or containing forest products is amazing. In addition to paper and lumber, wood is made into clothing (rayon). Cellulose is used for making cellophane and sponges and, as a filler and binder, is used in foods such as cereals, ice cream, and pet foods.

Tree Biology

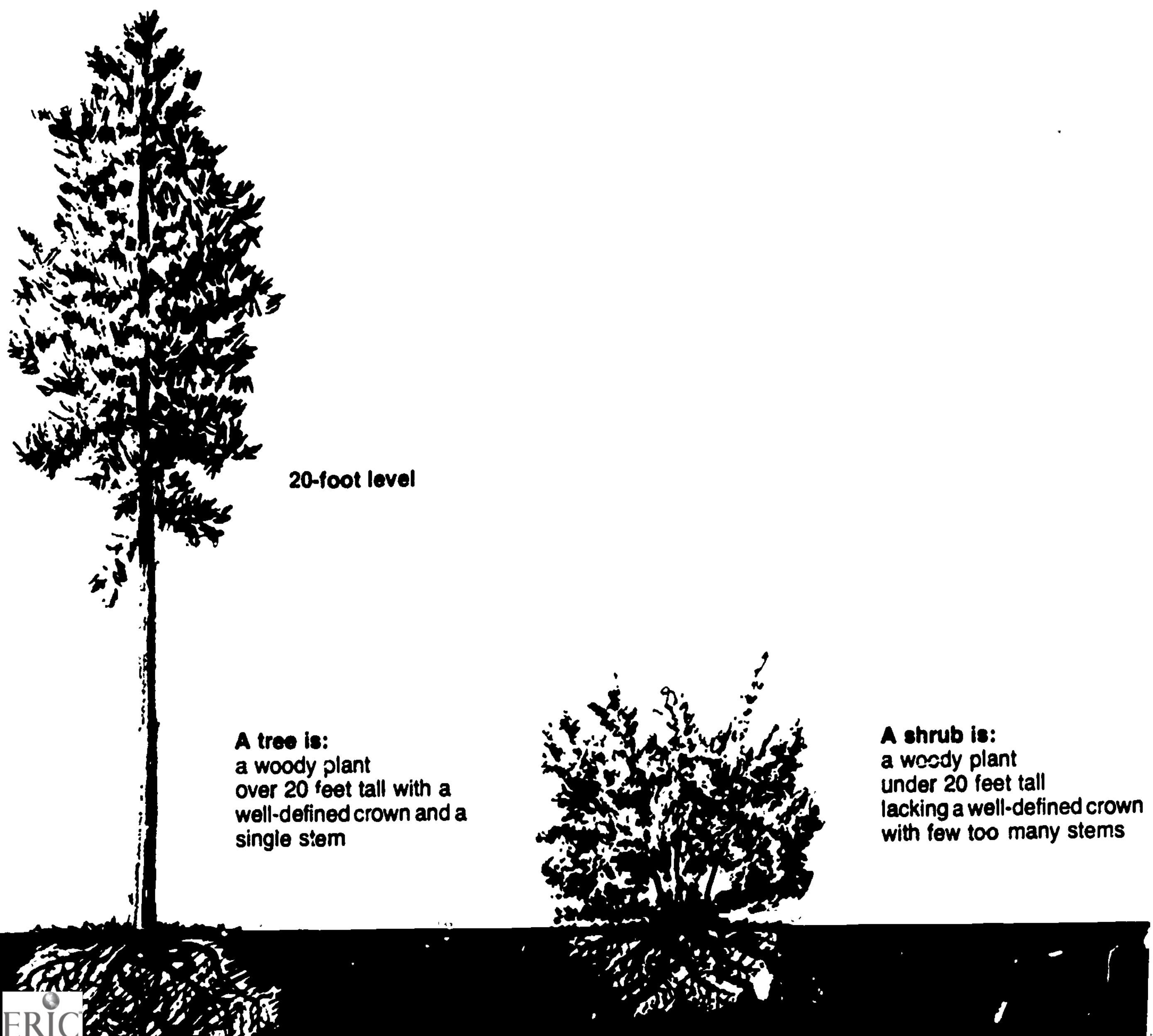
Competency: Explain How Trees Grow

Tasks: Describe the life cycle of a tree
Describe the parts of a tree
Describe common Alaskan commercial tree species and their uses

<u>What is the difference between trees, shrubs, and plants?</u>

Trees are woody plants with at least one trunk and several branches. Except under unfavorable growing conditions, most trees eventually will attain heights of at least twenty feet.

Although also woody, plants and shrubs generally grow to less than twenty feet. They tend to have many stems and lack well-defined crowns.



If you live in parts of Alaska with no or only small trees, you might be surprised to learn that certain trees are larger than any other living thing, plant or animal. Trees also live longer than any other organisms, as long as 6,000 years in the case of bristlecone pines.

Compare the size
and longevity of
MAN to

Largest land animal-Elephant
12 feet tall

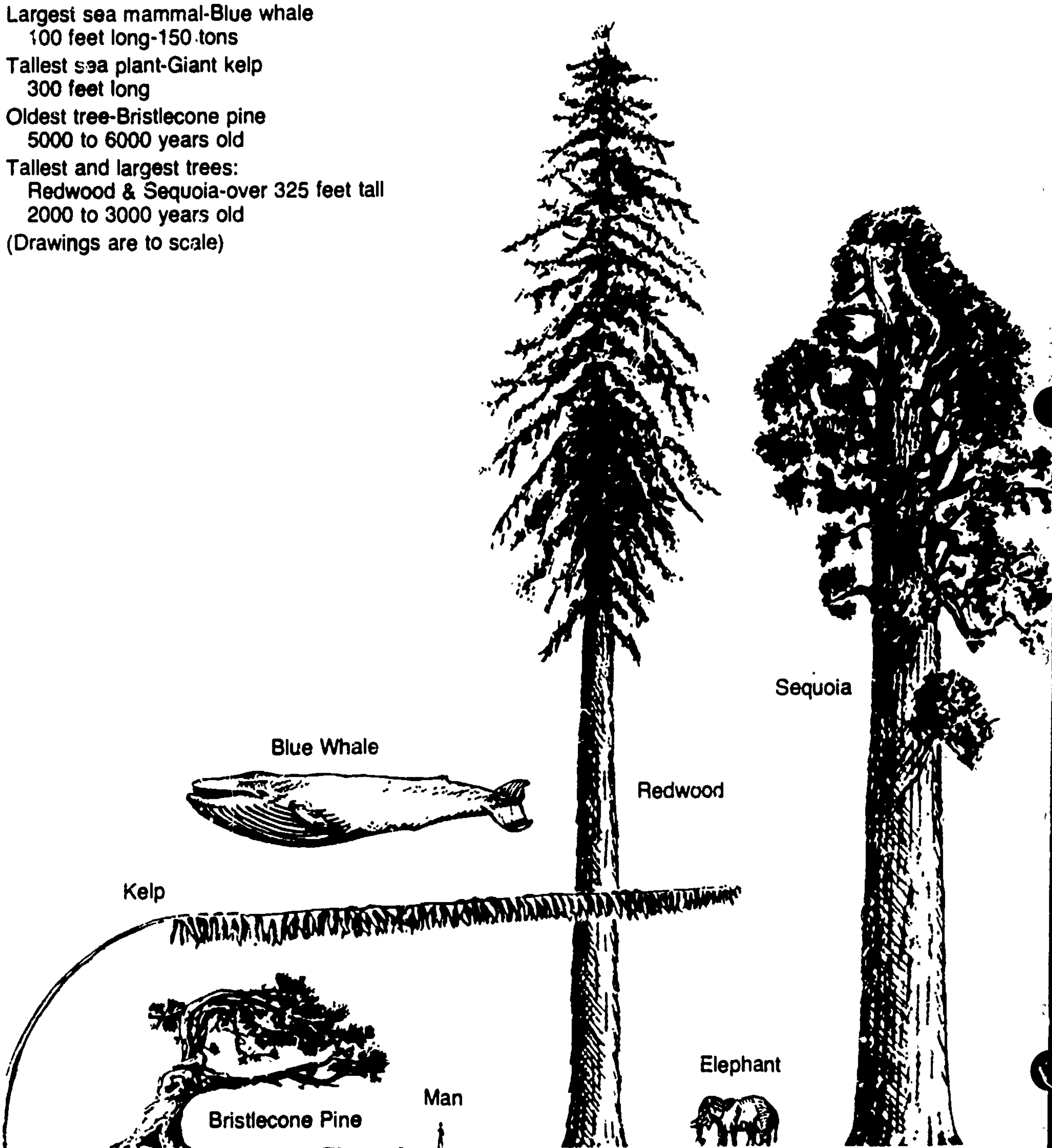
Largest sea mammal-Blue whale
100 feet long-150 tons

Tallest sea plant-Giant kelp
300 feet long

Oldest tree-Bristlecone pine
5000 to 6000 years old

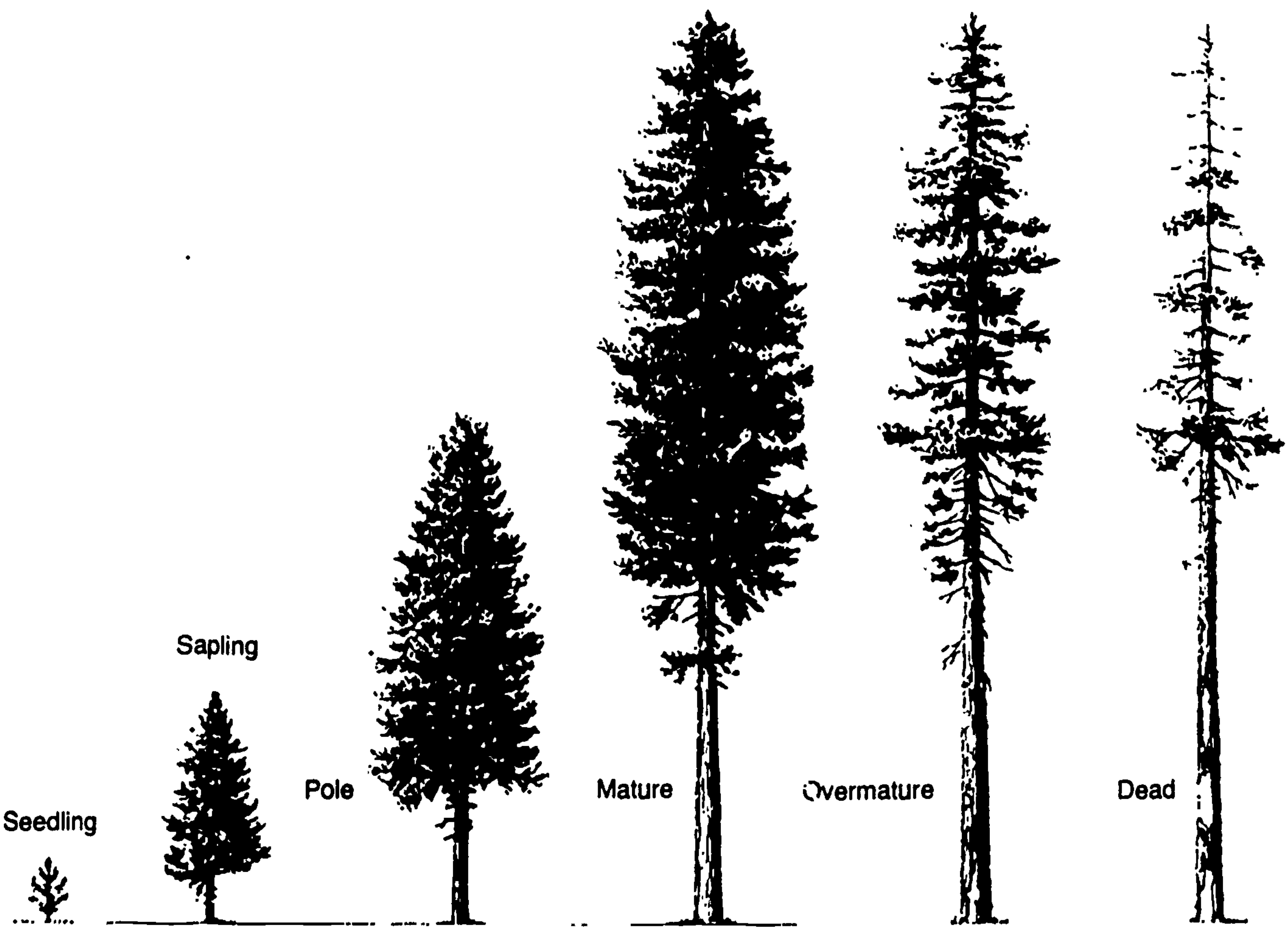
Tallest and largest trees:
Redwood & Sequoia-over 325 feet tall
2000 to 3000 years old

(Drawings are to scale)



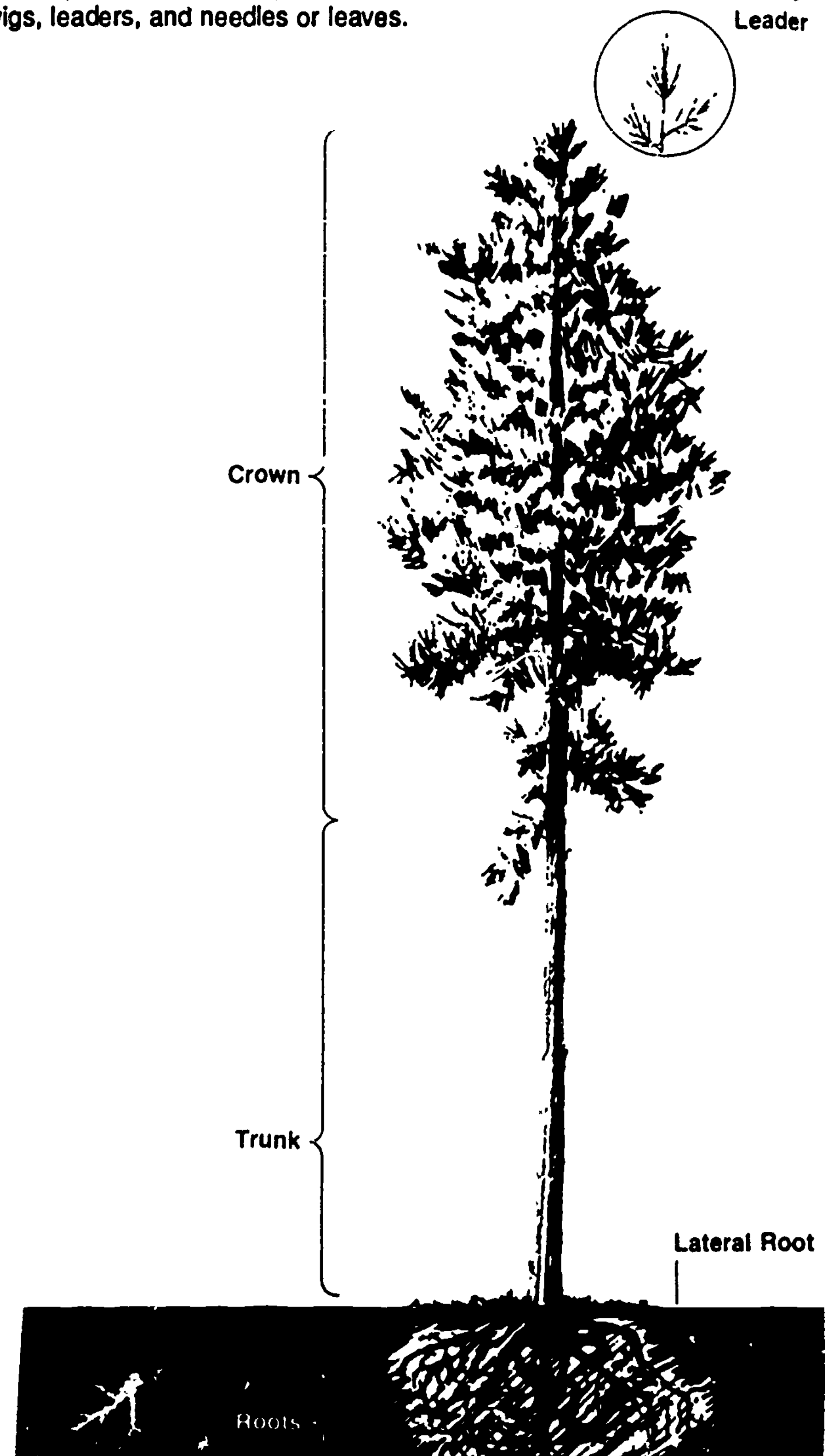
What is the life cycle of a tree?

Trees grow from seeds into seedlings, from seedlings to saplings, saplings to poles, and then to maturity. Trees will continue to grow after maturity, but much slower. They eventually die, if not blown, burned, knocked, or cut down first.



What are the parts of a tree?

Most trees have root systems, one or more trunks, a crown consisting of branches, and one or more leaders, or growing tips. Each of these components include a number of parts and subparts. For example, there is a taproot and lateral roots. The branches may include limbs, branches, twigs, leaders, and needles or leaves.



What about the bark?

Bark is to trees as skin is to people. It protects the tree from insects, pests, disease, fire, and loss of vital fluids. Trees continually produce new bark, just the way people continually produce new skin. When a tree has been girdled (had its bark removed) it dies.

Aren't tree trunks specialized?

Now you are getting to the heart of the matter. Tree trunks --also called boles--consist of several distinct layers, each of which plays a vital role in the life of the tree. Starting from the inside out, a trunk consists of outer bark, inner bark, cambium, sapwood, heartwood, and pith.

What is the difference between inner and outer bark?

The outer bark protects the tree from injury. The inner bark carries the food made in the tree's leaves to the twigs, branches, trunks, and roots. The inner bark is also called phloem (pronounced flow-em).

The next layer is the cambium?

Correct, the cambium is layer of cells between the inner bark and the sapwood. The cambium is very important. Its cells divide, forming a layer of bark on the outside and a layer of sapwood on the inside.

Tree growth occurs just inside the bark?

Yes. Each annual ring is actually a layer of sapwood added right on the inside of the cambium. If you think about it, this is the only place where a tree could grow; a tree which tried to grow from the inside out (from the pith, for example), would be constrained by the surrounding trunk.

Sapwood sounds as if it should be wet?

Right. Sapwood is full of sap, a combination of water and nutrients. The sapwood transports this sap from the roots to leaves. Because it is so wet and green, sapwood enables the tree to flex with the wind.

What is heartwood?

Heartwood is nothing more than dead cambium, left behind by succeeding years of growth. Heartwood adds strength to the trunk.

The soft spongy tissue at the tree's core is called pith.

Are roots as complex as trunks?

Almost. Most tree species have one of two types of root systems: Taproots, those with a large central root that goes rather deep into the ground; and Lateral roots, those with a number of shallower roots which spread horizontally away from the base of the trunk. Sitka spruce, western hemlock, and other trees which grow in wet ground have Lateral-type root systems. Species found in dry climates generally have Taproot systems.

What does the root do?

Roots do at least three very important things: They anchor the tree so that it will withstand all but the worst winds. In the winter, the roots store much of the tree's sap and nutrients. Finally, the smaller, or feeder, roots also collect from the soil the water and nutrients which the tree needs for growth.

How do roots take-up water?

Near their tips, feeder roots become very fine, and the finest of these are covered with root hairs. The root hairs absorb water just the way your skin does when it stays wet for very long. The root system may extend a great distance from the trunk, further than the longest branches.

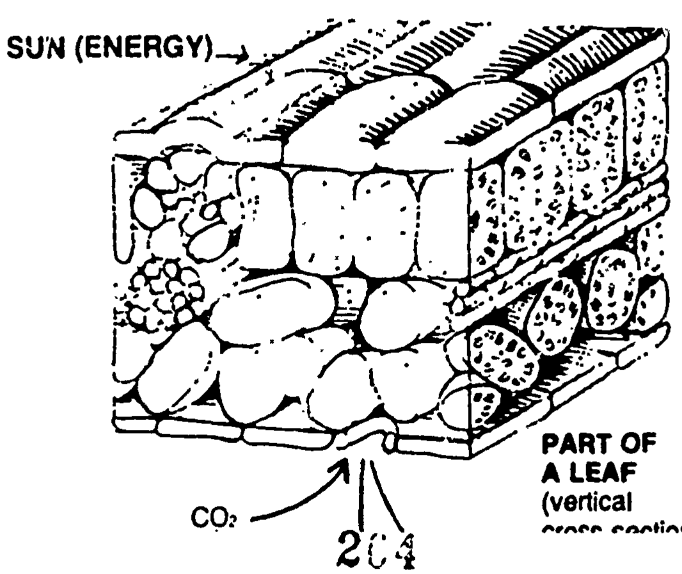
In climates where water is scarce, root systems sometimes emit chemicals (turpens) which inhibit the growth of other plants; this minimizes competition for water. (Chaparral, a shrub common to the American Southwest, is famous for this.)

Are the roots the most important part of the tree?

While it is true that roots are vital to tree growth and trees often die when their roots are damaged, trees cannot survive without all their parts, their roots, trunks, and crowns--just as people cannot survive without their skin, heart, and head.

What does the crown do?

The crown is the tree's solar collector. Chlorophyll (the green stuff) in the tree's leaves or needles transforms the sap into food through a process called photosynthesis (photo is Greek for light, synthesis comes from the Greek words for put together). Photosynthesis is the process central to all life on Earth.

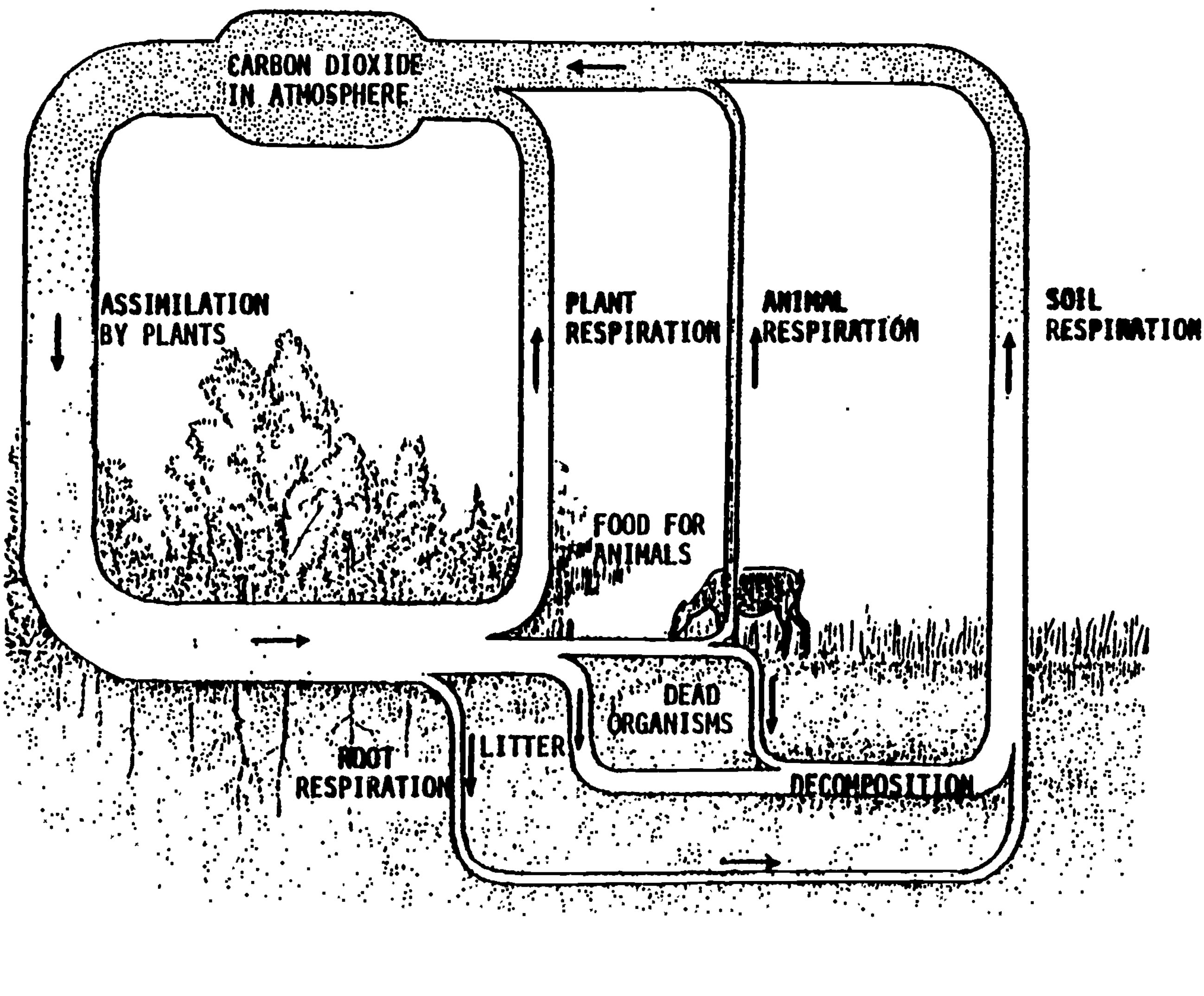


PART OF A LEAF (vertical cross section)

Why is photosynthesis so important?

Photosynthesis serves two vital functions. First, it converts the energy in sunlight to other energy forms (sugars) which plants and animals use. Without photosynthesis, there would be no plants or algae, nothing for animals and fish to eat, and therefore no life on Earth.

Secondly, the process of photosynthesis removes carbon dioxide from the atmosphere and releases oxygen in the process. This is the opposite of what animals do (Animals remove oxygen from the air and replace it with carbon dioxide.) In other words, trees play an important role in maintaining global air quality. When the production of oxygen from global photosynthesis roughly equals the rate of global carbon dioxide production (by insects, bacteria, animals, people, industrial processes, etc.), global carbon air quality should be good.



Courtesy of Dr. Art Kadama, University of Hawaii School of Public Health

When air pollution and acid rain start killing forests (as is happening in Eastern North America and Western Europe), global air pollution can be expected to increase rapidly because sick trees remove less C02 from the atmosphere; when they begin to rot, they will only add to it.

What determines the rate of tree growth?

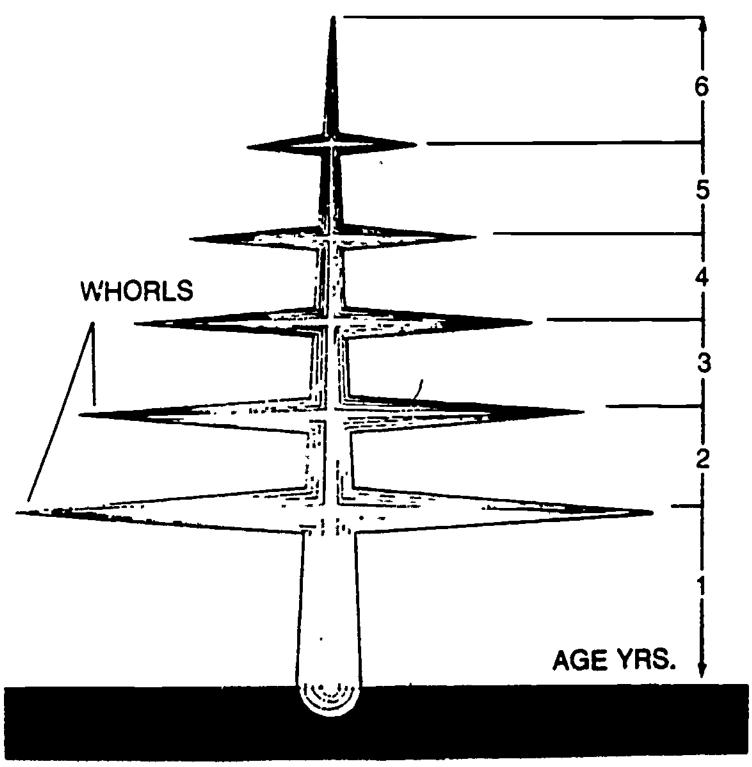
Growth rates depend on dozens of factors: species and seed genetics, soil and water conditions, climate, sunlight, competition, age, and pests. Poor growth rates generally can be traced to one or more of these factors.

How is the rate of growth determined?

Growth rates can be determined by looking at the size of the annual rings or by inspecting the leaders and the space between successive whorls.

What is a whorl?

Whorls are the set of new branches near the top of the trunk, or stem, which some trees, like spruce, grow each year. They are called whorls because they radiate out like wheel spokes, just as a rope would if you whirled it around you.

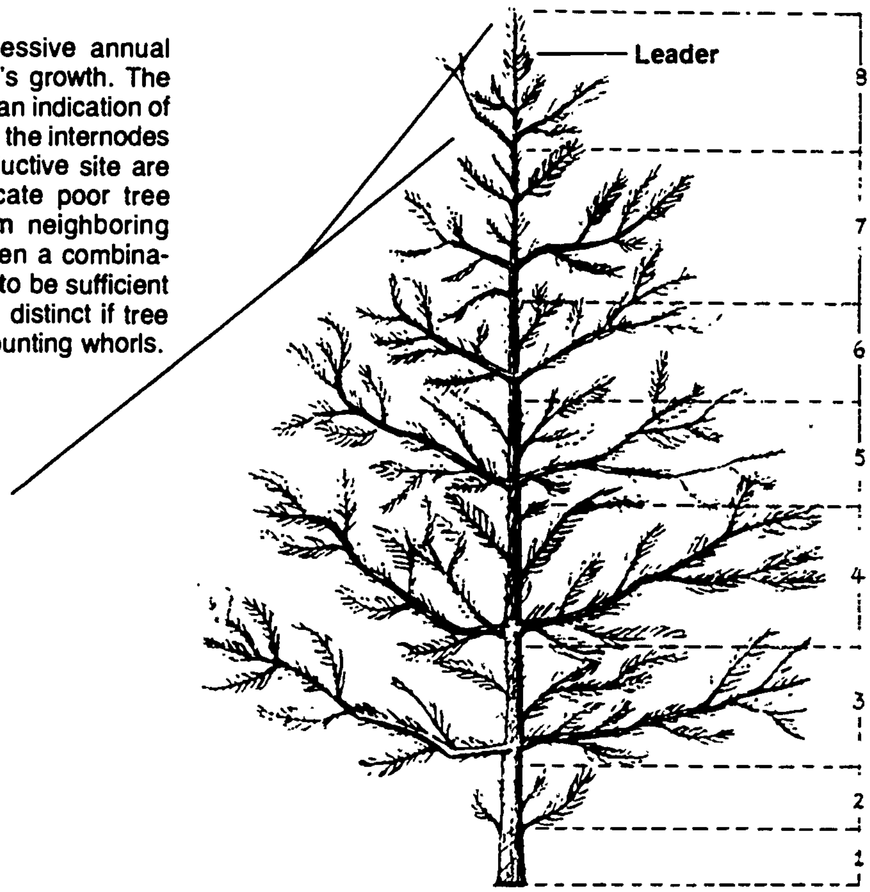


What is a leader?

The leader is the stem's growth above the most recent whorl. By measuring the length of the leader at the end of the growing season, you can determine how rapidly the tree is growing. Similarly, by measuring the distance between whorls, you can compare growth rates from year to year.

This approach reflects how rapidly a tree is growing upwards, but it may not give much information about how rapidly the tree produces wood.

The distance between any two successive annual layers or whorls of branches is 1 year's growth. The length of this distance, the internode, is an indication of the tree's reaction to its surroundings. If the internodes are long, good tree health and a productive site are indicated. Very short internodes indicate poor tree health, or too much competition from neighboring trees, or an unproductive site — or even a combination of such factors. Height growth has to be sufficient to separate the whorls and make them distinct if tree age is to be accurately estimated by counting whorls.



Terminal bud: the main bud at the tip of the leader or tip of any branch is a terminal bud. Those below or behind the terminals are *lateral buds*.

Leader: the stem's height growth during the most recent growing season. That portion of the stem above the topmost whorl.

Internode: that portion of the stem between any two consecutive whorls. Buds and branches on the internodes are *internodal* buds and branches.

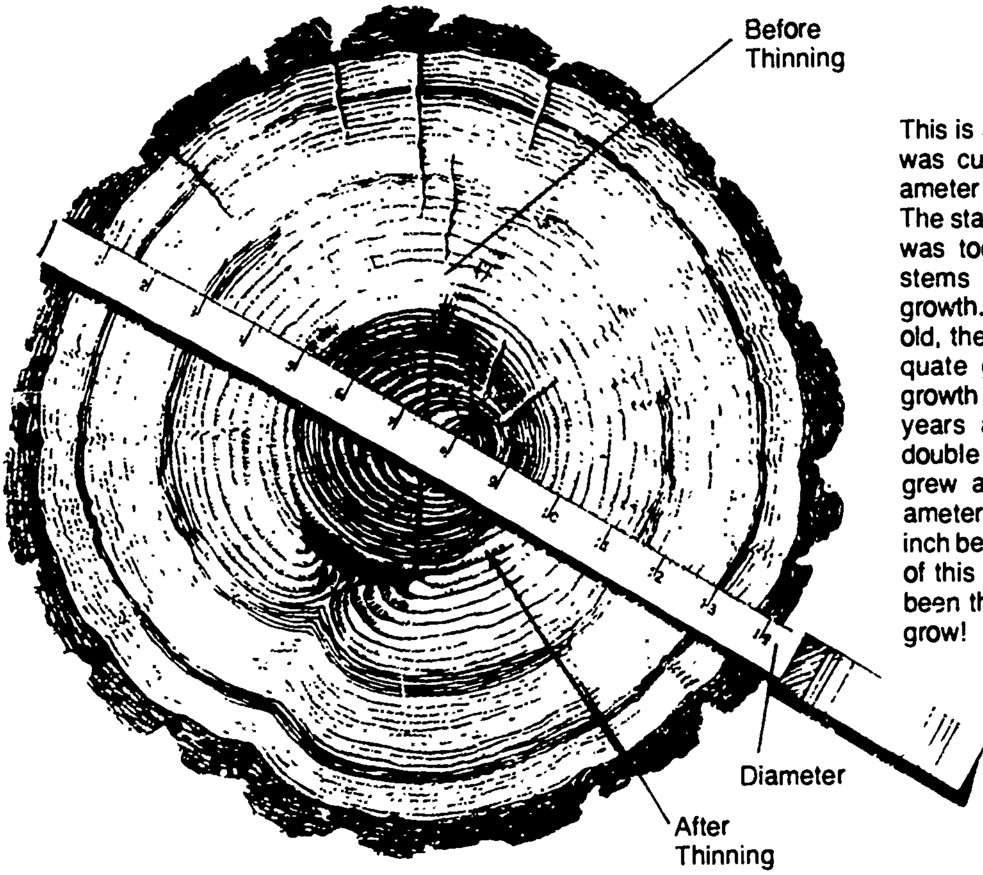
Whorl: the layer or grouping of branches at the beginning of each years growth (at each *node*) is a whorl.

How are wood-production rates measured?

To determine production rates, you need to compare the trees age to its diameter [usually at chest or bust height (DBH) which is measured as 4.5 feet above the ground on the uphill side. The easiest way to determine growth rates is with an increment borer.

What is an increment borer?

An increment borer is a T-shaped instrument that allows you to remove a core sample from a tree trunk. Counting the rings in the core sample and measuring the length of the sample will produce an accurate picture of growth rates and changes in those rates over time.



This is a cross-section from a tree tha was cut at 40 years of age. The di ameter was 14-inches outside the bark The stand where this tree was growin was too thick (i.e., it had too man stems too close together) for goo growth. When this tree was 25 year old, the stand was thinned. With ade quate growing space. the diamete growth rate of the tree during the 1 years after thinning was more tha double what it was before thinning. grew an average of 0.47 inch in d ameter afterwards compared to 0.2 inch before. Imagine what the diamete of this tree might be if the stand ha been thinned when the tree started grow!

Increment boring should be kept to a minimum, although the wound made by the borer usually heals without incident. By penetrating the bark, the borer provides an avenue for rot and fungus to reach the heart of the tree.

What is the difference between coniferous and deciduous trees?

Coniferous trees are cone-bearing. In other words, they produce cones (pine cones, spruce cones) as part of their reproductive strategy. Coniferous trees frequently have long thin leaves called needles, like spruce, hemlock, larch, pine, and cedar. Most, but not all, of these trees retain their leaves (needles) year-round, and so are called evergreen. For example, the needles of the tamarack or larch, a conifer found in Alaska, turn yellow and drop off each fall.

Generally, conifers are called softwoods because they have softer wood than most deciduous trees (hardwoods). Though classified as a hardwood, aspens, for example, have softer wood than larches.

Deciduous, or broadleaf, trees like alder, cottonwood, maple, birch, and aspen have thin flat leaves which they drop each fall or winter. A few deciduous trees, such as live oak and laurel, are evergreen.

As you can see, tree terminology can be quite confusing. Nature always presents strategies and combinations which resist the neat categories of botanists and other scientists.

What are some of Alaska's common commercial tree species?

Sitka Spruce is Alaska's largest and most valuable tree. It grows in coastal forests as far south as Washington state and as far west as Kodiak. In Alaska, the largest Sitka spruce are found in Southeast-where they reach heights of 160 feet, diameters of 8 feet, and ages of 500 to 700 years. Sitka spruce makes excellent lumber. The finest-grained sprucewood can be used to make pianos. Spruce need direct light, and so do very well on bare ground and clearcuts.

Spruce has platy, scaly grey-to russet bark; very sharp, prickly needles; and large (2-4 inch) cones. The top of young spruce trees stick straight up in a single spike. Until they droop with age, branches tend to stick straight out, or even slightly upward.

SITKA SPRUCE

Compliments of the U.S. Forest Service

Western hemlock account for about 70% of the trees in the coastal spruce & hemlock forests. They are slightly taller (190 feet) and slightly thinner (5 feet diameter) than the spruce. Shade-tolerant, hemlock thrive beneath, and eventually overtop, the spruce canopy. Hemlock is one of the best sources of pulp for paper, cardboard, and rayon. Hemlock also makes good railway ties, mine timbers, marine pilings, and plywood veneer.

The tops of young western hemlocks droop like tassels, or a weak wrist. Branches also droop. Needles are softer and more rounded than spruce's. Cones are jelly-bean sized. Grey to green bark is more elongated than the spruce's.

WESTERN HEMLOCK

Compliments of the U.S. Forest Service

Alaska- or yellow-cedars only attain heights of 40 to 80 feet and diameters of 4 feet. Found from Washington State to Yakutat, these slow-growing trees are exceedingly strong, dense, and rot-resistant. A 15-inch tree may be 200-300 years old. A specialty wood, yellow cedar is ideal for boat building, canoe paddles, exterior doors, furniture, and cabinetry.

Alaska-cedar wood is yellow in color; the bark comes in long, thin, grey-green strips; the branches tend to grow downward; the rounded needles lie flat and are not prickly, and the cones are small, hard, and berry-like.

ALASKA-CEDAR

Compliments of the U.S. Forest Service

Western Redcedar grows from Oregon to southern Southeast Alaska. The wood is very lightweight, strait-grained and rot-resistant. It makes excellent shakes and shingles, water pipe, foundations, fish traps, piling, posts, totem poles, and canoes.

From this species, the Haida of the Queen Charlotte Islands (just across Dixon Entrance from Alaska) made the best cedar dugouts which they traded with the Tlingits and other northern tribes as well as with tribes clear down to Puget Sound. The long, thick strips of pithy, rust-colored bark were used to make clothing, mats, and baskets.

Redcedar also grows slowly, usually only in shady wet bottom lands, after spruce and hemlock forest has reached maturity. The wood is so valuable and takes so long to replace that Japanese have been stockpiling cedar in mudflats where there is so much plant and animal decay that little oxygen remains and cedar may last for hundreds of years without rotting.

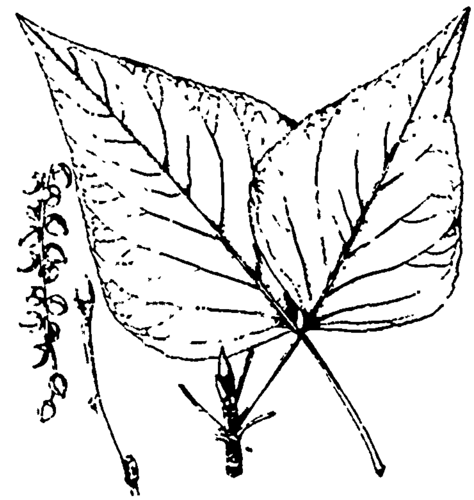
Redcedar generally grows faster than Alaskan cedar and has wider grain. The wood is red. Needles are sparser than yellow cedar's, and cones more bunched.

Compliments of the U.S. Forest Service

Black Cottonwood ranges from western Washington to Interior Alaska, and is typically found along the banks of mainland rivers and streams, aluvial fans, landslides, and the base of steep slopes. Cottonwood reach heights of 80-100 feet in Alaska. The largest black cottonwood in the world is found near Haines.

Although the Chinese have expressed some interest in using Cottonwood for furniture-making, thus far it faces very limited markets. When dried, cottonwood is very light and burns rapidly, producing little heat and considerable ash.

From a smooth, thin beginning, the bark of this broadleaf tree gradually thickens and fractures with age, to blocky appearance. Leaves are shaped like the spades in a card deck, and tend to be very waxy in the spring, when they emit a pungent, spicey smell. The name comes from the cottony filaments which carry the seeds on the winds.

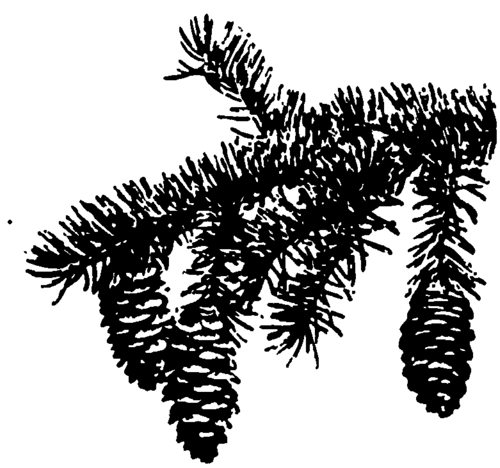


Compliments of the U.S. Forest Service

White Spruce grows throughout Interior Alaska, Yukon, and Western Canada. The most commercially-important species of the spruce-birch interior forest, white spruce reflects the harsher winters and drier summers (relative to coastal, southern Alaska). It rarely grows over 70 feet high or
20 inches in diameter. Near tree line, it looks more like a shrub.

Growing best on well-drained, south-facing slopes, white spruce makes good cabin logs, timbers for bridging, decking, and piling, and dimension-wood for light applications. The first sourdough prospectors used it for sluice-boxes, flumes, and boats.

The tree is named for the color of its wood. Needles are sharp like that of the Sitka spruce, and cones are approximately the same size (2-4 inches). Bark consists of scales, or plates.



Compliments of the U.S. Forest Service

Alaska paper birch is the most common and commercially-important of the birches found in Southcentral and Interior Alaska. Birch often grows after an area has been burned and is eventually over-grown by white and or black spruce. It is used for furniture, pulpwood, and carving.

Unlike the cottonwood's which are smooth, the paper birch's spade-shaped leaves have serrated edges. The white bark can be peeled on in one thick mass (for canoes, waste baskets, and water pipes) or in paper thin layers. Old-timers always carried a bundle of birch paper to use as a fire starter.

ALASKA PAPER BIRCH

Compliments of the U.S. Forest Service

Aren't some of the other trees found in Alaska valuable?

Every tree is valuable for something. Though sometimes dismissed as weeds, alders found in Southeast Alaska put nitrogen in the soil so that other trees can grow. Stripped of their bark, alder branches make some of the best smoke for curing salmon and other fish. Dry alder also makes great firewood.

Each species has its own virtues--as Alaska Natives well know. The wealth of the Northwest Coastal Indians had a great deal to do with their abundance of wood. But even the Inuit of treeless northernmost Alaska enriched themselves and their culture with the driftwood they found on their streams and beaches. In fact, the practical uses to which wood can be put are limited only by your imagination--which means that the uses of wood are unlimited. Some still wait to be discovered.

Logging Safety

Competency: Identify Safety Concerns

Tasks: Compare hazards of forestry to other professions
Discuss the forest setting
Discuss accident ingredients
Discuss injury mechanisms
Discuss the economics of accidents
Explain the importance of knowing first aid, CPR, and injury/accident procedures

Just how dangerous is forestry?

The amount of danger workers are exposed to depends a great deal on the work they are expected to perform. For example, a faller, someone who falls trees, is constantly exposed to much more life-threatening danger than a draftsperson or a road engineer.

According to government statistics the logging end of forestry is one of the ten most dangerous professions. One in three loggers will be killed or seriously injured this year in the U.S. In Alaska, 45 of every 100 logging camp workers will sustain an occupational injury. Each year in the U.S., hundreds of loggers die, and thousands are seriously injured. This costs millions of dollars in lost work time, lost wages, and medical and funeral expenses.

How much risk can be avoided?

Exposure to a certain amount of risk is inevitable, but many risks can be avoided or minimized. By following safe operating procedures you should be able to stretch a forestry job into a long and satisfying career.

What are safe operating procedures?

Although some procedures are job-specific, many apply to the entire field. Sometimes safety rules seem like the sissy-way, but generally they are designed to keep workers tough, rugged, and working as opposed to mangled, mashed, crippled, and unemployed. Here are some basic safety rules:

- follow standard safety practices, both written and understood
- understand the mechanisms of injury
- understand factors contributing to accidents
- wear all required and recommended protective equipment
- wear proper clothing
- do not disconnect/disarm safety devices
- follow manufacturers' instructions: use tools and equipment as they were intended to be used
- do not work when alcohol- or drug-impaired
- eat and sleep properly

- have, and practice following, a safety/accident plan
- never work alone
- know the limitations of your communication system, especially as they relate to terrain and weather
- maintain an adequate communication system within thejob site and between the job site and the outside world
- avoid working with unsafe operators
- don't rush or attempt to do more than you can safely accomplish
- make sure crew members are trained in emergency first aid, and know their ABC's (how to maintain an airway, control bleeding, and restore circulation[CPR])
- always think before doing something, and think SAFETY!

Regardless of the job, there are more and less safe ways to get it done. Sometimes it takes a little longer to do the job the safe way, but in the long run, the safe way will save everyone lots of time, money, and pain.

What is so dangerous about working in the woods?

The woods are not unusually hazardous for those content with contemplating nature. For the logger, however, the woods present a number of hazards. And if an accident occurs, medical facilities may be many miles and/or hours away.

Rough ground, steep hillsides, and slick footing can quickly fatigue even the strongest workers and cause them to trip or fall. If the force of the fall isn't enough to injure by itself, the presence of tree spikes, sharp stumps, and tools may.

Each of the four seasons presents its own particular sets of hazards. Cold, wet, or hot weather contributes to fatigue and makes the ground that much more slippery. Break-up and freeze-up each present special hazards underfoot. Short winter days encourage loggers to work in unsafe lighting conditions or when falling snow reduces visibility. Snow cover may make it impossible to run from a falling tree or rolling log. Summer brings distracting insects and long, long days; when a worker puts in 10, 12, even 16 hour days, the paychecks may be large, but so is the increased risk due to fatigue.

Brush causes accidents by snagging clothing and equipment. Brush leads to falls by concealing holes, gullies, cliffs, wells, and shafts. Brush may prevent workers from realizing how close they are to each other, with the result that one worker drops a tree or rolls a log on another.

Trees, logs, and rocks are just some of the overhead hazards in logging. Heavy equipment working on slopes, driving on roads cut into hills, or crossing improvised bridges may also succumb to gravity with disastrous results. In the Pacific Northwest logs are generally yarded up hill. In Southeast Alaska logs are often yarded downhill which increases the danger to those working at the landings.

Loud machinery adds to the fatigue factor.

Cables, chains, lines and tackle can give way with sufficient force to decapitate, crush, or drag a worker into mechanisms.

Saws, axes, chippers are all capable of producing deadly wounds.

The dangers are everywhere, and loggers have been killed in just about every conceivable way.

Once an accident occurs, the logging site presents another set of hazards related to its location. Many Alaskan logging sites are miles or hours away from medical help. Even a relatively minor injury, like a broken bone, can become life-threatening in a remote setting.

Transportation to and from the work site can be hazardous, whether by truck, plane, or helicopter. It doesn't make any sense to be a careful worker all day long, then drive home with a six pack, a careless driver, or a poorly maintained vehicle. At high RPM's, airplane propellers and helicopter rotors present sometimes invisible hazards. Those who will be working around aircraft should be thoroughly trained in the appropriate safety measures.

What factors are common to most accidents?

Most accidents are caused by carelessness resulting from one or more of the following:

- macho, cavalier, or fatalistic attitude
- haste
- fatigue
- anger or some other emotion
- distraction

What types of injuries are common in logging accidents?

Logging accidents include all classes of injuries and can involve soft tissue, bone, and vital organs:

- thermal injuries (burns, freezing, overheating, hypothermia)
- cuts (slashes, gashes)
- crushing
- avulsions
- blunt trauma from falls, etc.

Why aren't people trying to make logging safer?

They are. And forestry workers hold the key to making forestry safer. There was a time when most forestry workers were willing to put up with unnecessary risk but no more. There was a time when logging industry management was willing to accept high accident rates as part of doing business, but with few exceptions, those times are over.

What is the relationship between safety and productivity?

It used to be that the logging industry equated safety with reduced productivity. The faster a person worked, they figured, the more money the company made. Loggers, then, were under a great deal of pressure to cut corners--safety-wise. But how much work does a crew accomplish in the hours immediately following an accident? And how much does the accident cost the company in medical bills and hiring and training replacements?

In a recent year, the State of Oregon experienced 2,048 logging death or disabling injury claims costing at least $15.6 million. Those claims send insurance rates soaring, and soaring insurance rates can knock most marginal operations out of business.

It is much more profitable to take the time to do the job right. Although a few operators think they are saving money by not maintaining equipment, or forcing their crews to work too fast, they are merely giving up long-term productivity and profitability for a short period of slightly elevated productivity and profit.

Don't work for someone like that. If you are interested in making forestry a career, you owe it to yourself to find an operator with a good safety record and a good safety attitude.

Forest Management

Competency: Identify Modern Approaches To Forest Management

Tasks: Explain forest ecosystems
Explain forest management principles and terms
Explain raising trees as a crop
Explain pest control
Explain fire control

What is a forest?

A forest is a stand of trees, or timber. A forest may be as small as a few acres or as large as millions of acres. But a forest is more than just the wood, it is a complex ecosystem, which often includes both fish and wildlife.

What is an ecosystem?

Ecosystems are systems of ecological processes and communities of organisms engaged in complex interactions and interrelationships. Forest ecosystems consist of a maize of inter-related elemental (carbon, oxygen, nitrogen, etc.) and nutrient cycles and food-chains.

For example, the nutrients responsible for tree-growth are continually cycled through the entire ecosystem. Nitrogen is essential for plant growth. Alders and certain other plants remove nitrogen from the air and deposit it in the soil where it can be picked up by tree roots and eventually fixed in leaves and needles. These in turn are either eaten by animals or insects which excrete the nitrogen in the form of nitrates or eventually fall to the ground where bacteria and other decomposers release the nitrogen so that it is once more available for the roots.

Each element has a similar cycle, and so too, do many compounds such as water, carbon dioxide, etc. All the organisms (plants, insects, and animals) have life cycles. In most cases, the life cycle for a given organism involves hundreds of other organisms and cycles. This complexity makes for great stability.

What is forestry?

The term forestry encompasses everything having to do with studying, growing, managing, and harvesting trees and forests. Other terms for forestry include silvaculture and tree-farming.

Are logging and forestry synonymous?

To some people, logging and forestry mean the same thing. But logging is just one part of forestry, the part having to do with cutting down trees. In addition to logging, forestry includes fire control, recreation, fish & wildlife management, and other types of resource enhancement and extraction.

What is multiple-use?

Forests which are managed in an attempt to accommodate a number of different interests and users are said to be multiple-use forests. The multiple-use concept recognizes the fact that forests are more than just a source of wood.

What other values does multiple-use recognize?

Multiple use acknowledges the forest's role in water quality, wildlife habitat, and recreation. In certain cases, forest management will give these other values priority. When any single value becomes predominant, the forest is no longer multiple- but single-use.

How is logging staged in multiple-use forests?

In forests managed for multiple use, logging is usually scheduled under a sustained-yield basis.

What is sustained yield?

The idea behind sustained yield is to never cut more wood in a given period (usually a year), than the forest can regrow in the same amount of time. For example, if the trees take 100 years to grow to commercial size, only 1/100th of the forest should be cut in any given year. That way, there will always be wood to cut.

Wouldn't it be possible to cut all the trees down in a few years, and then just wait until they all grew back?

It would, but then there wouldn't be any work--at least in that forest--for any loggers for the rest of the 100 years. Furthermore, during the time it takes the forest to regrow, other of the multiple uses might be impaired. Related to multiple-use and sustained-yield principles is the notion that a forest is a renewable resource.

What is a renewable resource?

Renewable resources are resources which can be replenished by natural processes after they have been used. Generally, crops, fish, forests, air, water, and sunlight are considered renewable resources. On the other hand, non-renewable resources are those which natural processes do not replace. For example natural processes do not replenish most mineral deposits after the mining ends.

Are there different types of logging?

There many ways to log. Most fall into one of two categories: clearcutting or selective logging.

What is clearcut logging?

In clearcut logging, virtually every tree in a given area is cut down. Clearcuts range in size from less than an acre to hundreds of acres.

What is selective logging?

In selective logging, only the most valuable--generally the largest--trees are felled. Smaller trees are left to continue growing.

How does a forester decide whether to clearcut or selective log?

Such decisions are based on many considerations, although economics usually carries the most weight. In other words, the most profitable option usually is chosen.

Are there advantages and disadvantages to each method?

If your logging operation depends on volume, clearcutting is the method of choice. Clearcutting simplifies the access problem: tens of acres of downed trees can be yarded to a single landing. Certain species such as spruce regenerate more quickly after clearcutting because there is less competition for light. On the other hand, many people consider recent clearcuts eyesores. The brush left in the wake of logging can be almost impenetrable. The trees along the edge of a clearcut sometimes blow down during strong winds.

If a forest contains just a small portion of high value trees, selective logging has certain advantages. From a distance, at least, selective logging tends to be less of an eyesore. And properly done, it is normally less destructive to other forest resources. Selective logging may be better suited for the small operator. In selective logging, a small tractor or even a horse can be used to snake (haul) all but the largest trees out of the woods.

If trees are renewable, they must grow back naturally after logging?

Generally, they do. Sometimes, foresters give them a little help. This is called reforestation.

What does reforestation involve?

Reforestation can be left completely to nature, or it can be intensively managed. The latter case could include burning of slash and debris, putting logging roads to bed (grading, reseeding, and removal of culverts), planting of seedlings, fertilization, pest control (parasites, insects, rodents, and large animals), and repeated thinnings (every 5-10 years).

Are forests renewable?

That is a matter of much debate. Forests, like trees, have life cycles. Unlike trees, forests rarely die. Instead, they usually just evolve into something approaching a steady state, where the amount of growth roughly equals the amount of rot and the number of species and individuals of each species of tree and plants varies little.

What is the difference between second-growth and climax forests?

Forests can be divided into two categories: second growth and climax. A second growth forest is one which grows back after some sort of disturbance (fire, flood, logging, roading, etc.). A second growth forest is really just a phase, or series of phases, in transition to a climax forest. These transitional phases are characterized by the dominance and submission of a series of different tree species. Each species begins to flourish under special light and soil conditions, and as it grows these conditions change. When conditions have changed sufficiently, some other species for which the conditions are more favorable will take over.

In Southeast Alaska, starting from bare sands and gravels, forest succession might consist of lichens, moss, dryas, willow and alder, cottonwood, spruce, and hemlock--and in some case red and/or yellow-cedar.

In the climax forest one or two species usually dominate. Beneath the overstory or canopy formed by the dominant species, a complex assemblage of plants and shrubs will flourish. This understory is what supports a rich diversity of wildlife. In the intermediate stages of forest development this understory will be negligible and the forest will be relatively barren of wildlife.

What is the basis of the debate about whether forests are renewable resources?

Most people agree that trees are renewable resources. The debate focuses on the question of whether the forest will be managed so that the climax forest will be allowed to grow back after logging. In Southeast Alaska, a mature climax forest may take 250 to 500 years to develop. Once cut, most Southeast forests are scheduled to be relogged every 100 years. Under such a schedule, the old growth forest will not have sufficient time to redevelop.

Why don't foresters allow the stands to grow for 250 years or whatever it takes for the old-growth to recover?

In the first place it hardly makes sense to go to all that effort to establish a climax plant community if one is merely going to clearcut it as soon as it has been attained.
(It might make sense if one was going to shift to selective logging.) But there is a more practical reason, too.

If you think of trees as a crop, then like any farmer you want to harvest your crop as often as possible. In the case of trees, the time to harvest is just after the tree's growth rate begins to decline from the maximum. In Southeast Alaska, that is sometime after the tree's hundredth year.

How big will a tree grow in one hundred years in Southeast Alaska?

Growth rates vary markedly from site to site. In the best Alaskan locations under optimal conditions, a tree might attain 12 to 15 inches diameter in one hundred years--about the same size a tree could grow in the Southeastern U.S. in half the time. On some Southeast Alaska sites growth rates may only be half that of the optimal Southeast Alaska sites.

Is a 12" inch tree marketable?

Yes. Although the grain may be large, and boards made from such a tree tend to be weaker than those made from fine-grained, slower growing old-growth trees.

How does one grow trees as a crop?

To grow trees as a crop, foresters make tree growth the over-riding forest management priority. Typically, they begin by preparing the ground for seedlings. In the case of logged over land, this usually means clearing and burning slash, cutting down all standing trees, with the possible exception of seed trees.

Different species have different growing requirements. But generally only those species which produce relatively high quality wood relatively quickly, for example Sitka spruce, are grown commercially.

Planting seedlings enables foresters to control the genetics of their new crop and accelerate reforestation by from five to ten years. Depending on how intensely the crop will be managed, the foresters may cut down brush which shades the seedlings.

If seedlings were planted close together, periodic thinning will be required to ensure that the most vigorous trees are not crowded by the less vigorous. In Southeast Alaska, the most intensely-managed stands are thinned every ten to twenty years. Fertilizer may be added to speed growth. When plant genetics are controlled and only one tree species is grown, crops are extremely susceptible to damage from insects. This vulnerability may induce foresters to apply pesticides to control unwanted weeds, insects, rusts, fungus, etc. Of course, these type of management activities insure a monoculture, rather than a forest.

What is monoculture?

Monoculture means one, or single, crop. Like other types of farming, tree farming is generally a one-species activity. Although farmers may grow a variety of crops, any given plot or field only has one.

What are the advantages and disadvantages of monoculture?

Monoculture lends itself to efficiency. All individuals of a single species share certain growing requirements, will grow at approximately the same rate, and can be harvested at the same time.

On the other hand, monoculture farming may require more intensive management (fertilizing and pest control) and minimizes the diversity of the accompanying biological community. Without diversity, the balances between prey and predator species (between the crop and potential pests) are much more precarious.

Fire-Fighting

Competency: Identify Fire-Fighting Principles and Terms

Tasks: Explain the principles of fire ecology
Explain the factors involved in deciding whether or not to fight a fire
Explain basic fire-fighting safety principles
Explain basic forest fire fighting techniques

What role does fire play in modern forestry?

As long as there have been forests, there have been forest fires. Until recently, society has fought forest fires with all the technology and labor it could muster. With the rise of ecological science, the beneficial affects of fires has begun to be rediscovered, and now society is more discriminating in its approach to forest fires.

What are the beneficial affects of forest fires?

Certain Native American tribes recognized the mixed blessings of forest fire. Generations ago, the Indians summering in the Eastern Cascades of Washington would torch off the woods and meadows when they headed for the low country each fall. This was their way of preventing seedlings from overgrowing their grazing meadows.

Today, wildlife biologists and range managers recognize that forest fire encourages the growth of willow, alder, and other browse which are beneficial to moose, elk, bison, and other popular game animals. Indeed, in Southcentral and Interior Alaska browse species grow beyond the reach of browsers after two or more decades without fire.

Many species (Redwood, Sequoia, Ponderosa pine) can tolerate small ground fires, but when too much fuel collects on the ground and a fire starts, the ensuing inferno injures the roots or trunk or jumps into the crown, killing the tree. Douglas fir seedlings are more likely to grow after fire removes underbrush and other competition. Species like the Bristlecone Pine need the heat of a forest fire to release their seeds.

In California and other parts of the American West, foresters periodically conduct controlled burns to minimize the build-up of brush and debris on the forest floor. These controlled burns create a great deal of smoke, but not much heat. They hasten the return of nutrients to the soil, and open up the forest floor for forage plants. Furthermore, they prevent the build-up of fuel which results in uncontrollable wildfires that sweep across the landscape devastating the forest and its wildlife.

How does a forester decide whether or not to let a fire burn?

Foresters must weigh a number of considerations before deciding whether to fight a fire or let it burn. Typically, the factors they consider include:

- value of resources threatened
- proximity of communities and populated areas
- cost of fighting the fire
- availability of fire fighters
- terrain, fuel, and fire weather

All aspects must be carefully considered. For example, in valuing resources, the forester must ask:

- is this commercial timberland?
  if so, how will fire affect the value of the timber?
- is this important recreation land?
  if so, how will fire affect recreation opportunities?
- is this an important watershed, or part of a municipal water supply?
  if so, how will fire affect water quality and quantity?
- how far is this fire likely to burn?
- what happens if fire spreads to adjacent lands?

Generally, when fires threaten important resources such as commercial timberlands, municipal watersheds, or adjacent property owners, the forester is obligated to fight them with all the resources at his or her disposal. Since the forester stands the best chance of suppressing a fire when it is still in its infancy, these decisions must be made in a matter of seconds or minutes.

Forestry has become increasingly specialized in the past few decades. Forest fire control is big business. With hundreds of lives, millions of dollars of equipment, and hundreds of millions of dollars of property at stake, its no wonder that an entire subspecialty has been created. The men and women who make a career of forest fire suppression undergo intensive training so that they can make the best decisions in the shortest amount of time.

How are forest fires fought?

Forest fire-fighting has become very specialized in the last two decades. But the basic principles remain the same. Fire fighters know that their best chance of stopping a fire is when it is small. Therefore, a great deal of emphasis is placed on the initial attack.

What is the initial attack?

The initial attack is the first attempt to knock down the fire or extinguish it. In most forest-fire prone areas (such as Interior Alaska) initial attack crews stand-by throughout the fire season. These crews stay busy training, performing maintenance, and doing routine patrol work until the call comes. Then they are expected to be ready for action within seconds or minutes. The most experienced fire fighters get to be members of elite smoke-jumper, heletack, and hot-shot crews.

What do these crews do upon arriving on the scene?

This depends a great deal on the size of the fire, weather and fuel conditions, and the terrain. In the case of a small fire, say a lightning-struck snag, the initial attack crew tries to bring the fire under control as soon as possible. Large or fast moving fires require a great deal more caution.

How does a crew get a fire under control?

Fires need three things to burn: heat, fuel, and oxygen. These are called the fire triangle. Remove any one of the triangle's three legs, and the fire can be controlled.

All fire-fighting methods attack at least one leg of the triangle. For example, encircling the fire with a fire line attempts to remove or at least limit the amount of fuel available. Dumping water, snow, dirt, or fire-retardant chemicals on the fire displaces air and reduces heat. A successful backfire robs the fire of fuel.

What is a fire-line?

A fire-line is a non-flammable zone. Fire-line can either be constructed with handtools such as shovels and pulaskis, or heavy equipment such as bulldozers. Natural features like rock outcrops, unvegetated ridges, boulder fields, glaciers, lakes, and streams make excellent fire-breaks/lines. The size and nature of the fire determines the line's width and location. The goal is a fire-break that is wider than the fire's ability to jump or travel.

Where is the fire line usually dug?

Generally speaking, the first priority is to block the fire's advance. This means building fire-line out in front of the fire, if it is travelling. However, frequently it too dangerous to put a crew directly in the path of a moving fire. Then the strategy is to write-off a certain amount of forest and build a line further ahead of the blaze where it is safe to work.

In other cases, the direction in which the fire is travelling may pose less of a threat than if the fire were suddenly to shift direction. In some areas, wind shifts are quite predictable at certain times of day, or as weather patterns change. In steep terrain, fires move up hill, spreading laterally by wind or when burning materials tumble downslope. In such cases, the fire crew might concentrate their efforts on the flanks or rear of the fire.

What is back-firing?

Fast moving fires are frequently too dangerous to put a crew directly in front of. Where such a fire must be stopped, fire-fighters will sometimes light a fire in front of the oncoming blaze. If timing, location, and conditions are just right, winds caused by the larger, oncoming fire will draw the smaller, back-fire towards it, thus robbing itself of fuel. Back-fires are desperation tactics which should only be attempted by trained experts. Sometimes they don't do any good, sometimes they just speed the fire's advance, and sometimes fire-fighters get trapped trying to ignite them.

Do forest fires make their own winds?

Yes, large fires are like thunderheads. All the rising heat and smoke create strong up-drafts and draw relatively cool air along the ground into the fire. These updrafts and accompanying winds can shower sparks and cinders ahead of the fire, so that the fire leapfrogs over many acres. One of the worst scenarios is when a fire crowns.

What is a crowning fire?

A crown fire is the opposite of a creeping fire which moves slowly along the ground, burning the duff and brush. Crown fires burn in the forest canopy. There, the intense heat cooks resins in the upper branches and needles until they explode into flames. Under the worst conditions, the explosion sends flaming tree tops hundreds of yards ahead. Such fires can travel ten or twenty miles in an hour and tend to destroy everything in their path.

How dangerous is forest-fire fighting?

Because forest fires are somewhat unpredictable and have enormous destructive power, they are very dangerous to work around. Excitement, smoke, noise, fatigue, and the need for action add to the risks normally associated with forestry and logging type work. Rules have been developed to control these hazards as much as possible. The ten standard fire-fighters rules are listed below:

1. Keep informed on fire weather conditions and forecasts.

2. Know what your fire is doing at all times--observe personally, use scouts.

3. Base all actions on current and expected behavior of fire.

4. Have escape routes for everyone and make them known.

5. Post a lookout when there is possible danger.

6. Remember to be alert, keep calm, think clearly, act decisively.

7. Maintain prompt communication with your crew, your boss, and the adjoining forces.

8. If in charge of a crew, give clear instructions, and be sure they are understood.

9. Maintain control of your fire fighters at all times.

10. Fight fire aggressively, but provide for safety first.

Are large fires more dangerous than small fires?

You can get cooked just as easily by a 10-acre blaze as by a 10,000 acre blaze. However, the larger fires tend to be more dangerous because they involve so much more energy and exert so much more influence on local weather conditions. The more aircraft, heavy equipment, and people involved, the more hazardous fire-fighting is likely to be. In a small fire, crews on the ground tend to have a much clearer idea of what the fire is doing.

How are forest fire fighting crews organized?

Fighting forest fires is a bit like war, and the larger the battle, the larger the organizational structure. Often called a line worker, the individual fire fighter is part of a fire crew. Each fire crew will have its own crew boss. On larger fires, crew bosses will be under the direction of sector bosses, who in turn answer to the fire boss. In addition, the fire boss will have the assistance of paymasters, quartermasters, air controllers, weather observers, communication officers, and a host of other specialists.

What are some of the standard fire fighting tools?

Different tools are used in different parts of the U.S., depending on local preferences and fuel conditions. The most common fire fighting tools include:

Bladder and can-type backpack water pumps
McLeod or council tool for grubbing fire line
Brush hooks
Pulaski
Double-bit axe
Lady shovel
Chain-saw

For back-firing:

Drip torch
Fusees

Are there special safety procedures for working with fire tools?

Yes. The same general precautions which apply to all tools apply to fire tools as well. To minimize the potential for injury, these tools should be carefully carried, wielded, and stored. When building and maintaining the fire line, workers should space themselves sufficiently so that there is no chance of one worker being hit by the working end of another's tool. Cutting edges (axes, shovels, pulaskis, etc.) should be sheathed when the tool is not in use or is being carried from one location to another. Fire fighters should be familiar with the special hazards and safety procedures accompanying each fire tool.

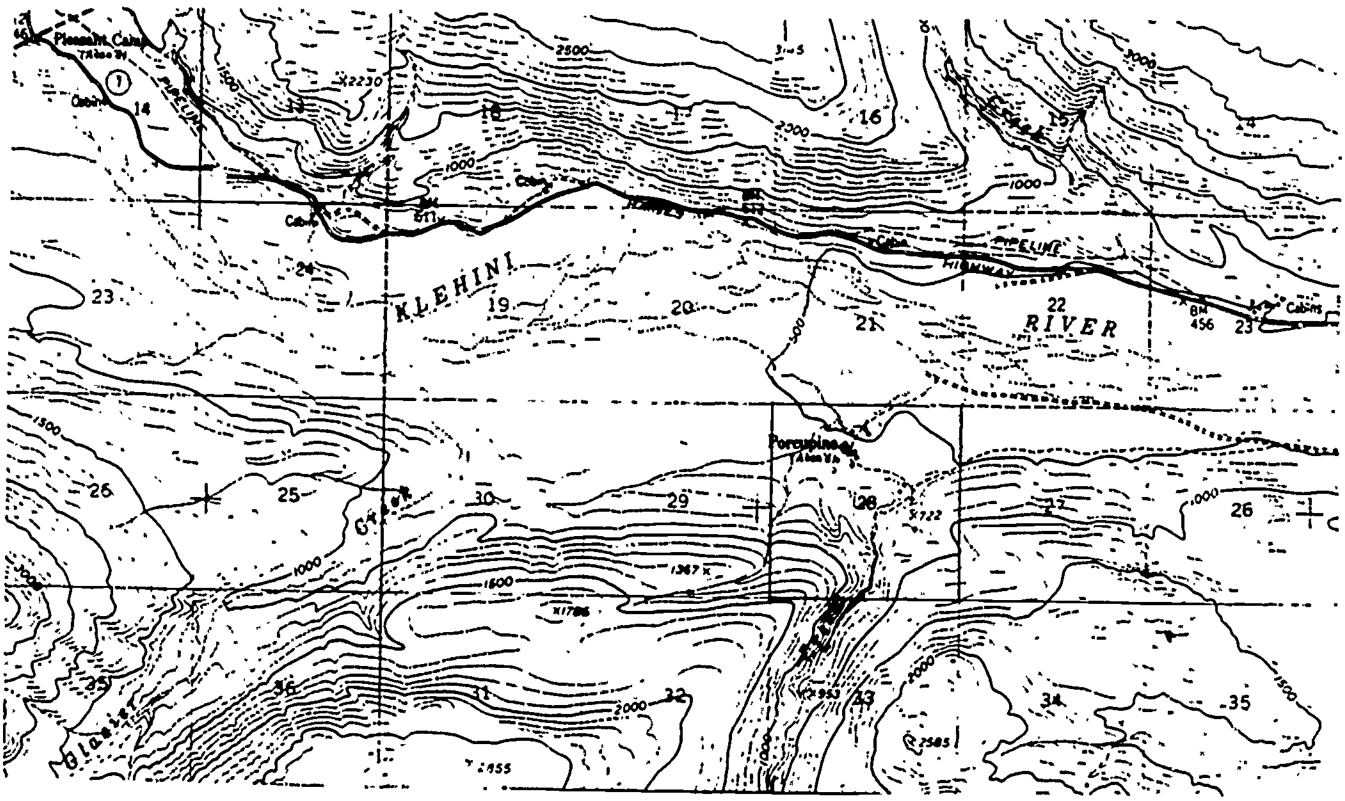
Map and Compass Skills

Competency: Identify Map and Compass Skills

Tasks: Identify sap Symbols
Determine scale
Use a compass
Orient a map
Explain triangulation

What is a topographic map?

Topographic (topo) maps show topography or physical features, including terrain, elevation, slope, water bodies, structures, trails, roads, mines, airports, and communities.



How are these features shown?

Since maps are not photographs and space is limited, maps use symbols to convey the various features. Some of the symbols are explained on the map itself; others will remain a mystery without a legend. Some maps have legends inset, or along a margin. The legend for most topographic maps are on a separate sheet.

How are topographic maps made?

The most common topographic maps are made by the United States Geological Survey (U.S.G.S.). Map making involves establishing control points on the ground by means of a survey.

What is a control point?

A control point is a specific and known location and altitude--often marked on the ground with a special stake called a monument. In the old days, these were surveyed in by using transits, compasses, and theodolites. Today, this method is rapidly yielding to using field computers and geo-stationary satellites.

What is the purpose of control points?

Control points make it possible to establish and check the exact location of any object or feature on the ground. Making topographic maps begins with stereophotography.

What is stereophotography?

Stereo means three-dimensional; it comes from stereos, Greek for solid. Stereophotography is a special method of photography which shows the subject in its three dimensions. This is accomplished by photographing one area from two opposite directions at the same angle. Viewing the resultant photos once they've been properly aligned through a pair of stereoglasses reveals the terrain's three dimensions. By tracing the features with special instruments the cartographer/topographer can transfer the features onto a blank sheet of paper which will eventually become a topographic map.

Why are topographic maps so important?

Topographic maps are important because they contain so much useful information. Indeed, while conveying an accurate picture of an area, they can be organized to accent or direct the viewer's attention to certain features such as slope, terrain, human habitation and changes (property lines) on the landscape. Furthermore, by the use of contour lines, bench marks, and altitude numbers, they show exact altitudes which could only be guessed at from a photograph.

Of course, the most important thing about topographic maps is that they enable people to determine their exact location. In the woods, knowing your location can be a matter of life and death.

How can you determine your location from a map?

If you were blindfolded and plopped down in the middle of the woods with the local topo map and a compass, you might not know your location, but you could determine it eventually, by a process of trial and error.

How would you begin?

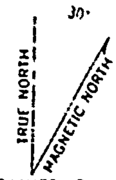
Assume the woods are so dense that you can see only a few feet, and no reference points or topographic features (no peaks, ridges, roads, or water bodies) are visible. You are essentially lost. But being lost is relative. You still are in Alaska, and chances are you know within a mile or two, or five or ten, where you are. So the boundaries of the area in which you are lost are finite. If you were to walk in any one direction, eventually you would encounter a topographic feature which you could identify with the help of your map and compass. Then you would no longer be lost. Reaching comfort and safety would be only a matter of navigation and time.

The first thing you would need to do, would be to orient your map, and yourself, with regard to the four cardinal directions, (North, South, East, and West).

How do you orient a map?

First you need to be aware of the difference between map (geographic) and compass (magnetic) north. The North Magnetic Pole is located in northern Canada northwest of Bathurst Island in the Queen Elizabeth Islands (approximately 77 degrees North and 101 degrees West). This is the north pole to which compass needles point. Maps, on the other hand, are oriented towards the geographic North Pole. In Alaska, the angle (declination) formed between a given location and the two directions is around 30 degrees and varies from place to place.

U.S.G.S. topo maps and NOAA nautical charts usually indicate local declination by means of a diagram.



APPROXIMATE MEAN DECLINATION, 1954

To orient a map, one merely turns it until its north-south lines (which are geographic) line up with north-south as indicated by the compass.

Why is declination in Alaska east?

Because in Alaska the magnetic north bears to the east of geographic north on a compass housing. Locations east of a line between the two poles (such as New York, Boston, London, Paris, etc.) have west declination.

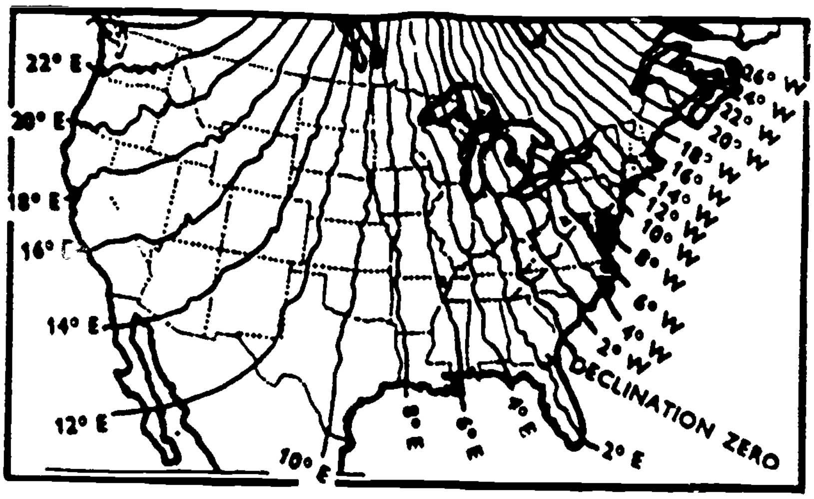


Fig. 12. Above map shows declination of the compass in North America. East of the zero line, declination is "Westerly". West of the zero line, declination is "Easterly".

It is easy to become disoriented--especially in Alaska where the sun rarely cuts across the sky from east to west as it does in the mid-latitudes and the tropics. (In Alaska it lurks largely in the southern quadrant in the winter and swings a huge lazy arc from north-northeast to north-northwest in summer.) When in doubt, trust the compass.

Generally, when you have a compass and the proper map for the area, you will be able to determine which direction to head in order to reach a given feature. The important thing to remember is that in going back and forth between map and compass, you need to constantly allow for declination.

How does one allow for declination?

Getting caught by darkness and/or fog can induce a feeling of panic in even the best outdoorsperson. The best way to prevent panic is to be proficient at compass-work. Proficiency begins with having a fool-proof method for making declination-allowance computations. The rule is: Changing Declination from Magnetic to True Add East. The U.S. military tries to aid memorization by teaching recruits to remember "Can Dead Men vote Twice At Elections."

How do you change bearings from true to magnetic?

In Alaska where the declination is east, you would simply subtract the declination. Most good compasses come with instruction manuals which explain map and compass work. If you can understand the instructions and practice doing the exercises, and if you remember to take along a compass and the proper map, you should never be lost for very long.

What do you do after taking a siting?

First, you have to determine the reciprocal heading, the direction from the object to you. This is done by adding or subtracting 180 degrees. Once this has been done, draw a line on your map from that object on the reciprocal heading. Make sure to allow for declination, without allowing for it twice. Repeat this exercise for one or two more objects. Where the lines intersect should be your location. You have located your position by triangulation.

What is triangulation?

Triangulation is a method of location in which you use two other known points to establish a location. Though of little value in dense forest, it is one of the most important methods of navigation.

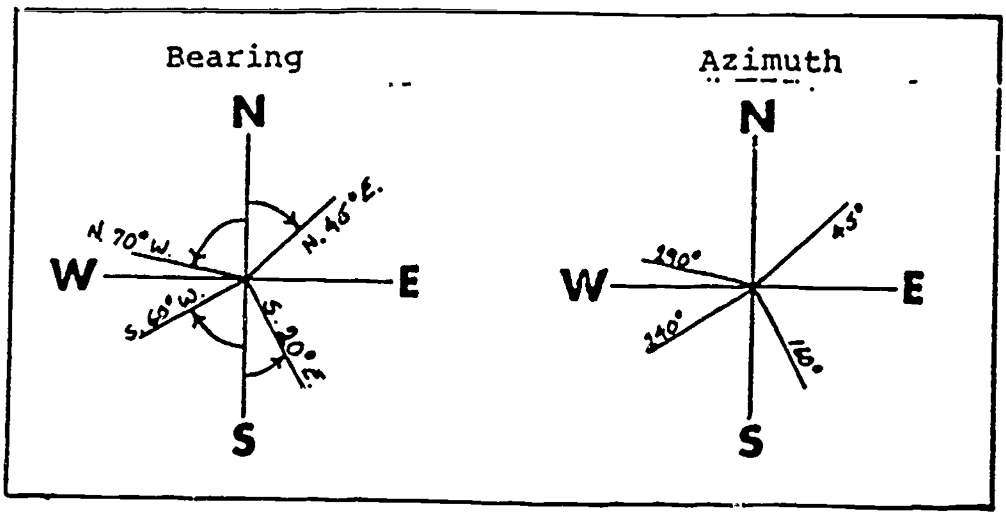
How does triangulation work?

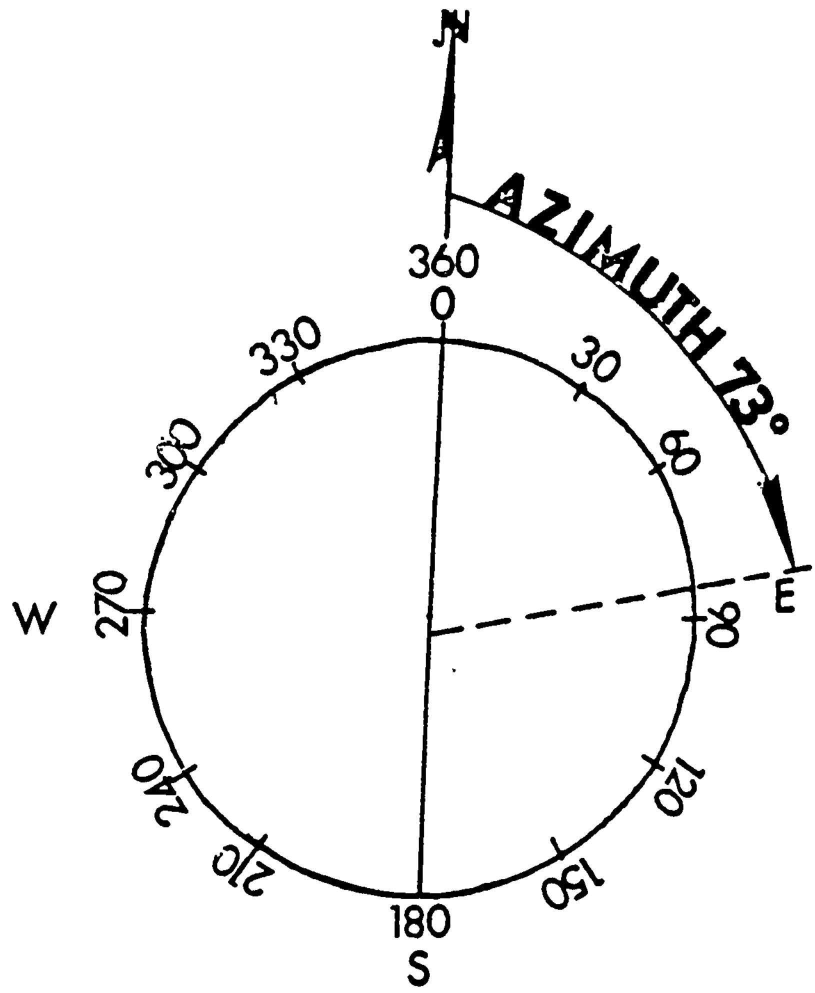
Assume you are in a meadow, or on an open water body, and can see some landmark in the distance, a peak, a point or a building. If you can locate that landmark on your map or chart and obtain a compass bearing between yourself and that point, you should be able to draw a line on that map representing the bearing (having oriented your chart and allowed for declination).

You know that you are located somewhere on that line, but you need some way of pinpointing your location on that line.
Assuming that you aren't standing atop a benchmark or some other identifiable and mapped feature, your best chance of pinpointing your location is to take a compass reading on another mapped landmark. Ideally, choose a landmark about 90 degrees away from the first. If you draw that bearing line on your map, you should be where the two lines intersect. You can check the accuracy of your work by taking bearings on other landmarks and drawing those lines on your map.

What is the difference between bearing and azimuth?

An azimuth is simply the direction as read on a compass housing. Bearings are read as degrees East or West from whichever is closer, the north or south.





What are the grid lines on topo maps?

In mapping North America, map-makers had to start somewhere. They established meridians which are parallel to the north-south running lines of longitude and base lines which are parallel to the east-west running lines of latitude. Perhaps you've heard of the Copper River, Seward, or Fairbanks Meridians.

What is a township?

In order to more precisely locate things, North America has been subdivided into townships, which are squares 6 miles to the side. The townships are then further subdivided into 36 sections, each having an area of one square mile. These sections are then numbered always in the same sequence. This system facilitates locating things such as forest fires.

What does the T. and the R. on topo maps stand for?

T stands for township and R stands for range. Each is followed by a number and a letter designating one of the cardinal directions. The number refers to the location in the grid, the letter to the direction from the point on which the grid is established.

Why are some grid lines solid black while others are dashed in red?

The solid black lines have been marked on the ground. The dashed lines have not.

What are chains?

Chains are a unit of measurement commonly used by surveyors and foresters. Although at first the units may seem strange, they are particularly useful in calculating acreages. Forestry and survey technicians are typically instructed to "pace off so many chains" in a given direction. This is why surveyors assistants are frequently called chainmen/persons.

1 chain = 66 feet
10 square chains = 1 acre
80 chains = 1 miles
640 acres = 1 section = 1 square mile

Survey

Competency: Identify Survey Terms and Principles

Tasks: Explain survey tools and terminology
Explain survey principles
Explain legal considerations

What is a survey?

There are many types of surveys. Their common purpose is to locate and mark property lines, boundaries, and structures and determine acreages.

What are the different types of surveying?

Land, cadastral, site, and construction are some of the more common surveys. Each type of surveying has its own procedures and standards of accuracy. In some cases, the application of lasers and radars in the past decade has made it much easier to meet or exceed these standards. In rough land surveying the purpose is to locate property and boundary lines on the ground.

Cadastral surveying is the establishment of grid systems and township and section corner monuments and lines on the ground so that future surveyors have accurate reference points from which to work.

Land surveys are done to locate property lines and determine ownership. Forest surveys, wherein clearcuts and logging roads are laid out, are a variant of land surveys.

Site surveys are done to determine terrain features such as slopes and drainage patterns in order that engineers may design a site for construction.

Construction surveys assure that structures are built according to construction specifications --that building corners, structural members, and bridge abutments are exactly where they are supposed to be.

Why are surveys needed?

Surveys are essential for determining precise locations and quantities and for establishing land ownership. In forestry, information from surveys is used to determine timber volumes, lay-out cuts, and locate roads, landings and stream crossings.

Who can perform a survey?

Although most anyone can learn basic surveying skills, most surveys require the participation and/or oversight of a licensed surveyor--also known as a Registered Land Surveyor (R.L.S.)

Why is a license needed?

The licensing process is a form of quality control which assures that the surveyor has the knowledge and skills to perform survey to the required degree of accuracy.

When a registered surveyor affixes his or her professional seal to a document, the surveyor becomes legally responsible for its accuracy. Should a dispute arise as the result of the survey, and a court finds the survey at fault, the surveyor may be liable for damages. In the case of forest surveys which result in more trees being cut than should have been, the surveyor may be responsible for treble stumpage fees.

How are surveys conducted?

Generally, a survey starts from a known location, preferably a bench mark placed by the U.S. government. Although the earth is round and its surface is irregular, property lines tend to be straight. The surveyor then has the often difficult task of reconciling a square world with a spherical globe, surveying up, down, and across slopes and other obstacles. Trees and brush obstruct visibility and often must be removed.

What tools are typically used by surveyors?

In the past, surveyors used transits, levels, theodolites, signal fires, bruntons, clinometers, measuring tapes and pedometers depending on the accuracy required. Today, they may also use computers and satellites to pinpoint locations, and geodimeters to measure point to point distances.

What is a transit?

Transits are tripod-mounted surveying instruments which measure horizontal and vertical angles. They are similar to the slightly more complicated theodolite. Transits are typically used with level rods.

What are level rods?

Level rods are long, usually white calibrated poles. They have a movable marker upon which the transit operator can sight. In the hands of a capable assistant, the level rod enables a surveyor to see over low obstacles (grass, brush, logs, rocks, etc.) to determine the relative elevations of two locations.

With an angle from the transit, the elevations of the transit and the marker on the leveling rod, the distance either from a measuring tape or a geodimeter, and some geometry, the surveyor can layout property lines, roads, and building sites.

What is a signal fire?

In the old days, a survey party would place members on a peaks which were visible from many parts of the surrounding country. The person on the mountain would maintain a fire at night, providing a point of light from which the survey crews could obtain accurate bearings.

By means of triangulation, the surveyors would eventually be able to accurately locate a number of reference points.

What is a brunton?

A brunton is a fancy compass with a sight and a clinometer, or level capable of measuring slopes. It is used by geologists and rough land surveyors.

What is a clinometer?

A clinometer is one of the simplest instruments for determining slopes. More complex instruments include abney levels, transits, and theodolites. Slopes are generally given as degrees, percentages, or ratios (rise over run).

What is a geodimeter?

Geodimeters send and measure the time which a laser beam takes to travel to a special prism target held by an associate and back to the instrument. From the elapsed time, the geodimeter computes the distance, providing a very quick, economical, and accurate measurement.

What skills does a surveyors assistant, or chainperson, need?

Surveyors assistants need to be able to take bearings, shoot azimuths, and record field notes. They should also learn enough trigonometry to be able to determine slopes, reduce data, and calculate acreages. Assistants, or chainpersons, should be able to brush lines, survey lines, and measure chains.

Timber Cruising

Competency: Identify Timber Cruising Methods

Tasks: Explain timber cruising terms and principles

What is timber cruising?

Timber cruising is the most accurate way--short of logging-- of determining the species, quantity, marketability, and volume of timber in a given stand or area. It is basically a scientific sampling method requiring considerable judgement and knowledge on the cruiser's part.

Does a cruise entail examining each tree?

Not necessarily. Although examining each tree would be the most accurate way to quantify timber volumes, it would also be extremely costly. Examining every tree is possible in the case of small stands and experimental forests where costs are less of a factor. The idea of a cruise is to inventory representative stands, then extend the results to similar stands in the remainder of the forest as indicated by aerial photography and other remote sensing materials.

Who normally performs a timber cruise?

Timber cruising is a skilled profession. Although anyone can learn the rudiments of cruising with study and practices, it takes time and practice to perfect the techniques and develop the judgement required to accurately estimate timber volumes and values. The best cruisers tend to be specialists who do little else.

What are the timber cruiser's tools?

Timber cruising requires a few simple tools, including a clinometer, a diameter (D-) tape, an increment bore, a wedge prism, and a water-proof notebook.

What is the clinometer for?

Clinometers are used to generate the angles necessary for the geometry used to determine merchantable tree height.

What is a diameter tape?

D-tapes are specially calibrated measuring tapes which allow you to measure tree diameter without having to make any calculations. Most D-tapes also have standard calibrations which can be used to measure anything, such as the height or circumference.

What is the increment bore's purpose?

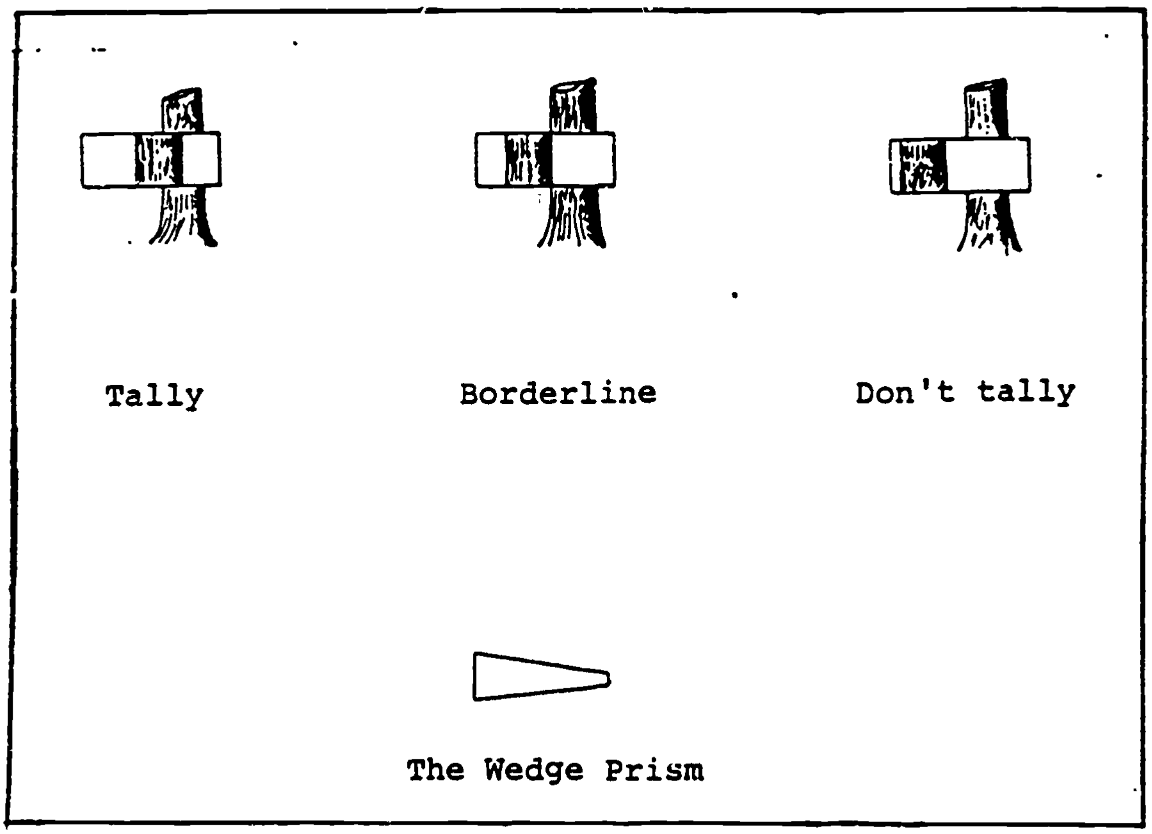
The increment bore allows you to determine the age of the tree and the extent, if any, of rot. This information can also be used to determine growth rates.

What is a wedge prism?

Wedge prisms are devices which enable the cruiser to determine whether or not to include a given tree in the cruise.

How does a wedge prism work?

Like any prism, wedge prisms bend light. But wedge prisms bend light in a special way so that, when viewed through the prism, objects at different distances will be in or out of the crosshatching in the prism's viewer.



How is the D-tape used?

Measure the tree 4.5 feet above the ground, on the uphill side if the tree is on a slope. Be sure to measure both circumference and diameter. Make sure tape is level and snug. Record the diameter of each tree measured in the proper category on the summary chart. Note any unusual conditions such as multiple trunks, injuries, burls.

How is the clinometer used?

In order to tell the height of merchantable wood in a given tree, the cruiser needs to know the distance from the trunk to the clinometer, and the angle from horizontal at the observer to the merchantable top. Whenever possible, use 100 feet horizontally away from the center of the base of the trunk as measured with a steel tape as the distance from the trunk.

What do cruisers assistants do?

They help with the measurements, carry gear, and record and reduce data.

How are timber volumes measured?

Usually timber volumes are given in terms of thousands of board feet (Mbf) per acre, or in the case of the annual production of large forests like the Stikine District of Tongass National Forest, millions of board feet (MMbf) per year.

How is forest productivity measured?

As you might expect, each corner of the forest has slightly different growing conditions. These combine to result in a growth rate which is expressed in terms of a site index.

How are site indices calculated?

The site index factors tree diameter, age, and height to determine annual incremental growth. Different site indices are used throughout the country, which makes it difficult to compare growth rates from one region to another. For example, three different ways of measuring site indices are currently used in Tongass National Forest--two using a 100-year cycle, one using the 50 year period more common in the Pacific Northwest and the Southeastern U.S. In the Tongass, one uses the average tree height, one the tallest, the other the average height of the tallest 40 trees.

By combining site indices and stocking, or timber volumes, from many randomly selected plots of every timber-type and site-type in the forest, timber inventory specialists are able to generate an estimate of the entire forest's total timber volume.

Forest Practice Regulations

Competency: Identify Applicable Forest Practice Regulations

Tasks: Explain forest practice regulation terms and principles

What are forest practice regulations?

Forest practice regulations are laws which foresters and loggers must follow. No matter where you are in Alaska, and no matter who owns the land, some set of regulations--either federal or state--govern how you operate. This is even true for people working on their own land.

How do you know which regulations apply?

All logging activities on National Forest lands are governed by federal regulations promulgated and enforced by the U.S. Forest Service. Logging activities on all other lands in Alaska are governed by the State Forest Resource Practice Act of 1980.

What is the purpose of forest practice regulations?

The purpose of regulations is two-fold: to protect natural resources while allowing for logging, on the one hand; and to provide the logger/operator with guidance which clearly proscribe what the operator can and can not do.

How do forest practice regulations protect resources?

By specifying such things as set-backs and special procedures for logging steep slopes, the regulations help protect anadromous fish streams from the introduction of logging debris (stumps, roots wads, cull logs, etc.) and siltation arising from erosion and slope failure.

Regulations governing the placement, construction, and retirement of logging roads have similar intent.

What is the difference between mandatory and advisory language?

Mandatory language includes such words as shall, must, and will. Advisory language includes such words as should. Mandatory language has teeth; it is enforceable. Advisory language can be taken more as advice, suggestion, or recommendation.

Why were forest practice regulations developed?

Forest practice regulations were developed to correct the worst abuses associated with the least-environmentally conscious operators. These included leaving debris and yarding logs through anadromous fish streams, logging excessively steep, failure-prone slopes, and leaving slash and tall stumps.

Why not just let loggers use their own judgement?

Both state and federal regulations leave a certain amount to the discretion of the operator and the forester. However, operators face heavy pressures to keep operations as inexpensive as possible. Often, it takes more time and costs more money to operate in an environmentally-sound manner. Some of the most valuable timber may have to be left untouched, if other important resource values (fish, wildlife, scenery, water quality, etc.) are to be protected. In such cases, the regulations help protect the general public's rights and interests.

Furthermore, the absence of clearly defined regulations invites operators to get away with as much as they can and places foresters in the difficult position of arbitrating between the loggers's need to maximize profits and multiple use considerations. There is less chance for misunderstanding when everyone knows the rules.

Finally, it is frequently much cheaper to avoid damaging a resource than it is to repair a damaged resource. By making the operators do things right, regulations protect society from the expenses and reduced productivity due to resource damage.

Chainsaws

Competency: Use a Chainsaw

Tasks: Explain chainsaw parts and terminology
Explain safety hazards and procedures
Explain routine maintenance procedures

What is a chain saw?

Chain saws are portable, usually gasoline-powered, saws which are used to rip through wood.

How does a chain saw cut?

The chain carries a set of teeth which chisel or rip--as opposed to slicing--their way through the wood. The efficiency of the saw depends on the length, sharpness, and regularity of the teeth.

Why are chain saws so dangerous?

Chain saws are dangerous for two main reasons. In the first place, saw design requires the operator to work in close proximity to several feet of very vast and very sharp chain. Secondly, chain saws are used to cut trees, no two of which are exactly alike. The wood may have grown with a twist, have some defect, or be under great pressure or located in an awkward position. In other words, the tree may place the sawyer in a vulnerable position, and it may kick the saw back at the operator.

What are the chain saw's basic parts?

- fuel tank and cap
- engine housing
- throttle
- switch
- choke level or button
- carburetor
- transmission oil fill cap
- chain oil fill cap and oil plunger button (if not automatic)
- handle bars
- sprocket and bar adjustment
- bar and chains
- dogs
- air cleaner
- spark plug
- starter assembly
- exhaust

What are the standard pre-start procedures?

With the saw off, make sure chain is on and properly tensioned. If it is too loose, the chain may jump out of the groove in the bar, causing injury, damage, or binding in cut. If it is too tight, the chain, sprocket, and bar will overheat and wear excessively.

Adjust by loosening bar nuts and tuning the bar adjustment as necessary. Tighten bar nuts when finished.

Check also the condition of the chain rivets. If excessively worn, these rivets are probably about to fail which means that the chain could break and cause an injury. If necessary, replace rivets and/or chains.

Make sure chain guide plates are installed in their proper orientation so oil can reach the chain. Clean out sawdust, wood chips, and debris, so that oil flow is unimpeded.

Gasoline is a high-explosive. When working around fuel, do not smoke. Allow the saw to cool before refilling. Pour fuel with care; avoid dousing the engine housing and/or clothing.

Before starting, ensure that proper fuel is being used. Most saws have two-cycle engines which require fuel to which a specific amount of two-cycle engine oil has been added and fully mixed. Improper fuel oil ratios either clog spark plugs or cause the valves to overheat and seize up. In the latter case, repairs typically cost about 80% of the price of a new saw.

If you are uncertain about the contents of the fuel you intend to use, mix your own, starting from scratch. If you are uncertain about the proper mixture, check the saw for instructions. Typically instructions can be found on gas tank filler caps. Make sure that you have the correct cap/instructions.

Finally check the carburetor filter screen. Remove and clean off any debris, dirt, or sawdust. Replace the filter screen.

It doesn't hurt to repeat these procedures each time you fill the tank, or at least once every hour or two.

What are proper start-up procedures?

Place the saw on a flat surface. Stand behind the saw. Place your left hand on the safety handle and your right foot on the trigger handle, and grasp the start cord in right hand. Flip the power switch toggle to the "ON" position, adjust the choke and trigger lock mechanism, as required (see manufacturer's instructions). Make sure the bar/chain is clear of all obstructions/hazards. Pull firmly on the starter cord, but not so far as to rip the cord out of the housing. Adjust and repeat as necessary. Anticipate and be prepared to overcome the saw's tendency to kick back.

Technological Impacts

Technological Impacts
Teacher Page

Introduction

This curriculum begins with several competencies which introduce terms and principles fundamental to any discussion of technological impacts. Then more specific types of impacts, such as air and water pollution, are discussed. Although attempts have been made to categorize these impacts (Air Pollution, Water Pollution, Hazardous Wastes, etc.), most technological developments have far-reaching and multiple effects. A given invention or process, for example, can change the way whole societies live, and can produce whole new health and environmental concerns. If nothing else, the following material presents convincing evidence of the inter-relationship of all things--and of the importance of always keeping those inter-relationships in mind in planning and carrying out activities.

The following material will likely affect each student differently. Some students will be skeptical while others may be so overwhelmed by the problems their generation faces that they become depressed.

To the skeptics, it must be admitted that a certain amount of skepticism is healthy. Despite all the problems, pollution, and predictions, (in the words of Chicken Little a fairy tale character who ran around spreading alarm by saying over and over again "the sky is falling") the sky has not fallen--at least not yet for most of us. On the other hand, one can never tell which straw will break a camel's back until the camel's back has been broken.

But the sky, or at least part of it, has fallen for some people, for example victims of various carcinogens and other hazards such as killer smogs (London, New York, Pittsburg) and toxic spills (Bhopal, India; Crown Point, Alaska). Indeed, on almost any day of the year, the newspapers print stories about chemical spills and the hazards posed by a seemingly endless number of substances. Some of these hazards are well-known, some are almost too subtle to detect. In the case of the most hazardous substances, the solution may be obvious: stop production and use. In many cases, it is harder to know what if any action should be taken. The question is not only how much pollution and environmental degradation can the planet withstand, but what kind of a world do you want to live in?

To those who may become depressed, it must be admitted that there is a great cause for concern and many warning signs. On the other hand, the situation is not hopeless. Society has made progress in the past three decades. Natural processes and systems are much better understood, and a great many environmental protection laws have been passed. Furthermore, natural systems have shown a great deal more resilience than some suspected was possible, and some species have recovered from the brink of pollution.

There are things which can be done not only to prevent the situation from getting worse, but also to make it better. For example, Cleveland's Cuyahoga River was so polluted with industrial wastes 15 years ago that it would catch fire and burn for days. A coalition of industries, environmentalists, and government agencies decided to clean up the river. Now the Cuyahoga is a popular recreation area--part of the National Park System.

Essential to a resolution of the problems created by our technology is a thorough understanding of all the relevant facts--about chemical and physical processes and social, environmental, and health impacts. This curriculum is but a brief introduction to a complex and rapidly expanding field of inquiry.

Overview

When it comes to career opportunities, the field of technological impacts is a good news/bad news situation. The bad news is that technology produces a great deal of problems, including hazardous wastes. The good news is that dealing with those problems and cleaning up the wastes is a growth industry. The bad news is that cleaning up pollution and hazardous wastes exposes workers to a host of known--and probably an equally large number of unknown--health hazards. But the good news is that workers may be at least partly compensated for these risks--as with hazardous duty or combat pay in the military.

Ultimately, individuals will have to determine for themselves whether the extra risk is worth the extra money. In order to decide whether the additional risk is worth the money, and in order to minimize the hazards they face, it is essential that people understand beforehand as much as they can about those risks.

Technological impacts have created another occupational field called technological assessment. Technological assessment is really a sub-field of many different disciplines and sub-disciplines, including sociology, anthropology, political science, computer science, geography, meteorology, geology, hydrology, biology, chemistry, physics, and mathematics. Depending on whether the assessment constitutes academic research or sampling of hazardous wastes, it can be more or less hazardous than cleanup work.

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Technology Terms and Principles

Competency: Identify technology terms and principles

Tasks: Define technological terms
Explain technological impact principles

What is technology?

Technology is the application of knowledge to human objectives, particularly manufacturing, transportation, and construction. Technology can be as simple as the invention of the wheel, a cookpot, or bow and arrow, or as complex as as a supersonic fighter-interceptor, computer, or satellite.

Technology is tools. It is science or knowledge applied to solving problems, doing work, or making life easier or better--at least in theory.

What is a technological fix?

The word fix has several meanings. On the one hand, when something broken is repaired, when some problem is solved, it is considered fixed. On the other hand, when someone is in a jam, when they are stuck with a problem, they are said to be in a fix. A technological fix is a solution to a problem that creates an equally or more serious problem.

What are some examples of technological fixes?

Pollution control devices and nuclear reactors are technological fixes. In the first case, engineers invented catalytic converters and other pollution control devices to reduce the amount of pollutants emitted by vehicles. These devices do what they are designed to do, but they also reduce fuel economy; a vehicle equipped with them gets poorer mileage and can't go as far on a gallon of fuel as would the same vehicle without all that equipment. In other words, the solution to one problem (pollution) exacerbates another problem (fuel consumption).

Nuclear power has been hailed as the solution to the world's energy crisis. However, as long as world power consumption rates continue to grow at the present rate, no combination of power sources presently available--nuclear included-- will be able to keep pace with demand. Nuclear energy is great when it works, but when things go wrong, they really go wrong. So far there is no way to solve or address many of the resultant problems. Even when things go right, nuclear energy creates radioactive wastes. Despite the fact that the many of the world's best scientists and engineers have been working on the problem for more than 40 years, no safe method has been found for storing these materials for even a fraction of the thousands of years required for them to decay into harmless materials. Furthermore, a single reactor may produce hundreds of pounds of plutonium a year, and ten pounds is all it takes to make a bomb capable of enormous destructive potential. Although it might seem that designing a system capable of guarding these materials should be relatively easy, even this has not been the case thus far--judging from the frequency with which plutonium and other radioactive wastes disappear.

What is the solution for a technological fix?

Sometimes technology will ultimately come to the rescue. Scientists and engineers will develop processes which solve all the significant problems without creating new ones. At least as often, the only viable solution is to change consumer demands and lifestyles. For example, the simplest way to reduce air pollution from automobiles is to reduce the number of automobiles and/or the amount of driving. Similarly, the easiest way to solve the energy crisis and avoid the problems resulting from ever-increasing reliance on nuclear power and imported fossil fuels is to use less energy.

So why doesn't society use less energy?

The United States has been doing just that--using less energy--for the past few years as a result of individual and government measures to avoid rising energy costs. The problem is that for decades energy was relatively cheap. Engineers and manufacturers designed factories, processes, and products with little regard to energy-efficiency. Now society is stuck with those plants and technologies.

Why doesn't the government make energy conservation the law of the land?

Using less energy and driving less is sometimes easier said than done. Our country is justifiably proud of its heritage of letting the individual do as the individual pleases, and politicians are extremely reluctant to impose such changes on those who have the power to remove them from office. However, what pleases the individual may not always be best for the society and balances need to be struck. In fact, the so-called "primitive" cultures are sometimes better at balancing the needs of the individual with those of the society--because these cultures understand that the survival of the individual depends on the survival of the society.

While it might seem impossible to imagine "doing without," driving less and using less energy, our present high rate of energy consumption really didn't begin until less than three decades ago. The energy crisis in which the nation depends on other countries not to shut off oil supplies is part of the tradeoff society pays for individual liberties.

What is a trade-off?

Trade-off is simply another word for a choice, for trading one problem for another. For example, in the past ten years, many Americans have chosen to spend more money to insulate their homes in order to save money on heating costs. Knowing the pros and cons--tradeoffs--involved in making choices, makes it possible to determine beforehand which choice is best. For example, you can drive as much as you want (assuming you can afford to), but if you do, you have to be willing to accept increases in air and water pollution and car accidents, repairs, and replacements, etc.

Is technology good or bad?

Obviously, the answer depends on how it is used. Is it used properly, abused, overused, misapplied? Technology, like love, is blind. It is neither good nor bad but has enormous potential to be either. Cars, airplanes, guns, plastics, television, computers--practically any technological invention--can be either good or bad. When society remembers that technological inventions are tools--rather than toys--and uses the right technology for the right application, then technology can be very useful. When technology is designed, built, and used in such a way that natural processes and systems are either enhanced or not impaired, technology is good. This matching of technology with need and nature is called *Appropriate Technology.*

What exactly is the idea behind appropriate technology?

Appropriate technology is matching the technology to the job. The idea is to bring the right amount of technology to bear on a given job. Behind the notion of appropriate technology is the idea that some technologies are inappropriate for certain applications. For example, say someone wanted to heat water for bathing. This water only needs to be between 100 and 120 degrees. In many parts of the world, for at least part of the year, sunlight/solar power can heat water to this temperature. When solar power is available, it is irrational to burn oil to heat water to 120 F.

So appropriate technology is partly a sizing issue?

That's one way of putting it. The size and capacity of the system should be roughly equivalent to the need. There's no reason to build a massive hydroelectric dam to generate electricity for a few families or cabins--and yet that is often exactly what is done in the hopes of stimulating economic growth.

Is there anything wrong with attracting industry and stimulating economic growth?

Again, the answer depends on many considerations and varies from individual to individual and from situation to situation. People can't live without the basic necessities of life, and in this day and age and for most people, that means money and work. However, if the local economy is largely subsistence or tourism-related, industrialization may cause a great deal of social and economic disruption and environmental impacts.

What are impacts?

Anything which causes an effect or change is said to have an impact on that thing. People, products, processes, and technologies can all impact other people, products, processes, and technologies. Virtually everything has an impact. For example, although there is much debate about whether television is good or bad, there can be no doubt that it has changed the home, and the same can be said for cars and tens of thousands of other objects including food processors, portable hair dryers, microwave ovens, and electric toothbrushes.

How can these items change society?

They make it easier and faster to do certain things, but they also substitute one sort of power (electricity) for another (muscle). Their manufacture and use may require more or less natural resources and energy and produce more or less waste than the technologies they replace. They may have shorter or longer service lives, and their disposal may be harder or easier than that which they replaced.

Are there different types of impacts?

Generally speaking, technological impacts (those impacts caused by technology) can be broken into two broad categories: environmental impacts and social impacts. Environmental impacts include changes on ecosystems and natural processes and affect communities, species, and individuals. Similarly, social impacts affect society, culture, communities, families, and individuals. Of course, a given technology can--and likely will--have both social and environmental impacts.

What are social impacts?

Social impacts are those which affect society. Included in this broad category are affects on individuals, families, communities, cultures, religions. countries, and the world's humanity as a whole. A given invention (such as an automobile or television), by changing how individuals live and think, has the potential to remake the world.

Sometimes seemingly insignificant technological advances result in great changes. Predicting or assessing the impact of a given technology or invention can be very difficult, but given a few basic principles, social and environmental scientists can often predict these impacts with a certain degree of success.

How does society determine whether the impacts of a given technology or product are acceptable?

Frequently, these questions are overlooked because people are in a hurry or no person in a position of power cared to broach them. However, impact assessments usually consider:

- the lifestyles of local residents
- type of industry/activity and type of growth likely to occur
- suitability of area for industrial development and growth
- vulnerability of fish & wildlife populations
- abundance and fragility of natural resources

Ecology Terms and Principles

Competency: Identify Ecological Terms and Principles

Tasks: Explain ecological terms and principles

What is ecology?

Ecology is the science, or study, of ecosystems. Ecology comes from the Greek word for house (oiklos) and the German word for science or study (logie) [biology = study of life; geology = study of earth]. The greeks thought of their world as a household. Keeping that analogy in mind may simplify your task of learning about technological impacts because whenever you bring something into, store in, or try to throw something out of the household, your actions will effect either the household or the backyard, or both.

When people say something about "hurting the ecology," they are using the word incorrectly. An action can hurt an individual, a species, an environment, or an ecosystem, but it isn't likely to hurt a science--in fact, it will just give ecologists more job security in the form of something else to study.

What is an ecosystem?

An ecosystem is an ecological community. Each bog, pond, river, and watershed is a separate ecosystem. Yet, since no bog, pond, river, or watershed is completely separated (closed off) from other ecosystems, the entire earth is in a way one large ecosystem, sometimes called the biosphere.

What's the difference between closed and open systems?

A closed system is one which is completely sealed off from the rest of the world, the outside environment--for example, the inside of a glass fishing float. An open system stands ready to gain and lose substances to the outside environment, for example, a bird bath into which falls rain, dust, leaves, and bird feathers and droppings, and from which water evaporates and is drunk.

So the bog is an open system because animals can enter and leave it, as can water, gases, plants, and nutrients. Similarly even huge ecosystems like the Yukon River watershed, are open systems because plants and animals can enter and exit, either under their own power (moose, caribou, wolves, salmon, seals, birds) or carried by the winds (plants, pollen, dust). As if to prove just how open they are, all of these systems transact business daily with the world beyond the planet earth, receiving energy from the sun and radiating it back out into space.

One of the most important things to remember about ecosystems is that they encompass more than just the plants and animals within their borders, they encompass all chemicals and minerals and all the chemical and physical processes which occur in that system.

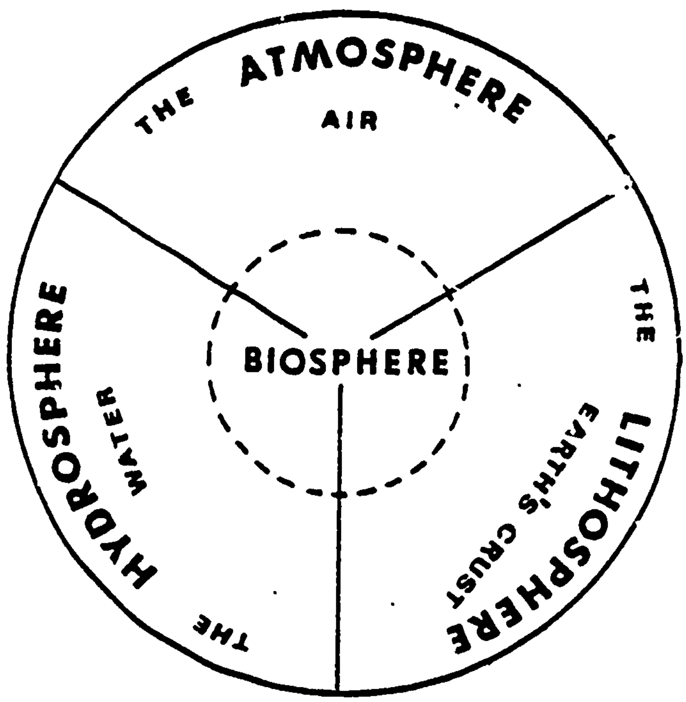
What is the biosphere?

The biosphere is that part of the planet in which living things exist. It includes everything from the deepest submarine trench, six miles below the surface of the ocean, to the summit of Mt. Everest, or K-2, whichever proves to be higher, nearly six miles above sea level. In fact, since birds, lichens, pollen, and other organisms can survive at least temporarily at that altitude, the biosphere may be several miles higher than the world's tallest summit.

What is an environment?

In one sense, the environment is the surroundings, the neighborhood. Environments come in many types: sylvan (forest), lacustrine (lake), fluvial (river), riparian (river banks/flood plain), alpine (above tree-line in the mountains), tundra (north of tree line in the Northern Hemisphere), taiga (the subarctic evergreen forest), etc. And each environment and each ecosystem is unique because no other spot on earth will have exactly the same combination of soil, plants, animals, weather.

All habitable environments are part of the biosphere, that part of the Earth where there is life. The biosphere has three components, air, water, and minerals:



Courtesy of Dr. Art Kadama, University of Hawaii School of Public Health

What is an ecologist?

An ecologist studies ecosystems. These scientists differ from environmentalists, individuals who advocate the protection of natural environments. Although sometimes these words are used carelessly and interchangeably, ecologists also differ from conservationists, people who advocate conserving, or using wisely. natural resources, and from preservationists, people who believe that the wisest use of certain ecosystems is to preserve them relatively intact from human activities.

What is a developer?

A developer is an individual who advocates the use and/or development of natural resources such as timber, minerals, water, and land.

Aren't words like environmentalist and developers just labels?

Correct! Labeling someone may make it easier to predict how the person will react to a given proposal. Unfortunately, labeling makes it very easy to dismiss what the person is saying. When it comes to solving problems, a thorough search for facts and understanding of the processes involved is essential--and environmental and technological problem solving is no different.

Who are the good guys and who are the bad guys?

We are. Although words like environmentalists, preservationist, and developer are sometimes used in name-calling, most people are a little bit of each. Indeed, it is hard to think of a person who could live for very long without conserving something (such as electricity, energy, food, or money) or participating (by virtue of wearing clothing, eating food, using paper, etc.) in some sort of development. Who the good and bad guys are depends largely on your perspective. As the cartoon character Pogo has said, "we have found the enemy; the enemy is us."

What are the basic laws governing the science of ecology?

Like any other science, ecology is obliged to observe the laws of physics. For every action there is a reaction. Energy is neither created nor destroyed, it merely changes form. Matter is neither created nor destroyed, it merely changes form. Systems tend to deteriorate (from conditions of order to conditions of disorder). Biological processes are inefficient.

How does the action/reaction law work?

The action/reaction law predicts that any action or event in a system will have a predictable result or reaction. In other words, if something is added to a system, the system will be changed.

How can it be that energy is neither created nor destroyed?

It is true. Energy can only change form. Burning gasoline in an internal combustion engine changes the energy in that particular fuel into work and waste heat, but the total amount of energy does not change, only the quality or usefulness of the energy changes. The same general transformations occur when an eagle eats a fish.

How can it be that matter is neither created nor destroyed?

Again if gasoline is burned in the presence of oxygen in an internal combustion engine, the total number of carbon, oxygen, hydrogen, sulfur, nitrogen and other molecules does not change. Only the chemical composition changes. Instead of gasoline, the engine produces a number of chemical compounds, most of which are considered waste, because they cannot be used for performing work, and most of which are considered pollutants because they are toxic to living organisms and damage various substances. Similarly, your body utilizes only a fraction of the food you eat. The rest is excreted.

What is behind this inefficiency?

This tendency is called entropy, and there is ample proof for its existence. A car not maintained will only run for so long before it breaks down completely. Even the great pyramids are slowly being weathered. It's only a matter of time before they are gone forever. Similarly, the Alaska Range and Denali will someday be eroded flat. It may take a million years, it may take 500 million years, but someday the Alaska Range will be gone--unless the same processes responsible for the current mountain-building continue to exert themselves.

Entropy overtakes plants and animals, too. Some flourish for a year, a decade, or even thousand of years--in the case of bristlecone pine trees--but eventually they succumb. Species may flourish for hundreds of thousands or even hundreds of millions of years, but entropy always gets them in the end.

If systems tend to deteriorate towards maximum disorder how can there be any life at all?

That is a good question, one which cannot be readily answered. Plants and animals do show an amazing ability to organize, evolve, adapt, grow, even thrive, under sometimes harsh conditions. But these same animals and plants--both plants and species--will eventually succumb.

How can biological process be inefficient?

Just as a car can only travel so far on a gallon of gas because most of the energy in the gasoline is lost to inefficiency in the form of internal friction and waste heat, plants and animals make effective use of only a fraction of the energy they receive. Most animals are able to extract only about 10% of the energy contained in the food they eat. This means that each step up the food chain has approximately only 10% of the biomass and energy of the next level down.

The technical term for these steps, or energy levels, is trophic levels. On any given trophic level, all of the organisms would share similar functions; in other words, on one level all would be producers, while on another level all would be decomposers, etc.

What is the significance of ecological thinking?

Once someone begins to think of the environment and its ecosystems in terms of dynamic systems, then several important things happen.

In the first place, the complexity of the systems and the multiplicity of interrelationships becomes apparent. In deed, it may soon seem that any change in one part of the system affects all the other parts of the system--which is frequently the case.

The most important significance of the ecological thinking is the realization that once produced, compounds must either be cycled through the ecosystem, or exported to other ecosystems for processing. There is no magic involved. And all this cycling, transporting, and processing has consequences for the ecosystems involved.

Systems can absorb inputs of varying amounts of various substances, but for any given substance or combination of substances, there will be a threshold quantity which overloads the system, causing backlogs and failures to process. Sometimes, how much material a system can absorb can be calculated. However, the more complex a system, the harder such predictions or calculations will be.

Is complexity bad?

No, actually complexity is good because it leads towards stability. For example, predators are animals that eat other animals (prey). Ecosystems where the number of prey species and predator species is relatively small (like those found in the sub-arctic and the desert) are subject to huge population swings.

One of the classic examples of this is the lynx-rabbit cycle which occurs in many parts of Alaska. Rabbit populations tend to peak approximately every seven to ten years, with the rabbits so numerous that they run out of food and are subject to diseases. A year after the peak in the rabbit cycle, there are almost no rabbits. In the meantime, the lynx population has peaked because food (rabbit) was so abundant. However, with little to eat, the lynx population crashes as a result of disease and malnutrition. The absence of predators allows the rabbit population to increase which it does at a geometric rate. Unfortunately, since lynx breed but once a year and have but one litter a year, the lynx population is always at least a year behind.

As bad as the lynx-rabbit relationship must be for many of the individual lynx and rabbits--especially those which starve--it would be a much worse situation in a simpler ecosystem. Fox, wolves, coyotes, and birds of prey also hunt rabbits, but none of those animals' population cycles are so closely linked with the rabbits' as the lynx. Lynx also prey on squirrels, ptarmigan, voles, and lemmings, but none of these species plays such an important role as do rabbits in the lynx life-cycle. Even so, if the lynx could only feed on rabbits, if there were no other prey species, the lynx species might not survive for very many cycles, because the lynx would have to kill the last rabbit in order to survive, thereby guaranteeing its own extinction as well.

Conservation Terms and Principles

Competency: Identify Conservation Principles and Terms

Tasks: Differentiate Between Renewable and Non-Renewable Natural Resources
Explain Conservation Techniques

What is conservation?

To conserve something means to use it wisely; it means to not waste. Sometimes, making the best or wisest use out of a natural resource means to not use the resource at all, or to find a substitute for it.

What is the difference between a renewable and a non-renewable natural resource?

Renewable natural resources are those which naturally renew themselves, or grow back. For example, the air that we use for breathing is eventually renewed by the oxygen and carbon cycles so that it is reusable--either by us or by some other animal. Similarly, the water we use for bathing is also eventually purified by the water cycle so that it can be used again for drinking and bathing by others. Trees and crops are other renewable resources. So is solar energy--something that can be used again and again and which always reappears--almost as if by magic. Generally the renewal isn't magic, but a complex and sometimes delicate process.

Non-renewable natural resources are those which natural processes do not renew--or renew so slowly that their rate of replacement is insignificant to society. Minerals are the most obvious of the non-renewable natural resources. Usually, minerals are mined from the highest grade, or most concentrated, deposits known to exist. With time, these deposits are exhausted (mined out) and miners move on to increasingly lower grade deposits. However, at some point, all of the remaining deposits will be of such low concentration that they will no longer be economical to mine.

What happens when the supply of a non-renewable resource is exhausted?

At that point, one or more things can happen:

- New mining techniques and processing techniques are invented which make it economical to extract low-grade deposits,
- Government subsidizes mining either to stimulate economic development or because the mineral in question is deemed essential to society,
- Society starts recycling the mineral,
- Society substitutes a combination of other minerals, or
- Society does without the mineral altogether.

These options for mineral extraction are just as applicable for the extraction of any resource, whether it be plant, animal, soil, air, or water.

Resource experts are gradually coming to recognize a third category of natural resources--those which are renewable, but are being extracted or developed at a rate faster than they can be renewed. Old-growth forests, fossil water, and soil exemplify this category.

What is an old-growth forest?

An old-growth, or climax, forest is one in which the trees are of different ages and sizes and species. As a result, the forest canopy is irregular and sunlight succeeds in reaching the forest floor, making possible the growth of a variety of shrubs and plants.

Are old growth trees valuable?

Although some of the trees may be defective (rotting or damaged by storms), those which aren't tend to be very large and therefore commercially valuable. The wood tends to be fine-grained and strong--ideal for making big timbers and other specialized applications. These characteristics make old growth forests very valuable to industry and result in great pressures to log.

What is the difference between old- and second-growth?

The old-growth forest contrasts sharply with a second-growth forest--one which has grown back in the wake of logging. In coastal Alaska the second-growth forest is characterized by densely packed trees whose intermingling branches form a canopy which prevents almost all the sunlight from reaching the ground for the first 90 to 100 years. For the first 20 to 40 years after logging, such a forest may be impenetrable for people and most animals. For the first 90 to 100 years, almost no plants or shrubs will be able to grow beneath the canopy. Only a few mosses and sapprophytes--plants that obtain their energy from dead and decaying trees and animals--will grow. After 100-150 years, the weaker trees will begin to die, allowing shafts of light to reach the forest floor and nurture the types of shrubs and plants such as huckleberry upon which so many animals depend for food. Between 300 and 500 years, the forest will reach the climax stage and will continue indefinitely thereafter--barring fire, windstorm, or logging.

What are the different arguments in the battle over old-growth forest management?

Conservationists argue that logging such forests faster than the rate at which they can be replaced is essentially mining. In other words, if a forest takes 350 years to grow, in any given year only 1/350th of the forest should be logged. Such a schedule, they argue, would insure that in any given year there will always be some climax forest. Their concern stems in part from aesthetics, but more importantly from the knowledge that old growth forests provide homes for a whole variety of plants and animals, while second growth forests are for their first hundred or more years, basically a monoculture--in other words, produce only one or two species of trees and none of the plant and animal diversity people associate with forests.

Preservationists argue that so few old growth coastal rainforests remain in North America, that all or most of those remaining should be preserved in their natural state.
Developers and timber-industry supporters argue that logging clears the way for younger, faster growing trees and creates jobs.

How much old-growth logging occurs in Alaska?

Somewhere between 20 and 30 square miles of forest are scheduled for logging annually on National Forest and Native corporation lands in Southeast Alaska.

Does everybody agree that logging is a problem?

Although destruction of old-growth forests is not universally recognized as a serious problem in Alaska, recognition is more widespread in the case of the world's tropical rainforests. There, forests are being felled at alarming rates for their valuable hardwoods and/or to make room for exploding populations. The process of clearing forest in order to grow crops is called slash-and burn. Generally, the tropical soil remains fertile for only a couple of years after clearing. The combination of harvesting crops and heavy rainfall soon deplete the nutrients in the soil, and then the settlers have to move on again. Slash-and burn-economies have been practiced for centuries in places like the Amazon basin, but the scale of clearing and burning has increased so much that scientists from around the world are concerned about species extinctions and on the relationship between logging and global climatic change.

Another type of renewable resource extraction progressing thousands of times faster than the renewal process is the mining of fossil water in the western United States. With a few notable exceptions (either coastal areas or mountain ranges), lands west of 100 W. Longitude receive little rainfall, less than 20 inches a year. Since the turn of the century, and especially after World War II, these areas have grown rapidly. Booming population and agribusiness have put huge demands on the region's water supplies. Most of the rivers have been dammed for hydropower, drinking water and irrigation. In addition, tens of thousands of wells have been driven into aquifers--sometimes thousands of feet below the surface. These aquifers may contain huge amounts of water; however, it took centuries and perhaps millenia--and probably during wetter climatic periods--for all that water to seep into the ground and fill those aquifers. The water is called fossil because of its age and because of the huge amount of time required to fill the aquifers. Presently, these aquifers are being pumped hundreds if not thousands of times faster than they can recharge naturally.

What happens when aquifers are pumped faster than they recharge?

In the first place, farmers and others have to continually redrive wells to increasingly deeper depths. Secondly, the lowering water tables increase the chances of contaminating groundwater supplies with pollutants in the form of salts and minerals and agricultural and industrial residues. Pumping causes land to subside, or sink, sometimes as much as fifty feet. In coastal areas, pumping can cause land to sink below sea level and/or cause the water table to be invaded by saltwater.

Can "mining" aquifers cause surface problems?

On the surface, all the irrigation creates problems as well. In areas like the Southwestern U.S., the hot, dry climate accelerates water evaporation. Before evaporation, water dissolves minerals in the soil. After evaporation these minerals form a layer near the surface. Over the period of a few years or decades, this layer of minerals can become several inches or feet thick. The resultant soil is called hardpan, or caliche, and may be almost rock-like, so that and so hard that no plant can grow in it and ordinary tractor plows and harrows cannot break it.

What happens when hardpan develops?

Productivity declines as the hardpan enlarges. In the end, ground which could support prairie or desert ecosystems with birds, animals, and endemic (naturally-occurring) plants is capable of growing nothing but prickly pear. Some farmer may or may not have made a living growing cotton for a few years. But the damage to the land may last for centuries--or at least until a major climatic change.

The results of agriculture in the desert sound strangely similar to the results of agriculture in tropical rain forests: a few good years, then long periods of infertility, and a permanently damaged ecosystem. It is precisely because of such problems that new sciences and fields such as ecology, soil conservation, and natural resource management have developed in the last forty years.

Having now learned about the problems of farming in the rainforest and the desert, you shouldn't be surprised to learn that farming can be one of the most destructive of all human activities in terms of the soil .

How does farming contribute to erosion?

Typically, grazing livestock or planting crops begins a cycle characterized by replacing indigenous plants (those which can grow unaided in an area without depleting the soil) with domesticated plants which require cultivation (plowing, weeding, watering, and fertilizer). By exposing the soil for at least part of the year, the process of cultivation increases erosion and evaporation. In a relatively short period (compared to the thousands or tens of thousands of years which the soil took to form) all the soil can be lost and/or become infertile.

Where is farming-related erosion a big problem?

This is currently a very serious problem in the Palouse Hills along the border of Eastern Washington and Western Idaho. The Palouse has some of the richest soil in the world, but dry land and irrigated wheat farming results in wind and water erosion of several inches a year.

A similar situation in the Great Plains (the Dakotas, Nebraska, and Oklahoma) became an environmental disaster during the 1930's when several years of severe drought combined with exhausted soil unprotected by endemic plants resulted in dust storms and erosion the likes of which man had never before seen in North America. A resumption of normal rainfall patterns, changes in farming techniques and massive increases in the use of fertilizers eventually slowed the cycle of erosion and restored productivity of some of many of the lands. However, the next "dustbowl" may only be as afar away as the next multi-year drought.

Land is equally damaged by small scale agriculture and grazing. Presently in Africa, the Sahara desert advances spreads southward into the Sahel region several miles per year because of a combination of prolonged drought and overgrazing by nomads. The resultant famine has costs hundreds of thousands of lives and untold human misery. In Nepal, overgrazing and deforestation resulting from rapidly growing population, rising expectations, and tourism are rapidly increasing soil erosion in the foothills of the Himalaya mountains. In addition to deadly landslides and increased flooding and siltation locally, the erosion is contributing to the formation of the delta and the large islands at the mouth of the Ganges river in the Bay of Bengal 600 miles downstream.

Are there erosion-control techniques?

Yes, the U.S. Soil Conservation Service works closely with scientists, engineers, and farmers to control soil erosion. Typical soil-conservation techniques include planting trees to hold the soil and break the wind, contour plowing, and specialized tilling techniques.

In what way are logging, mining, and farming impacts technological?

These impacts are technological because resource development and utilization depends on a number of tools and processes--many of them highly sophisticated. Clearcut logging, for example, requires sophisticated machinery for felling, yarding, transportation, and processing.

Knowing the difference between renewable and non-renewable natural resources, and knowing that agriculture and silvaculture (growing trees) can be destructive, you might want to know more about approaches to conserving natural resources.

What is substitution?

Substitution is simply the replacement of one resource or compound for another. If scarcity or some other consideration makes a material too expensive to produce, if toxicity makes a material too dangerous to use, then society and its technicians attempt to find a substitute for that material or process.

For example, until the 1970's all automotive fuels and many household paints contained lead. Concern about the health affects of lead on people and animals began in the 1950's. Although scientific data rapidly mounted, government did not take action to limit or remove lead from these products until the 1970's. Indeed, leaded automotive and aviation fuel and paints are still on the market.

At the same time, scientists and engineers worked to develop substitute compounds which would keep internal combustion engines from knocking without having the harmful side effects which accompany lead. The prevalence of automobiles which run on unleaded gas testifies to their success.

Finding substitutions for compounds and elements is not always easy. Each element has distinct chemical and physical properties. While scientists can synthesize gems such as diamonds and rubies, there are likely to be no substitutes for gold, platinum, uranium, mercury and other elements. As deposits of these materials become increasingly lean, extraction requires increasing amount of capital, equipment, resources, and energy and results in increasing environmental damage.

Conservation is often the best way to avoid the coming crunch. For example, ninety-percent of the world's annual silver production is used for photography. As silver becomes rarer and more expensive, people may take fewer pictures--and photography labs will be increasingly careful about recycling processing chemicals.

What is recycling?

To recycle something is to re-use it. A large number of commonly used materials lend themselves to recycling. Newspaper, for example can be recycled--through a relatively simple process of washing and bleaching-- and used again. Aluminum foil and cans can be remelted and used again--at a fraction of the cost and with a fraction of the energy required to smelt aluminum from bauxite (aluminum ore). Part of the savings (generally about $0.10 a pound) can be passed on to civic groups who run recycling collection centers. Glass containers are also recyclable.

How does appropriate technology conserve resources?

When the most appropriate materials and techniques are used for a given process, then society is getting the most use out of the least resources. Properly insulating a house, for example, reduces the chance that energy will be wasted. Using solar energy to heat a house and domestic hot water reduces the consumption of fossil fuels and the pollution created by their extraction, transportation, and consumption.

Why conserve even in the case of abundant resources?

The earth and its resources are finite. The abundances of various elements have been calculated with reasonable accuracy. Even if there were no pollution associated with using resources, there are physical constraints on how much can be used. However, extracting, processing, and using any given resource does produce environmental impacts. Even in the case of abundant and renewable resources, such as water, conservation is the only strategy which will prove feasible over the long-term. At some point, consumption will have to be limited to that amount which is sustainable.

What is the problem with ever-expanding consumption?

When consumption increases each year, eventually consumption doubles. The period it takes for consumption to double is called the doubling time.

What is the significance of doubling times?

Doubling time is simply that period during which it takes the consumption to double. The shorter the doubling time, the faster a finite resource will be used up. The longer the doubling time, the longer a finite resource will last.

For example, if your community burns 100 cords of wood during its first year of existence, and then wood consumption increases 10 per cent each year, in less than eight years your community will be burning 200 chords. Assuming that the consumption continues to increase at the same rate of 10% per year, the quantity consumed will double again in less than 15 years.

Look at the following table:

10% increase per year

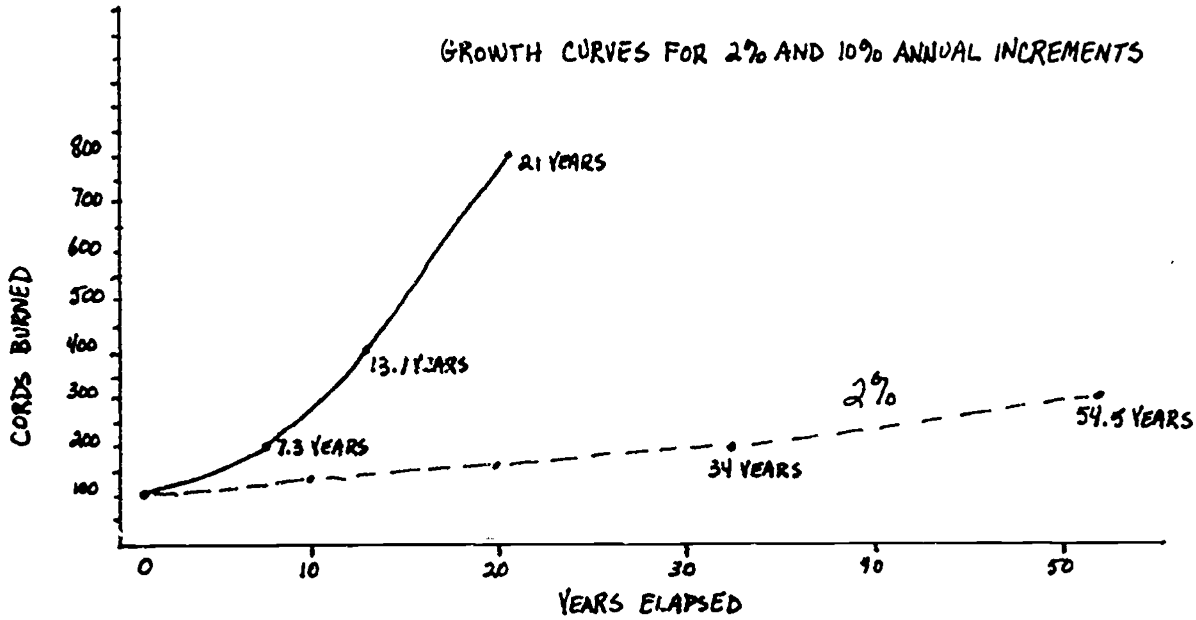
Year	Cords Consumed
0	100
1	110
2	121
3	133.1
4	146.4
5	161.1
6	177.2
7	194.9
8	214.4
9	235.8
10	259.4
11	285.3
12	313.9
13	345.2
14	379.7
15	417.7

2% increase per year

Year	Cords consumed
0	100
1	102
5	110.4
10	121.8
15	134.5
20	146.7
25	161.9
30	178.8
35	197.4
36	201.3

According to the table on the left, at a 10% increase per year, consumption doubles approximately once every seven and one-third years. At the 2% per year increase rate shown on the right, doubling takes about thirty-five and two-third years. The second doubling, when 400 cords are consumed annually, won't arrive until the 71st year.

Both situations are examples of exponential growth. If graphed, they curve upwards at ever increasing rates, the 10% (indicated by the solid line) more steeply.



Just how likely is it that a community's wood consumption increases at 10% a year?

It all depends on the community. But if you think of the planet as a community and substitute energy for wood, the 10% growth curve is fairly representative for the global increase of energy consumption since the turn of the century. And the same can be said for dozens of other resources such as minerals, wood, water, and air.

In the past ten years, fossil fuel consumption has leveled off in the United States, Canada, and Western Europe. However, the developing world (Eastern Europe, Africa, Asia, and Central and South America) have more than made up for these conservation measures. Indeed, at the present rate of increase, annual global energy consumption will exceed that amount incoming from the sun. One does not have to be an environmentalist or a scientist to suspect that it is unlikely that society will ever be able to use that amount of energy without the most drastic consequences.

Is there an alternative to using ever-increasing amounts of resources?

Some people think so. They advocate transitioning from economic and political systems based on growth to steady- state systems.

What is a steady-state system?

A steady-state system is one in which inputs and outputs vary little over time. Most politicians and economists call anything less than 2% annual growth economic stagnation. So according to their definition, a steady-state economy would be stagnant. However, assuming that the population remained the same or declined, a steady-state economy wouldn't necessarily be stagnant. It would continue to change in response to consumer demands and needs and resource availability.

Most organisms and systems try to achieve a steady-state, or equilibrium, with their environment. For example, your body maintains internal temperatures by adding and removing clothing and by burning calories and perspiring. If temperatures vary more than a degree or two from normal, critical processes and organs may be jeopardized.

Why don't countries abandon economies based on growth for those based on a steady-state model?

Internal (domestic) and external (foreign) reasons have thus far prevented nations from switching to steady-state economies. Most citizens want more wealth and material goods, and most governments need more revenue to cover the cost of their operations. The traditional way of generating more wealth and taxes (stimulating economic growth) is to use more resources. Other methods such as increasing taxes or redistributing wealth cause social unrest and economic dislocation.

Nations also have appetites for wealth, materials, and power. If one nation adopts a steady-state econcomy, what assurance does it have that its competitors and enemies will do the same? Almost none. As a result, nearly every country in the world, is engaged in races to corner and use natural resources and wealth. In the world's poorer countries, the arms race alone consumes as much as 50% of the annual gross national product.

Have steady-state economies ever worked?

It depends on which definition of "work" you use. If by "work," you mean has there ever been a dominant country (like the U.S.) which has been able maintain its strength relative to other countries despite having a steady state economy, the answer is probably no. However, if by "worked" you mean have their ever been societies or countries in which economic conditions persisted for decades withut dire consequences, the answer is probably yes.

In any case, technology has allowed a relatively few countries to gain control of a majority of the world's resources and wealth. In addition to environmental impacts, these technologies have and will continue to have enormous social and political impacts. To what extent wealth will continue to be unequally distributed between and within countries remains to be seen. However, from the foregoing discussion of exponential growth, and from the coming discussion of technological impacts, it should be obvious that at some point consumption patterns will have to change.

Cycles

Competency: Understand Cycles

Tasks: Explain cycle terms and principles
Explain the common cycles (water, oxygen, hydrogen, carbon, nitrogen,nutrient)

What is a cycle?

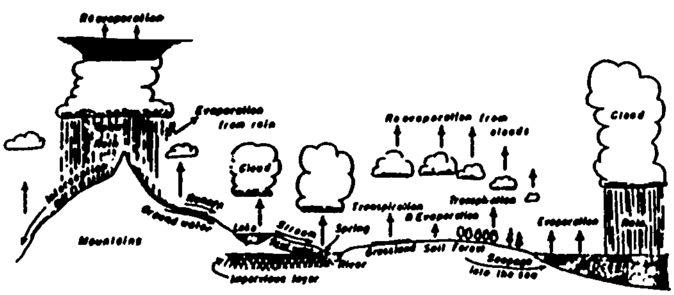
A cycle is one revolution, a completed circle, the processes which something undergoes to eventually lead it back to the location or state it was initially in. The sun has daily and yearly cycles--and the length of these cycles differs for each planet. Lunar cycles are measured in lunar days and months--slightly shorter than 24 hours and about 28 days. The cycles most frequently studied by ecologists are the carbon, hydrogen, nitrogen, oxygen, nutrient and water cycles.

What is the water cycle?

The water cycle traces the movement of water from its point of origin through its travels and back to the point of origin. Assume that the water molecule starts in the ocean, is evaporated into the atmosphere, is carried inland by prevailing winds, rises and cools over a mountain range, and along with other molecules condenses into a cloud, forms into a snowflake, falls on a glacier, is slowly compressed into ice, moves down the slopes, to where it eventually melts, and flows into a river, a lake, a larger river, and eventually back into the ocean.

Sound complicated? No, the above is a relatively simple path through the water cycle. It could happen in the Bering Sea, the Alaska Range, and the Kuskokwim River--or on the Gulf Of Alaska and the Coast Ranges.

The cycle could be much more complex. That water molecule could start out in the Bering Sea near the Aleutians and be carried all the way to Colorado only to be deposited on the east slope of the Rocky Mountains, where it could be taken up by a plant, eaten by an elk, and in turn by a cougar, excreted, evaporated, rained into the Platte River, washed into the Gulf Of Mexico, carried into the Atlantic by a tropical storm, rained onto the Gulf Stream, carried toward Europe, evaporated, rained down on West Germany, put into the atmosphere by some industrial process and carried to the North Pole with other pollution, and after several hundred years, back to the Bering Sea as part of an ice floe. (And you thought being a student was tough!)



Courtesy of Dr. Art Kadama, University of Hawaii School of Public Health

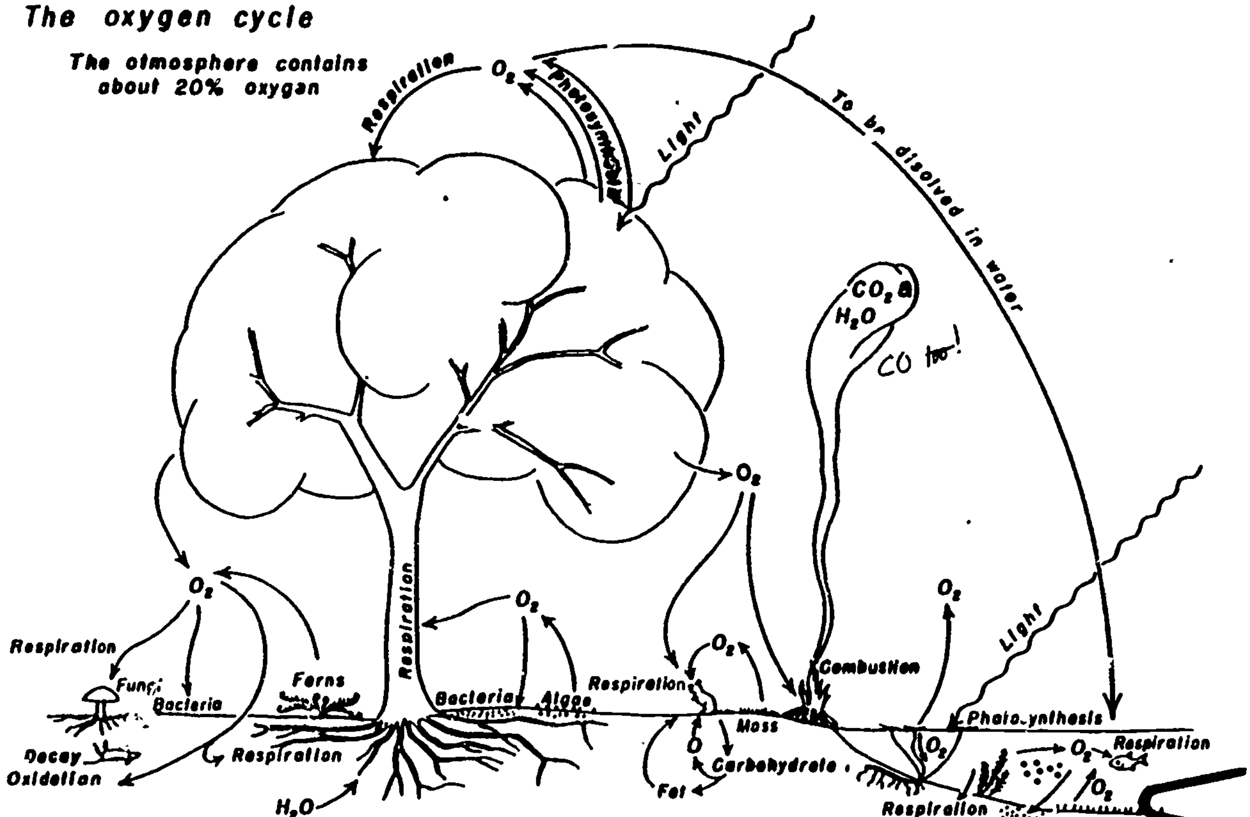
What are some of the other cycles?

Since you know that water is nothing more than hydrogen and oxygen, you probably would not be surprised to learn that both hydrogen and oxygen have their own cycles, sometimes overlapping (as in water) and sometimes separate. In fact, cycles have been described for many elements, especially the most common ones such as carbon and nitrogen.

What is the oxygen cycle?

The oxygen cycle consists of all the phases and changes through which oxygen can go. For example, plants release oxygen as a result of the process of photosynthesis. The oxygen may be inhaled by an animal and exhaled with carbon a a few minutes later having travelled throughout the animal's circulatory system. The carbon dioxide may combine with rain to form carbonic acid, a weak acid, but one capable of weathering limestone or concrete.

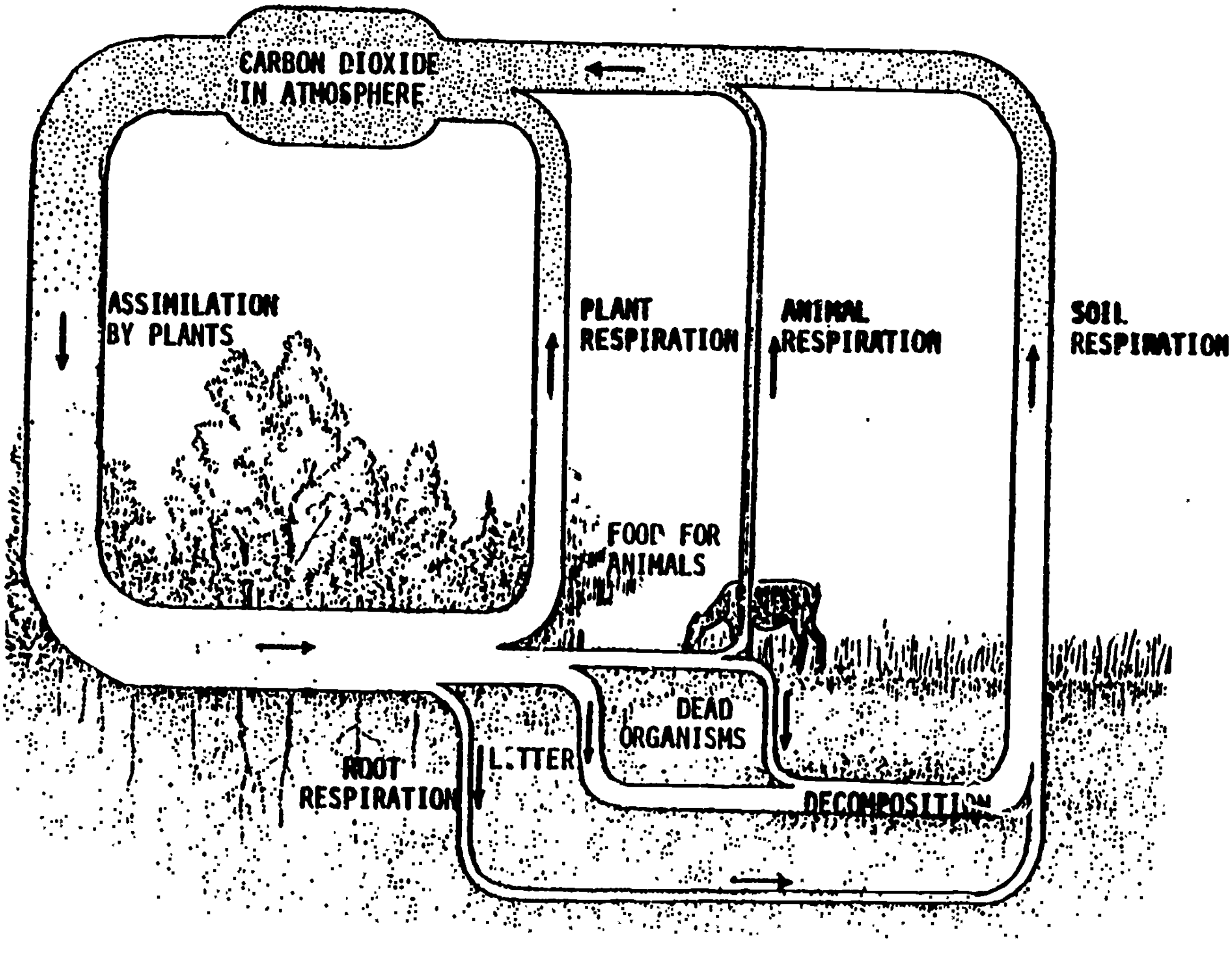
The oxygen cycle



Courtesy of Dr. Art Kadama, University of Hawaii School of Public Health

How come you're talking about carbon, isn't this the oxygen cycle?

Right, that's just the point. One can't follow one system without continually bumping into the others. In reality, the water, oxygen, hydrogen, carbon, nitrogen and other cycles all overlap, and molecules continually move back and forth between cycles. Frequently, the subtleties of these interrelationships go undiscovered until some industrial process or activity disrupts a cycle and damages the environment.



Courtesy of Dr. Art Kadama, University of Hawaii School of Public Health

What is so important about these cycles?

These cycles govern life on earth. Take the nitrogen cycle for example. Most plants require nitrogen-rich soil in order to grow; yet their growth depletes the nitrogen already in the soil.

Glaciers and rivers deposit silt and sediment which generally have little nitrogen. Yet in only a few years, a dense jungle may cover these moraines and gravel bars.

How does the nitrogen get into the soil in the first place?

Animal droppings contain urea and ammonia (NH_3) which are released into the soil by bacterial decay. Certain plants (vetch) and trees (alders) have nitrogen-fixing bacteria in their root nodules. The bacteria deposit in the soil the nitrogen which the plant drew in from the atmosphere.

Most crop plants lack the ability to fix their own nitrogen and soon deplete that already in the soil. The farmer then must either rotate the crops or add fertilizer.

Where do nitrogen, oxygen, carbon, hydrogen and the other elements come from in the first place?

Now that you know about cycles, you know that the answer can't be the atmosphere, or any other portion of the cycle. The original source of nitrogen and these other gases is the earth's crust.

Indeed, the earth, at one time, had no atmosphere, no free water, and no weather as we know it. That was three and a half billion years ago when the earth was very, very hot. But as it cooled and volcanoes continued to spew forth ash and gas, the atmosphere gradually evolved.

How do geologists know that the earth once had no atmosphere?

The banded-iron formations of the Mesabi Range of northeastern Minnesota are sedimentary rocks which were laid down during the time when free oxygen was just becoming available. (Free oxygen is that which isn't locked in chemical compounds.) Layer upon layer of these rocks alternate between the silver color of stainless steel and the red of rust---the silver laid down when there was no free oxygen, the rust when there was.

What is the significance of all these cycles relative to technological impacts?

In a healthy ecosystem, all these cycles are like gears in a well-tuned machine. Not everything will be working perfectly, but enough of the gears work well enough for the machine to function. However, a major disruption such as the infusion of wastes may completely clog one or more of the cycles, throwing a wrench in the machinery, and bringing all or part of the machine to a grinding halt. The extreme would be the extinction of all life on this planet--which, given the adaptablity of cockroaches and other insects, would be highly unlikely.

The significance of the cycles, then, is that by understanding them, people are in a better position to make intelligent decisions and rational choices about a wide range of activities.

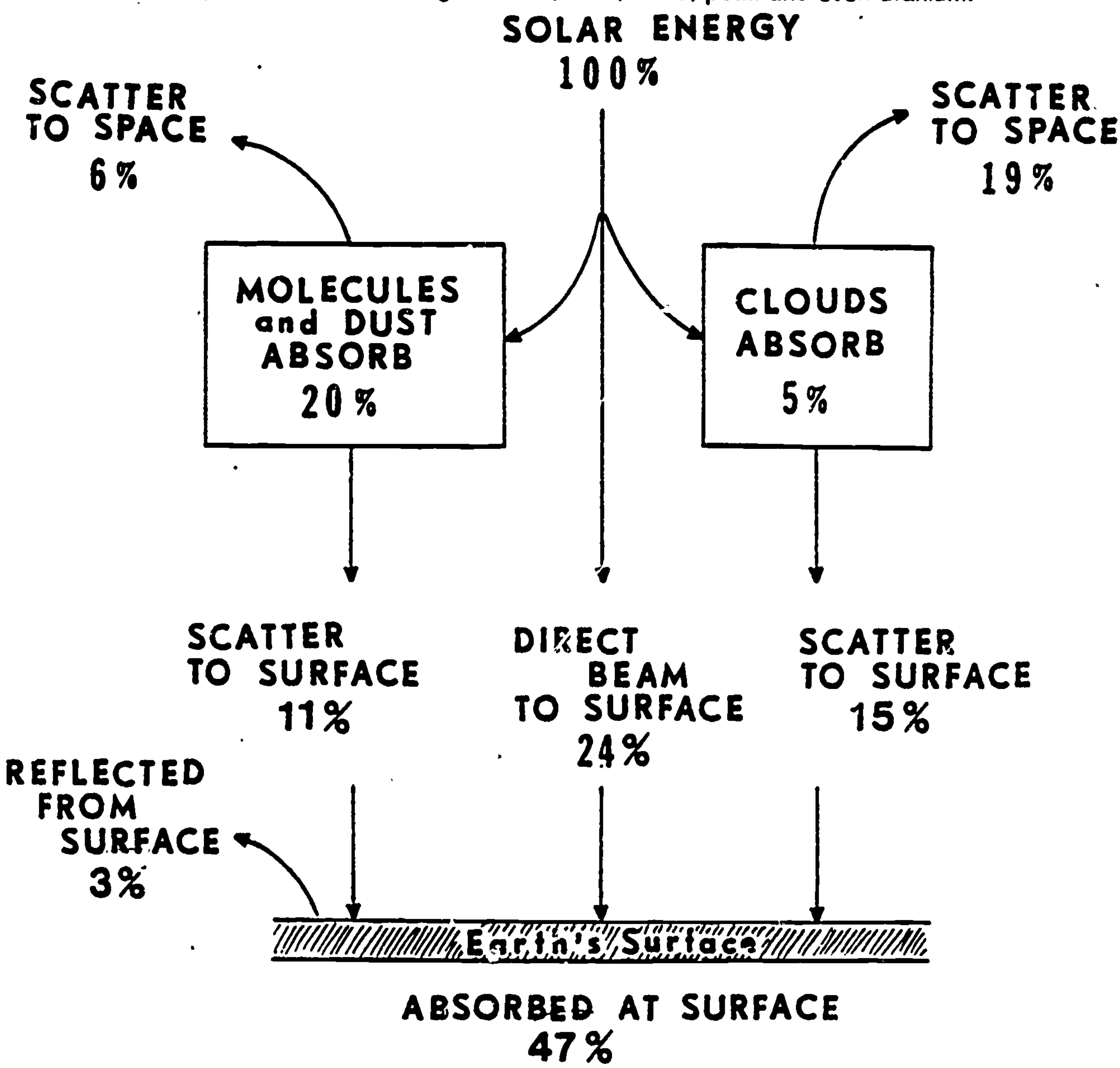
Energy Consumption

Competency: Identify Impacts of Energy Consumption

Tasks: Explain Recent Trends in Energy Consumption
Explain Social, Economic, and Environmental Implications of Ever-Increasing Energy Consumption

Where does energy come from?

For all practical purposes, all the energy on the earth comes from the sun. This includes the energy locked up in coal, oil, natural gas, water, wind, wood, peat. and even uranium.



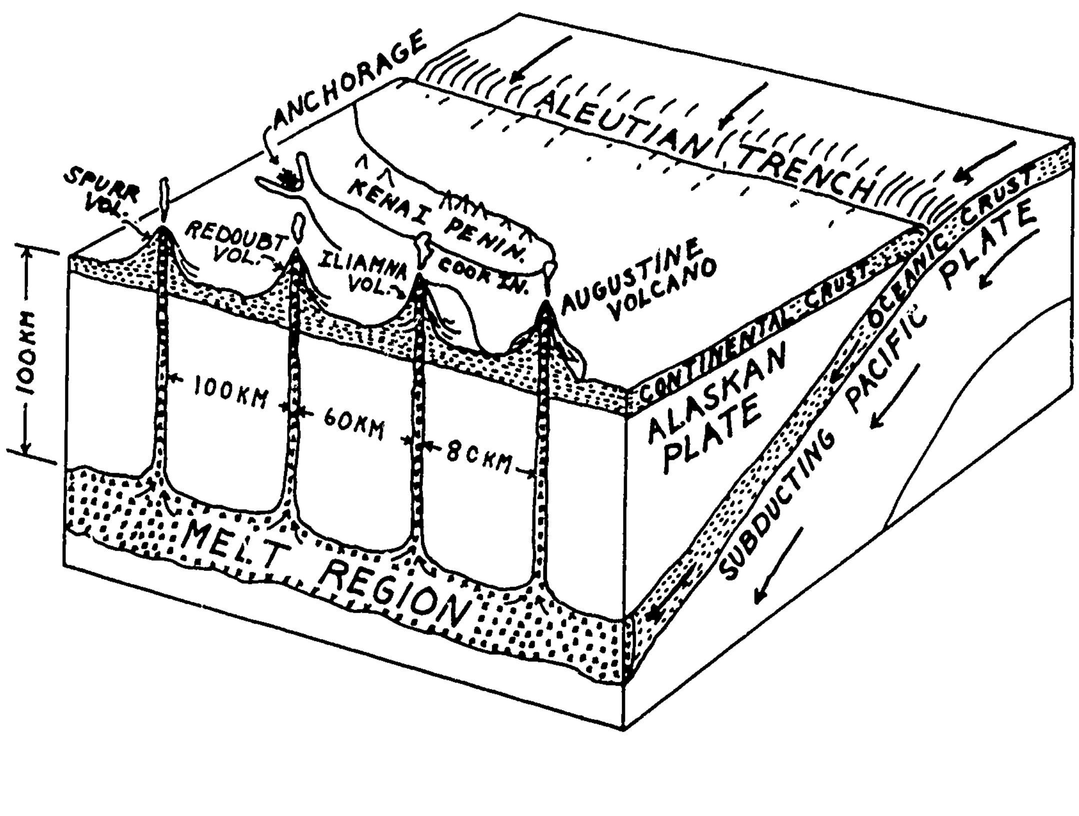
Courtesy of Dr. Art Kadama, University of Hawaii School of Public Health

How does the sun put energy in rocks buried deep within the earth?

Oil, coal, and natural gas are fossil fuels. The energy they contain was originally fixed by plants at the earth's surface or microorganisms afloat in the seas. Over millions of years, layers upon layers of the bodies of these organisms collected in sedimentary basins--areas where the land or seafloor was sinking. These were in turn buried by sediments and compacted and heated by the earth under great pressure so that their components such as water were squeezed out and the remaining energy was increasingly concentrated. The fact that these deposits may now be found thousands of miles from the nearest seacoast or hundreds of miles from the nearest sedimentary basin is due in part to plate tectonics.

What is plate tectonics?

Plate tectonics is a theory which holds that the earth's crust is made up of a series of plates or rafts which are in constant motion. Most of Alaska, for example sits on the North American Plate, but it also borders on the Pacific Plate. The Pacific Plate is moving northwest several centimeters per year. Where the two plates contact, huge forces build up in the earth's crust. Along the Fairweather and St. Elias ranges, the plates are mostly moving past one another and there are long fault zones and frequent earthquakes. Along the Kenai Peninsula and the Aleutian Islands the Pacific Plate is diving under the North American Plate, pulling the leading surface of the North American plate down with it, and creating so much heat deep within the earth that great rock material melts and rises to the earth's surface in the form of volcanos.



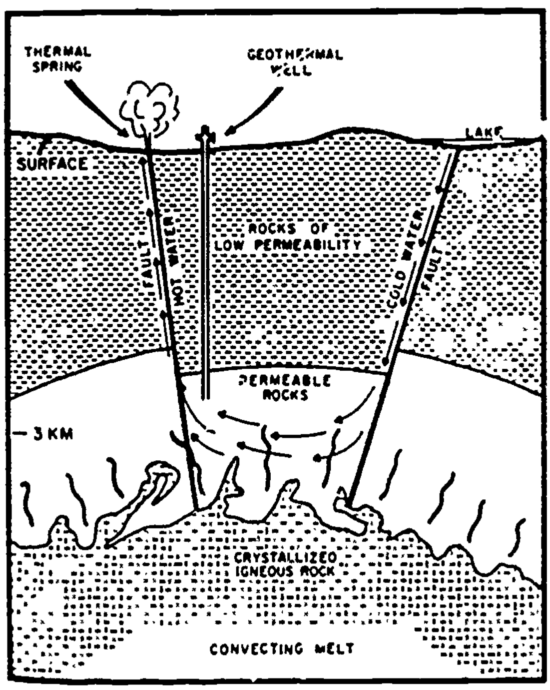
What energy drives plate motions?

It takes a great deal of energy to raft the earth's crust about. That energy originated in the sun, probably about 4.5 billion years ago, and has been gradually released as the earth has cooled. Much of it comes from the decay of radioactive elements like uranium.

If there's so much energy in the earth's crust, why doesn't society just tap it?

Society does. It's called geothermal energy. In places such as Alaska, California, Hawaii, Iceland, and Japan geothermal energy is being used to generate electricity and heat homes and greenhouses. Unfortunately, geothermal energy is not always found where it is needed. Furthermore, geothermal energy is not without its problems. For example, volcanic areas and hot springs often have dangerously high levels of radon, mercury, sulfur and other toxic elements.

This is a typical method of tapping geothermal energy:



Aren't there huge amounts of fossil fuels?

The reserves of fossil fuel, and coal in particular, are very large. But relative to present and anticipated levels of consumption, the size of these reserves are less impressive. In fact, although society has only been burning petroleum for about 100 years, over half of the world's supply of oil is gone--and the rate of consumption has increased so rapidly since World War II, that by the middle of the 21st Century probably 95% of the world's recoverable petroleum reserves will have been consumed--assuming that the extraction and consumption of these dwindling reserves doesn't lead to global conflict or environmental apocalypse before that time.

Isn't there plenty of coal?

There is enough coal in the United States and Alaska to meet present needs for another 200 years. However, much of this coal is of a lower grade than that which is currently being burned. The coal beds are buried deeper, and the coal itself contains more water, sulphur, and other impurities. In other words, it will become increasingly difficult and expensive to extract and transport. More land will be disturbed, larger more energy-intensive equipment and more capital will be required to produce the same amount of energy. More material will have to be burned to produce the same amount of electricity and burning will increase the amount of pollution. The problems will increase steadily with time until it just isn't worth it anymore. Hopefully, some alternative energy source will be found.

How about firewood?

Trees are a renewable energy resource, and a popular source of residential heat in many parts of Alaska. Although burning wood is traditionally associated with a healthy, vigorous lifestyle, woodsmoke is a growing health problem. Woodsmoke creates both indoor and outdoor air pollution. In certain airsheds, woodsmoke is such a problem that the authorities are studying ways to regulate it.

What is an air-shed?

An air-shed is a fancy word for an area where air tends to collect and/or stagnate during periods of calm. Usually air-sheds have hills, ridges, of mountains along their borders, just the way watersheds are delineated by drainage divides. One such air-shed is Juneau's Mendenhall valley. There, air tends to stagnate so that pollutants from automobiles and woodstoves collect rapidly. Air pollution gets so bad that people are not allowed to burn their wood stoves when the wind doesn't blow during the winter.

Just how much air pollution do woodstoves produce?

Woodstoves account for 95% of all carbon monoxide, 54% of all particulates, and 88% of all organic gasses emited into the atmosphere by residential heating in the U.S. The gases which are produced by incomplete combustion are called polycyclic organic matter (POM). Woodstoves account for 35% of all POM produced in the U.S. (The remainder come from cars, trucks, planes, forest fires, and industrial processes.)

Isn't there any way to reduce the amount of pollutants in wood smoke?

Yes. Catalytic combustors do just that. In fact, they not only reduce the amount of pollution, but they are more efficient than standard wood stoves; they squeeze more heat out of a given quantity of wood.

How does a catalytic combustor work?

The temperatures in most stoves do not get sufficiently hot to burn all of the gases and particles released from the wood. The catalyst in the combustor makes it possible to burn these at much lower temperatures.

What is a catalyst?

A catalyst is something--in this case a metal--which speeds up or facilitates a chemical reaction without being consumed by the reaction.

How much of a difference can a catalytic combustor make?

Compared to normal woodstoves, a stove equipped with a catalytic combustor can squeeze 50% more heat from a given piece of firewood, while reducing creosote deposits and other pollution as much as 90%.

Why aren't they required?

More and more communities are requiring catalytic combustors on all new stoves.

What about indoor air pollution?

Wood stoves can impair indoor air quality significantly. All but the tightest stoves leak varying quantities of soot, ash, creosote, benzenes, and carbon monoxide into the home. Many of these compounds are toxic and/or carcinogenic. Carbon monoxide can be deadly. Ideally, woodstoves should be equipped with sealed, outside combustion air/exhaust systems. In superinsulated houses, such systems are vital; without them occupants can become ill within minutes of lighting a fire. In any home, assuring adequate ventilation is essential to maintaining indoor air quality.

Why is indoor air quality so important?

Until recently, researchers paid little attention to indoor air quality. But then came the energy crisis of the 1970's. When people started adding insulation and vapor barriers, they succeeded in making virtually air-tight environments. Fifty years ago, indoor air quality concerns would have been limited to wood, coal, and oil burner smoke, paints, varnishes, and cleansers. But all the plastics and adhesives in modern building products (visqueen, particle board, plywood, caulking compounds, pvc pipe, etc) and furnishings (drapes, seat cushions, carpets), add to these earlier concerns. The importance of indoor air quality becomes obvious when you consider how much time people spend indoors.

No wonder people look for other sources of energy such as nuclear power.

Isn't nuclear power limitless?

No resource is endless, especially in the face of ever increasing rates of consumption. Nuclear energy has the potential to power America's industry for the next fifty or one-hundred years. However, the risks and costs associated with nuclear power generation are so great that society should think carefully before putting all its eggs in the nuclear basket. Uranium, like coal, must be mined--and like coal with considerable destruction of land and at great health risk to the miners and local inhabitants of the areas near the mines and processing centers. And there is a great deal less uranium than coal.

Isn't nuclear power clean?

Not necessarily. Just because nuclear power plants don't belch thick clouds of sooty smoke does not mean that those plants are sources of "clean" energy. For example, nuclear power generation creates a great deal of thermal pollution.

What is thermal pollution?

Thermal pollution is waste heat. Any process that creates large amounts of waste heat contributes to thermal pollution problems. Any plant which burns a fossil fuel to make energy is likely to produce thermal pollution. A large fraction of the energy in the gasoline used in your car ends up making waste heat. In the case of nuclear power plants, water is used to keep temperatures in the reactor core within safe operational limits. The water from power plants is either dumped into rivers or lakes. If it is more than a few degreees warmer than normal temperatures in the water body, it may completely change its chemistry and kill fish and other organisms. To reduce such problems, these warmed waters are often stored temporarily in cooling ponds. Typically, a great deal of steam and or moisture evaporates from these cooling ponds. Once in the atmosphere it can modify local weather patterns--exacerbating fog and icefog problems. These ponds typically release a great deal of steam. Even the "cleanest" reactors continually emit small amounts of radiation.

However, there is more to nuclear reactor pollution than simply warming up the environment. All reactors, x-ray machines, and other procedures that use radioactive isotopes, produce radioacitve wastes. In the case of reactors, radioactive wastes include spent fuel rods and contaminated coolant. When these wastes contain small amounts of radiation, they are called low level.

Hasn't society pretty much solved the technological problems involved with nuclear energy?

In 1987, Congressional investigations revealed that the nuclear power industry grew so quickly that many of the most basic problems were overlooked. Nuclear power generation is a risky business, subject to mechanical failure and human error and creating deadly compounds which must be stored for thousands of years. Thus far, scientists and engineers have been unable to develop storage methods or locations which can be relied on for more than a few decades. At the present rate, all of the existing storage capacity will be filled within 20 years.

At Hanford, Washington, the largest of the nation's three radioactive waste storage sites, accidental spills are frequent and commonly involve thousands of gallons of contaminants. These fluids frequently end up in the Columbia River, and scientists predict they will begin turning up in groundwater supplies in the next two decades.

Furthermore, nuclear power generation produces plutonium--a radioactive isotope which can be readily made into bombs. Burning nuclear energy also creates many security problems. In an attempt to assure safety, society may have to forego many of the freedoms and rights which Americans hold most dear.

How about synthetic fuels?

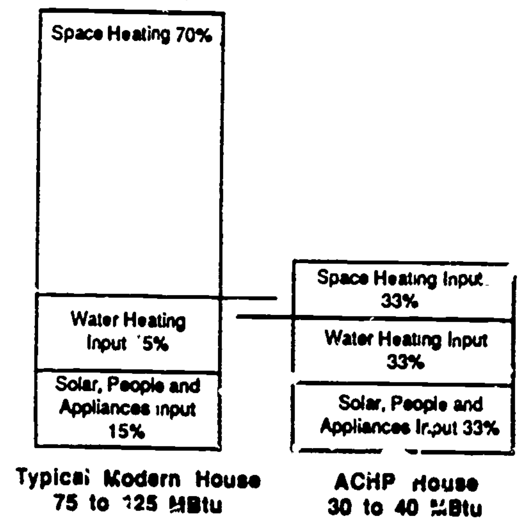
Synthetic fuels, like those made from tar sands, oil shales, methane, and alcohol, have potential to supply some of the nation's energy needs. However, as you may remember from the Laws of Thermodynamics, there is no free lunch. In other words, everything has a cost--and sometimes many costs. Tar sand and oil shale development have environmental and social costs. Making energy from plants and crops and animal excreta also has social and environmental costs. Land must be given over to production of crops. Tractors for plowing require fuel, soils require fertilization and/or rotation, and perhaps irrigation--which often requires fuel for pumps. Farming frequently accelerates soil erosion which increases the need for fertilizers and puts dust into the air and silt into rivers and streams. Finally, burning the fuel creates more air pollution.

What is the solution?

In the long run, the only workable solution is to burn less energy, develop more energy-efficient industrial processes, consume fewer material goods, and develop more energy-efficient lifestyles.

How can society burn less energy?

Almost any process which currently uses energy can be made more efficient. For example, retrofitting a house with insulation, vapor barriers, air-to-air heat exchangers, and energy-efficient doors, windows, and service openings can reduce heating requirements from 50 to 75%.



Courtesy from Alaska Craftsman Home Builder

Typical Modern House Energy Inputs Compared with Energy Efficient House Energy Inputs

How can society develop more energy-efficient industrial processes?

Engineers have been doing just that and with great success ever since the first Arab Oil Embargo in 1973. Typically, they devise energy-efficient processes and ways to use waste heat. Waste heat for example, can be used to warm water and generate electricity.

How can society use fewer material goods?

Sometimes it's hard to envision using less, however, people do it all the time--whether by squeezing a couple of extra day's worth of toothpaste out of a tube or using old newspaper instead of new paper towels to clean windows. Most Americans are in-grained with the notion of having to own everything they use. Many farmers, however, belong to cooperatives (co-ops) which allow them to share the cost of expensive infrequently used items such as farm machinery and grain elevators.

How can lifestyles be made more energy-efficient?

People can car-pool, bus, walk, or bicycle to work and/or school. They can save up their errands so that they needn't drive to the store every day. They can turn down thermostats and turn off lights in rooms that aren't being used. They can buy products in bulk or products which use less packaging. They can recycle newspapers, cans, and glass.

Would these conservation measures reduce the quality of life?

Not necessarily. It depends largely on how the quality is measured. For example, one yardstick the government uses to measure the quality of life is the gross national product (GNP). The GNP reflects the total amount of goods and services sold during a given period. Basically, it is a measurement of the quantity of materials produced. However, there are other ways to measure the quality of life. These include air, water, and noise pollution levels; infant mortality, cancer, crime, divorce, and life expectancy rates; and the distribution of wealth. Other criteria may be equally important but less quantifiable. These yardsticks may or may not be related to the amount of energy society consumes.

Substituting musclepower for horsepower wouldn't necessarily reduce the quality of life. If it were safe (clean air and bike paths separated from motor vehicles) to bicycle to work, you could satisfy your exercise and transportation needs simultaneously--without breathing in large amounts of smog and dust or contributing to air pollution and fossil fuel consumption.

This may seem like a pretty crude way to travel, but in many countries this is precisely how people get to work. For example, perhaps as many as half the people in China bicycle to work. In the Netherlands (Holland) more than half of the populace bicycles to work. This includes the wealthiest businesspersons and the most important government officials, many of them wearing three-piece suits. Although, Holland may be flatter than many Alaskan communities, it has a cold, damp climate similar to that of coastal Alaska.

The following diagram suggests the extent of the disposal problem in the United States. It already costs $5 billion annually to dispose of these materials, and that price will skyrocket as communities run out of space for landfills.

OUR ANNUAL "THROW-AWAY" LIST

48 billion cans	4 million tons of plastic
26 billion bottles & jars	7 million cars & trucks
30 million tons of paper	8 million TV sets

Courtesy of Dr. Art Kadamia University of Hawaii School of Public Health

Impacts of Roads

Competency: Identify the impacts of roads and roading on land-use and society

Tasks: Explain how roads bring change

How can a road change an area?

The answer to this question depends on the area and the road, upon who uses it and what they use it for. Let's start with the simplest case.

How does a road change a non-roaded area?

When roads are punched into non-roaded areas (wilderness), the area changes. For the first time, the area is accessible to motorized vehicles. The road makes it easier to hunt, fish, and extract other natural resources. Making something easier to do usually means that more people will do it, so the hunting and fishing success rates will probably decline and other resources will be extracted. If the road is not properly built and maintained, erosion will result and streams may be damaged by increased run-off and siltation.

People may also use the area to dump trash and old cars. Some people will see the improved access as well worth these costs, others will not.

Roads also remove acreage from production. In other words, the land under the road bed is no longer able to grow trees, plants, and animals. Although in the case of just one road, this loss may seem insignificant, in the case of a network of logging roads, it becomes significant. A mile of 30-foot-wide road removes approximately 3.6 acres from production. There are 640 acres in a square mile, and for every square mile logged there may be many miles of logging road. Finally, wildlife populations diminish from accidental and intentional road kill.

How does a road change a community which has not had road access?

Connecting a community to a road system generally makes it easier and cheaper to travel and transport goods between that community and the rest of the world. Such access is likely to increase economic activity--including tourism and resource development in the community and its surrounding area. The road may bring new jobs in the service sector, in restaurants, hotels, automobile maintenance, and road maintenance.

As a result of the road, scheduled air or ferry service may diminish, though it could improve if economic activity booms. Some local residents will view the influx of outsiders as a blessing, others as a needless invasion of privacy, an unwanted intrusion, a reminder of the world they tried to leave behind with its high crime rates and other social problems.

How does highway construction impact rural areas?

Upgrading of existing roads to highways or construction of highways and freeways can visit dramatic changes on rural areas. Increased access can drive up the cost of relatively cheap rural land located within commuting distance of urban areas, thus changing land use patterns from agricultural to residential/recreational.

During construction, segments of the local economy may boom, but farmers or other traditional landowners may eventually be displaced. Increased access will make the rural communities less autonomous and more dependent on the larger cities down the road. Local residents will tend to shop in larger towns where larger volumes result in lower prices.

Freeways gobble acreage: a 90 foot-wide, four-lane right of way can remove 11 or more acres per mile from production. With clover-leaves and interchanges, the total per-mile often exceeds 20 acres.

A highway through the heart of a town can snarl traffic to the point where shoppers avoid the downtown shopping district in favor of malls located on the town's outskirts or in completely different communities.

A freeway bisecting a town can make it difficult to go from one side of town to the other. With its bare roadway, masses of concrete and metal, and high speed traffic, freeways make sufficient noise to be audible several miles distant.

When new freeways by-pass towns, restaurants and services will relocate to the nearest exits, sometimes turning the former commercial district into something resembling a ghost town or skewing future growth in the direction of the nearest exit (s)--the latter, a form of urban sprawl, one of the commonest results of highway and freeway construction.

What is urban sprawl?

Urban sprawl is the tendency of cities to spread outwards like liquid spilled on a flat surface. Urban sprawl displaces earlier residents who either can't afford rising real estate prices and taxes or who dislike the accompanying noise and congestion.

What is leapfrog development?

Leapfrog development occurs on the outskirts of towns when businesses leap over one another in an attempt to locate further and further from the city center so as to be the first enterprise motorists encounter as they approach town. When other businesses start to fill in the gaps between the "leapfrogs," sprawl enters the strip development phase.

What is strip development?

Strip development occurs on towns whose economic heart is a through road or highway. As a result, the town elongates. Businesses tend to erect increasingly larger signs to gain the attention of motorists. Without strict sign ordinances, the town becomes one long eyesore, and even with strict control, the town is still bi-sected by a loud and noisy thoroughfare.

Does urban sprawl cause problems?

Indeed, sprawl, strip, and leapfrog development make it almost impossible for planners and zoners to guide urbanization. As a result, development may occur in places ill-suited for it--places where smog forms and tends not to disperse. Development may also occur in places better suited for some other use, such as parkland, wildlife habitat, sand and gravel, water supply, etc.

Aren't highways beneficial?

Higways tend to make it easier to move people and goods from one location to another, and that is good. Few people would drive from Anchorage to Fairbanks if the road was a dusty, single-lane dirt road.

However, the impact of beltways and interstate highways in the lower 48 states is well known. Access to the highway transportation system and the promise of large amounts of relatively cheap land encourages industry and businesses to relocate from the urban cores to industrial "parks" built near freeway interchanges. Such relocations rob the cities of jobs and taxes and clutter the countryside with subdivisions, traffic, and shopping malls. As the land along the outermost beltway becomes saturated with development, another one further out from the city center is built--as if the city were a tree putting out growth rings.

Although less advanced in Alaska, the beltway syndrome has reached Alaska. In Anchorage, for example, Muldoon and Tudor Roads were originally built partially as an urban bypass, to keep trucks travelling from the Kenai Peninsula to the Matanuska Valley and beyond out of the heart of downtown Anchorage. Now, however, Anchorage has spread across these roads and they are as congested as any in the Anchorage bowl.

Relative to nearby fields and woods, temperatures along roads are likely to be elevated during the summer, and depressed during the winter.

Does roading affect climate?

Roading and developing large amounts of land can change local climates. There is growing evidence that this is happening on the island of Oahu, Hawaii which is becoming hotter and drier and where the once gentle rains are becoming increasingly violent downpours with much of the water running off into storm drains rather than soaking into the soil and eventually recharging the aquifers (water table).

Cities make their own microclimates. Built up areas are hotter during the summer. And temperature changes influence weather. For example, increases in temperature and air pollution resulting from a growing use of automobiles around St. Louis, Missouri may be decreasing rainfall and increasing frequency of violent thunderstorms.

Does roading affect the water cycle?

Yes. In addition to climatic changes, roads change run-off rates. In other words, rather than being absorbed into the ground and eventually the water table, rain that falls on roads tends to quickly make its way into local drainage systems, streams, and rivers. Built up areas with significant areas of pavement and roadway are much more prone to flooding than undisturbed land because the pavement and buildings prevent rainfall from seeping into the ground.

Are roads resource intensive?

Yes. Manufacturing and fueling automobiles uses huge amounts of resources. Furthermore, the construction of asphalt roads consumes huge quantities of sand, gravel, and petroleum products. In addition to these resources, concrete road construction requires large amounts of water and lime.

Automobile Related Pollution

Competency: Identify Automobile-Related Pollution

Tasks: Explain internal combustion engine by-products

What is smog?

Smog is a word that was coined to explain the results of combining (sm)oke with f(og). The smoke can come from woodstoves, vehicular exhausts, or factories. The fog can originate from the same sources, or it may be naturally occurring, or some combination of the two. San Francisco, California, for example, is subject to frequent fog caused by the presence of a cold water body (the Pacific Ocean) next to a warm landmass. But water from automobiles, industrial processes, air conditioners, and gardening contribute to the fog.

What chemicals do automobiles contribute to smog?

Automobiles produce dozens of air pollutants. Some of the most common are briefly discussed below. Incomplete combustion is partly responsible.

Benzene, C_6H_6,comes from refineries and incomplete combustion. Long-term exposure may cause leukemia, a deadly form of cancer.

High concentrations of carbon monoxide (CO) from incomplete combustion (insufficient oxygen) kill outright because hemoglobin absorbs it 250 times more readily than oxygen. Small concentrations [.10 - .20 parts per million (ppm)] may damage the heart and impair brain function. Minute concentrations (0.5 to 0.1 ppm) may cause birth defects.

Formaldehyde (HCHO) from unburned gasoline vapors irritates nose and eyes.

Nitric and nitrous acids(HNO_3 & HONO) formed from vehicle exhausts lead to respiratory diseases.

Lead (Pb) a heavy metal added to gasoline to reduce knocking causes high blood pressure, brain damage, impaired growth, and birth defects. Some attribute the fall of the Roman Empire to the lead poisoning which resulted from using lead water pipes and lead containers for storing wine.

Sulfur dioxide (SO_2) from high sulfur fuels, especially diesel, irritates the eyes and makes breathing difficult.

What is photochemical smog?

Ultraviolet radiation from sunlight (photo is the Greek word for light) striking various chemicals (gases and particulates) in the atmosphere creates new pollutants.

Hydrocarbons from unburned gasoline vapors bond with nitrogen oxides.

Sulfuric acid (H_2SO_4) from high sulfur fuels, especially diesel fuels, causes respiratory ailments.

Nickel (Ni) from diesel fuels may cause lung cancer in those subject to prolonged exposure.

Nitric oxide (NO) from vehicle exhaust readily oxidizes to form nitrogen dioxide (NO_2) which lowers resistance to disease and causes bronchitis.

Ozone (O_3) and peroxyacetyl nitrate (PAN) produced by the reaction of nitrogen oxides and hydrocarbons irritate eyes and the respiratory system.

Hydroxyl radicals from vehicle exhaust (hydrocarbons and nitrogen oxides) combines with other compounds to form acid droplets.

The above list covers only the most common pollutants related to automobiles and is not meant to be exhaustive. There are literally thousands of chemicals floating around in the atmosphere, many of them as or more toxic than those mentioned.

How much oxygen does a car consume?

According to one writer, a single V-8 car (one with 8-cylinders) driving at highway speed for one hour consumes more oxygen than would 2,500,000 people in the same length of time.

How much air pollution does the same car produce?

The amount of pollution produced depends on the quality of the fuel, the presence or absence of air pollution control devices, and whether the engine is warmed up and properly tuned. Nevertheless, one can assume that roughly ten percent of the weight of the fuel will be dumped into the atmosphere as pollution.

Assuming that the V-8 achieves ten miles to the gallon, and travels at 60 miles per hour, and fuel weighs 8 pounds per gallon, the car will burn 48 pounds of fuel per hour and produce 4.8 pounds of pollution.

Even a four-cylinder vehicle which averages 30 miles per gallon will burn 16 pounds of fuel per hour and produce 1.6 pounds of pollution. In a city like Los Angeles with three or four million cars, those 1.6 and 4.8 pounds add up very quickly.

Does Alaska have air quality problems?

Although people from around the world associate Alaska with pristine environments and pure air and water, Alaskans know that this is no longer always the case. Indeed, Alaska's cities have some of the worst air quality problems in the United States.

Just how bad is the air in Alaska's cities?

Air quality problems in Juneau, Anchorage, and Fairbanks are well documented. Juneau's worst air quality is found in the Mendenhall Valley where wood smoke and automobile exhaust is trapped by thermal inversions caused by the Mendenhall Glacier. Although wood smoke particulates may be a significant problem in Anchorage and Fairbanks as well, there the biggest problem is carbon monoxide from automobile engines.

How much carbon monoxide does an automobile engine emit?

The colder an engine, the more carbon monoxide it emits. Because of incomplete combustion, a cold engine emits 20 times more carbon monoxide than a warm one. This is one reason why Anchorage, a relatively small city in terms of population, has the fifth-worse carbon monoxide problem of any U.S. city.

The impacts of technology on weather are more obvious in Fairbanks than any place else in Alaska because Fairbanks has the state's worst ice fog.

What is ice fog?

When temperatures drop, moisture in the air condenses into fog. The colder the air, the less moisture it can hold--which partially explains why most of the Arctic is a desert.

Burning wood, coal, and other fossil fuels like natural gas and gasoline releases water vapor, gases, and other particulates into the atmosphere. At approximately -35 F, the water vapor condenses into ice fog. Water vapor molecules also crystalize on particulates to form snowflakes.

As Fairbanks' population grows, so does the ice fog problem. More people, wood smoke, cars, and power generation from coal-fired electrical plants all contribute more water vapor and particulates. As a result, over the last several decades, ice fog has formed at increasingly warmer temperatures and the ice fog has become increasingly thick.

Why doesn't this air just rise and escape?

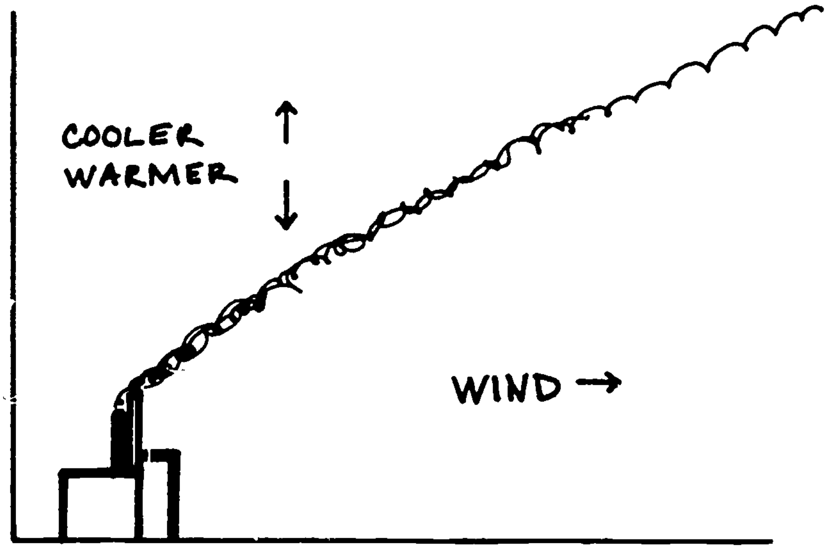
The warm air from vehicle exhaust pipes, stove pipes, and smokestacks does rise. However, sometimes this rising air is trapped by a thermal inversion; in cold weather, thermal inversions are common.

What is a thermal inversion?

Normally air cools as the altitude increases. In other words, the temperature at the top of the mountain is colder than the air at the mountain's base. (Usually the temperature changes about 1 F for each 100 vertical feet.) However, in an inversion, the opposite is true, the normal order of things has been inverted, the warm air sits above the cold.

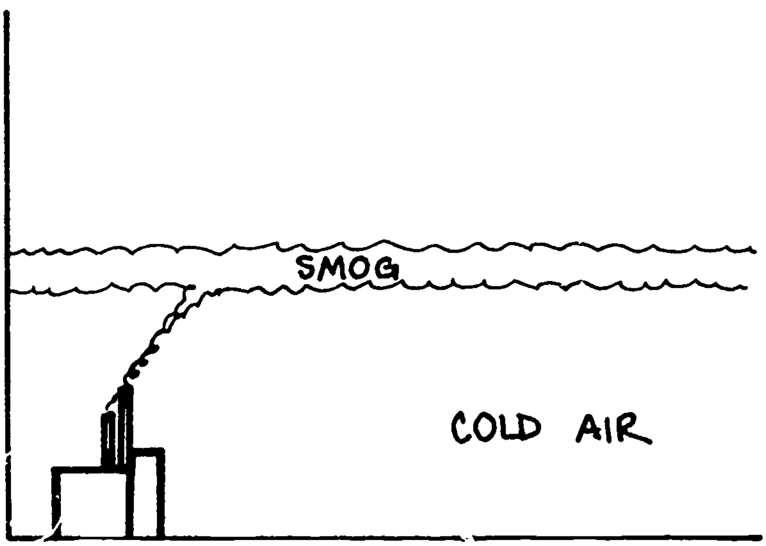
THERMAL INVERSION

A



NORMAL : TEMPERATURE DECREASES WITH ALTITUDE

B



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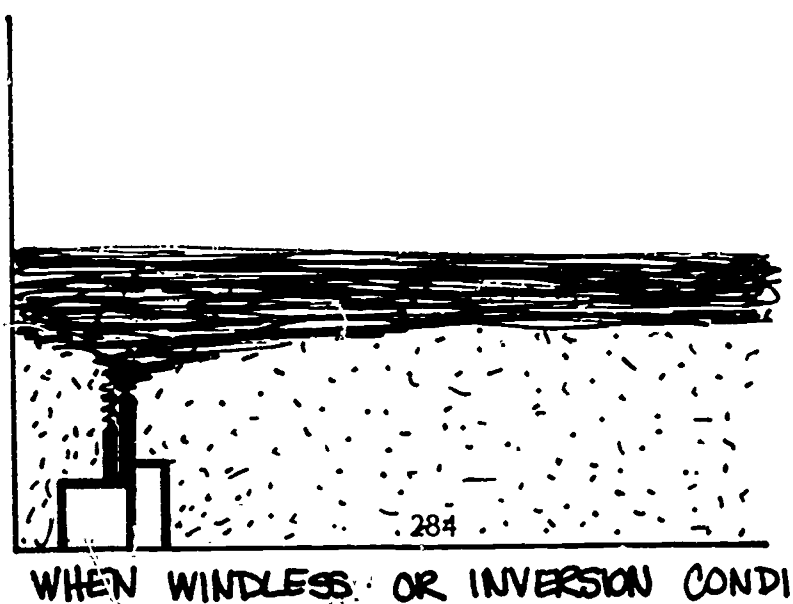


WHEN WINDLESS OR INVERSION CONDITIONS PERSIST,

What is so bad about ice fog?

In addition to being tough on morale, ice fog contains the many of the pollutants found in smog in other major cities like Los Angeles. However, because ice fog prevents the sun's rays from reaching the ground, it tends to perpetuate itself. In other words, once ice fog forms it resists dispersion. Normally, sunlight striking the ground causes differential heating which in turn causes winds which can disperse fog. However, because the sunlight cannot penetrate to the ground, there is no solar energy to generate local winds and the air stagnates. Nothing short of a major warming trend wind or a wind from somewhere else is likely to disperse the ice fog. One of the few good things about ice fog is that it contains less photochemical pollution than normal smog.

Why is ice fog so bad in Fairbanks?

Fairbanks has less wind than practically any other city in the United States. Local and regional topography encircles Fairbanks with several rings of progressively higher ridges (starting with Chena Ridge to Birch Hill to Salcha Ridge) and ultimately mountain ranges (the Alaska Range and the Kuskokwim, Ray, and Taylor Mountains) which block the prevailing winds.

Is Fairbanks the only place in Alaska beset by ice fog?

Many communities throughout Alaska have, or have the potential for, ice fog problems. Juneau and Anchorage have already been mentioned. Any community in Interior Alaska located in a valley or on low ground is a prime candidate--especially if subject to calm air during periods of intense cold. Built in a canyon on the banks of the Yukon River, Canada's Whitehorse also suffers from chronic ice fog problems.

What can be done about ice fog?

Everything and nothing. In many cases, such as Fairbanks, the first step is to reduce air pollution at the source. This means car-pooling, riding the bus, and avoiding driving when temperatures fall below -20 F. It means keeping your car's engine properly tuned and not driving until the engine of the car has warmed up. It means burning woodstoves at higher temperatures and installing catalytic cumbustors so that combustion is more complete. It may mean restricting the operations of certain industries to periods when the temperature is above a certain level. It means doing everything possible to prevent particulates and moisture from escaping into the atmosphere.

In Fairbanks, people have tried to escape the ice fog by moving up to the surrounding hills. At first this strategy worked. But it also meant more driving, and more driving meant more pollution. Now the ice fog is following them, each year creeping a little higher up the hillsides.

Can society benefit from increasing knowledge about ice fog?

As a result of what scientists are learning about ice fog and other technological impacts on air quality and climate, perhaps future communities will not be built in locations prone to cold weather air stagnation, inversions, and ice fog.

Is road sanding polluting?

Yes. In Alaska state and local highway departments sand icy roads to make them safer during winter. The sand improves traction and reduces stopping distances. Unfortunately, most of the time the "sand" is not pure sand, but contains large quantities of river silts and glacial loess. These fine-grained materials turn to dust upon drying and are blown into the air by passing vehicles and wind.

Even when the sand contains no "fines", it can pollute water bodies when rainfall washes it into streams where it buries bottom dwelling organisms and fills in pools where fish would otherwise find refuge from ice during the winter.

What is so bad about a little dust in the air?

This isn't necessarily a little dust. Sixty-six million pounds of sand are dumped on Anchorage roads each winter. Even assuming that only 5% are "fines" and no additional "fines" are produced by vehicles, that still leaves 1,650 tons potentially swirling through the air. For people with emphysema, asthma, and other respiratory problems, the dust can be life-threatening.

Were the dust pure dirt, it would be unhealthy enough even for the average citizen. However, because it comes from roads, it frequently contains lead, hydrocarbons, and other toxic compounds from automobiles--and these are carried deep into the lungs where they can eventually cause cancer and other debilitating illnesses.

Why don't highway departments use washed-sand?

Sometimes they do. However, removing all of the finer silt and loess from the sand costs more. Generally only enough of the fines are removed to meet state specifications (less than 5% fine-grained particles). The action of vehicles can rapidly increase this percentage once the sand is on the road--especially if the sand is derived from soft/weak materials. Some of the additional cost of washing might be recovered if the material stayed on the road longer--which the coarser grains should.

Furthermore, if the cost to society were the over-riding concern--as opposed to the cost to the highway department, then only washed, high-qualtiy sand might be used on roads. The potential savings in terms of public health and increased productivity might far-outweigh the slight additional cost to the highway department.

Presently, highway engineers are experimenting with heating sand so that it will melt part-way into the road's ice-covering and freeze into place.

Does road salt have health impacts?

Calcium chloride certainly is unhealthy for vehicles, causing them to rust at several times the normal rate. It's impacts on human health are not known. However, calcium chloride from roads does pollute streams and ponds. Since the salt corrodes vehicles, it also increases levels of metals--mostly iron, but also metals used in paints and primers--in these same water bodies. Some of these calcium chloride compounds inevitably become airborne and are inhaled.

Does road oiling impact health?

Oil and/or calcium chloride are used during the summer to control dust on dirt roads. Frequently, this is waste-oil; in other words, it has previously been used in the crankcase of a vehicle or some other engine. As a result, in addition to the carcinogenic hydrocarbons normally associated with petroleum products, oiled roads are likely to contain quantities of metals from the moving parts of engines. All these compounds can impair the health of those who live along the roads or use them frequently.

In the last decade, there have been several cases of people using PolyChlorinated Biphenyl-(PCB) contaminated oil for road dust control. The oil becomes contaminated when people mix the wastes either out of ignorance or greed. There will probably be more incidents in the future. PCB's are among the most toxic substances known. If you suspect that someone is or has used PCB-contaminated oil for dust-control, you should notify the Department of Environmental Conservation (DEC) Environmental Protection Agency (EPA), or the Alaska State Troopers immediately.

In order to avoid some of the problems associated with oiling, some road departments are switching to wetting dirt and gravel roads with solutions of water and calcium chloride.

Air Pollution Impacts

Competency: Identify Air Pollution Impacts

Tasks: Explain Air Pollution and Acid Rain
Explain Fluorocarbons and the Ozone Layer
Explain the Greenhouse Effect

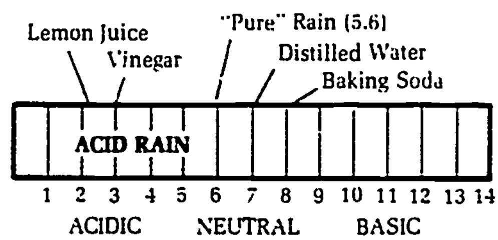
What is acid rain?

Acid rain is a term which expresses the pH of rain. (pH is a measure of acidity and alkalinity of the water on a scale of 1-14 with 7 being neutral. Generally, rainwater is slightly acid and has a pH between 6 and 7 ; however, rainwater from clouds containing industrial pollution can be hundreds of times more acidic (the scale is logarithmic).

Just how acidic is this rainwater?

The acidity of the rainwater depends on how much pollution the clouds contain. Thus far the most acidic rains in Europe have had pH's of 3 to 4.

How "Acid" Is Acid Rain?



The pH scale ranges from 0 to 14. A value of 7.0 is neutral. Readings below 7.0 are acidic: readings above 7.0 are alkaline. The more pH decreases below 7.0, the more acidity increases.

Because the pH scale is logarithmic, there is a tenfold difference between one number and the one next to it. Therefore, a drop in pH from 6.0 to 5.0 represents a tenfold increase in acidity, while a drop from 6.0 to 4.0 represents a hundredfold increase.

All rain is slightly acidic. Only rain with a pH below 5.6 is considered "acid rain."

What kind of acid comes from acid rain?

The most common acids in rainwater are sulfuric (H_2SO_4) and hydrochloric (HCl). These acids are commonly used in high school and college chemistry labs. When spilled, they tend to eat holes in clothing. The acids in rainfall are weaker, so they take longer to destroy fabric and other materials.

Which industrial processes produce the worst acid rain?

Although any process which puts hydrogen, chlorine, or sulfur into the atmosphere will make rain acid researchers have recently pinpointed coal-fired power plants in the American mid-West as the single-greatest contributors.

How can researchers tell where the pollution originates?

People have fingerprints; so does coal and every other compound. Coal contains trace elements in varying concentrations. Comparing the relative concentrations of these trace elements in clouds, rainfall, and power plant smokestacks makes it possible to determine where the pollution originated.

What does acid rain damage?

Acid rain corrodes metals and attacks cement and limestone buildings. It dissolves cars and clothes and turns once productive lakes and streams into biological deserts, and it kills trees and forests.

Are all areas equally vulnerable to acid rain?

Some areas are much more vulnerable than others. Obviously areas downwind from the power plants are much more likely to suffer damage from acid rain than other areas. However, the amount of damage is directly correlated to the bedrock and soil acidity. For example, the acid rain damage to lakes and forest in the granitic (granite is an acidic rock) Adirondack Mountains of upstate N.Y. has been much more serious than that in the Green Mountains of Vermont which are composed of limestones and marbles. The calcium carbonate rock and soils in Vermont are better able to buffer, or neutralize the incoming rainfall than those in the Adirondacks.

How do emissions from plants in the mid-West cause damage hundreds of miles away?

In an effort to reduce complaints from communities near the coal-fired generating plants, plant owners built smokestacks hundreds of feet tall--sufficiently high so that much of the smoke is carried away by the prevailing winds. The pollutants remain aloft until the prevailing winds encounter the Appalachain Mountains, form clouds, and begin to precipitate rain or snow.

In fact, hundreds of miles is not that far for airborne pollution to travel. Acid rain from the Mid-west is also causing a great deal of environmental damage in Eastern Canada and Western Europe. It even contributes to the Arctic haze problem.

What is Arctic haze?

Arctic haze was first reported by military pilots in the 1950's. In the 1970's researchers from the University of Alaska-Fairbanks began to study why air over the North Slope and the Arctic Ocean was brown with haze. Investigations as far north as the Pole confirmed that the entire Arctic basin fills with dirty air each winter.

Where did the air pollution originate?

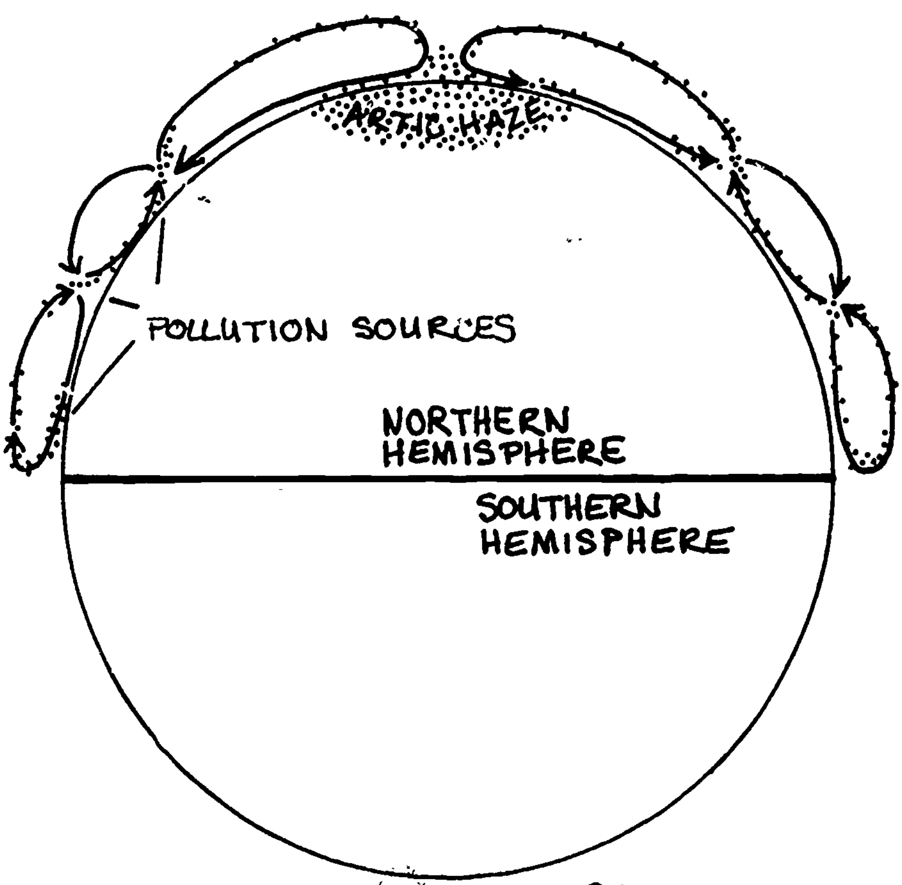
There is industry in the arctic. The Prudhoe Bay oilfields and even Barrow itself discharge large quantities of methane, water, and other by-products from the combustion of fossil fuels in general, and natural gas in particular. But this industry could not begin to account for the large amounts of haze found over the Arctic Ocean.

Next researchers looked at other circumpolar countries with large amounts of industry in the Arctic. Russia was an obvious candidate because it has a great deal of heavy and potentially dirty industry (coal mining and coal-power generation, for example) north of the Arctic Circle. Evidence that Russian industry was indeed responsible for a significant proportion of the Arctic Haze came in the form of unique combinations of heavy metals characteristic of smelters in the Ural Mountains on the boundary between European and Asian Russia.

But that was not all that the researchers found. They also discovered dust and pesticides from Africa and other pollutants from North America and Western Europe.

<u>How can pollution from thousands of miles away reach the Arctic?</u>

Pollution travels through the atmosphere by convection, the same way cooking odors spread from your kitchen through the rest of your home. Pollution is carried aloft by rising (usually warm or relatively warm) air masses. Once aloft, the pollution can be carried ever higher by winds and weather patterns until it reaches an altitude of several miles and global convection cells like the jet stream. Once in part of these circulating air masses, the pollution can find itself on a roller-coaster ride to the Arctic. This is basically the same process which quickly circulates the ash from a large volcanic eruption or the fallout from a nuclear explosion. For example, four days after the Chernobyl accident near Kiev in Russia radiation had reached Barrow and other parts of Alaska.



But there really isn't anything in the Arctic Ocean which can be damaged by pollution is there?

Circumpolar people of the north such as the Inuit of Siberia, Alaska, Canada, and Greenland and the Lapps of Scandinavia know that as harsh as the Arctic is, it also contains fish and wildlife--enough bounty in the summer to make year-round survival possible. In Northern Scandinavia, the Lapps had to destroy half of their reindeer herds because the meat was contaminated by radiation as a result of Chernobyl.

In Alaska in the 1950's, lichens were contaminated with strontium from above-ground nuclear weapons testing in Russia. Lichen constitute the main diet for caribou. For several years, Alaskans were warned by the Federal government not to eat caribou.

Does Arctic haze have implications for people living outside of the Arctic?

Dangerous as the pollution may be for Arctic life-forms, scientists were more concerned about the world-wide significance of Arctic haze. In the first place, circulation in Arctic ecosystems is very slow, and the Arctic Ocean is no different, so that once introduced, pollutants tend to remain for years. Scientists worry that the polar ice cap will start to melt as soot darkened snow absorbs more solar radiation. Significant changes in the size of the polar ice cap could change the world's weather and raise global sea levels enough to flood coastal areas.

Equally important, scientists recognized Arctic haze as further proof that the entire globe is one large biosphere--that pollution does not recognize political or geographic boundaries. As the laws of physics predict, matter is neither created nor destroyed; pollution doesn't just disappear because society wants it to. Instead, pollution enters the atmosphere and the hydrosphere, the hydrogen, carbon, and oxygen cycles, and there it stays until these cycles have time to process it. Too much pollution clogs natural processes. Perhaps you've heard about the ozone layer--another global atmospheric problem.

What is ozone?

Ozone is a molecule consisting of three atoms of oxygen (O3). In the lower atmosphere, ozone is harmful. Formed when sunlight, thunderstorms, or the sparkplugs in car engines act on nitrogen oxides and/or hydrocarbons, ozone causes respiratory problems and eye irritations. Increases in automobile pollution result in dramatic increases in ozone levels in the lower atmosphere which in turn may kill evergreens and reduce crop yields by as much as 20 %. Presently, scientists are even more concerned about changes far above the earth's surface in the ozone layer.

What is the ozone layer?

The ozone layer is an ozone-rich global envelope found in the stratosphere, some 12 to 30 miles above the earth's surface.

What does the ozone layer do?

The ozone layer screens out or blocks much of the most harmful wavelengths of the sun's ultraviolet (UV) radiation. UV radiation causes skin cancer, and worldwide skin cancer rates have doubled in the past decade.

Have rising skin cancer rates been linked to a thinning ozone layer?

Not conclusively. But scientists fear that if degradation of the ozone layer continues, skin cancer rates will double again and species extinctions may also increase. Ultraviolet radiation also may interfere with the body's immune system, and increase rates of cataracts, herpes, other diseases.

Since 1978, scientists using satellites have monitored ozone levels over the South Pole. Each year the ozone layer over the South Pole becomes thinner. In 1986, ozone concentrations over Antarctica were only 60% what they had been in 1978.

What is damaging the ozone?

Science has not answered that question yet. The theories include solar flares, upwelling of warm air resulting from oceanic warming (El Nino), high-flying jet aircraft, and chlorofluorocarbons.

What can be done about high-flying jet aircraft?

Congress banned flights of supersonic transport (SST) passenger planes over the continental U.S. These planes fly at 65,000 feet, at the bottom of the stratosphere. Congress' action ended the Boeing Aircraft Company's plans to build SSTs. Presently Air France and British Airways operate the Concorde on a few TransAtlantic and TransPacific Routes. Ten years after it went into service, this French-British airplane is the only SST in operation. Had Congress not banned SST flights over the U.S., there might be several hundred in service around the world. In the case of the SST, at least, American leadership in self-restraint set an example which has for the most part been followed.

What are chlorofluorocarbons ?

These compounds are used in refrigerants, spray-can propellants, and in the manufacture of plastics.

Aren't chlorofluorocarbon (CFC) propellants banned in the United States?

Yes. Reacting to concern about depleting the ozone layer, the Congress banned chlorofluorocarbon propellants in 1978. But Europe and other parts of the world continue to manufacture them.

Why are CFCs so popular?

CFCs are still widely used in the U.S. in non-propellant applications because they are non-flammable, non-carcinogenic, non-corrosive, and have low-toxicity and high energy-efficiency. CFCs were invented as a replacement for ammonia refrigerant which is toxic and potentially explosive. In other words, CFCs are a technological fix. The value of CFC-related goods and services surpasses $28 billion annually and 780,000 full-time jobs.

How do these propellants get into the stratosphere?

Once released, these lighter-than-air aerosols float upwards until they reach the stratosphere. There they remain for approximately 75 to 110 years.

Why are they suspected of harming the ozone layer?

Chlorofluorocarbons (CFCs) are generally unreactive in the lower atmosphere. However, in the presence of ultraviolet radiation they react readily with ozone. In fact each chlorofluorcarbon molecule consumes 100,000 molecules of ozone in a prolonged series of complex chemical reactions.

How rapidly is the ozone layer being depleted?

Atmospheric chlorine concentrations in 1900 are estimated to have been 0.6 parts per billion volume (ppbv). The present chlorine level in the atmosphere is 3.5 ppbv and is increasing at the rate of 1.0 ppbv per decade. The widespread use of CFCs only began in 1970.

How many CFC's are being released to the atmosphere annually?

Each year industry society releases 1 million tons of CFCs into the atmosphere.

What are some of the wider implications of depleting the ozone layer?

Allowing UV radiation to reach the earth's surface contributes to the greenhouse effect.

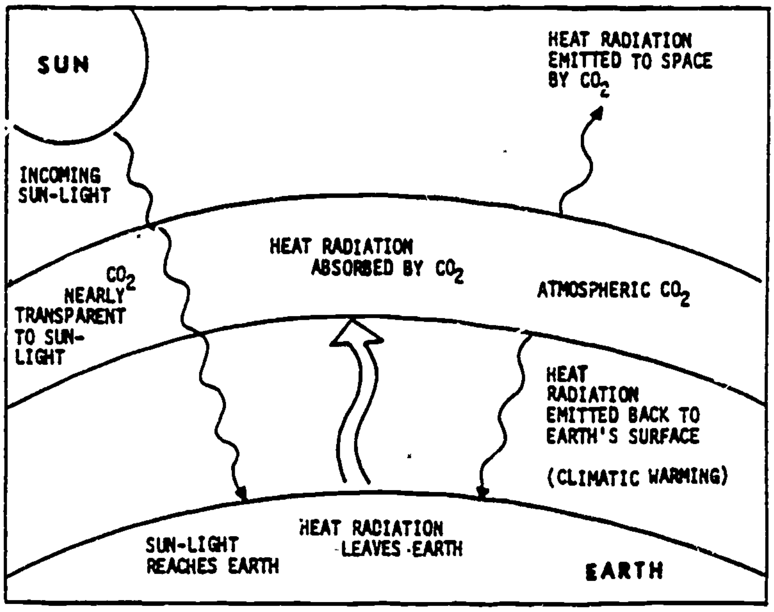
What is the greenhouse effect?

The greenhouse effect is planetary warming caused by increasing levels of carbon monoxide in the earth's atmosphere.

How does the carbon monoxide warm the atmosphere?

Although atmospheric carbon monoxide will reflect some incoming solar radiation, slightly diminishing the total amount reaching the earth's surface, this effect is more than compensated for by the amount of radiation which the carbon monoxide blanket traps in the atmosphere. Ultraviolet wavelengths change to infra-red upon striking the earth's surface. After striking, the waves rebound towards space. Many are prevented from escaping by the blanket of carbon monoxide. This trapped radiation drives up temperatures around the globe.

The "Greenhouse" Effect of CO_2:

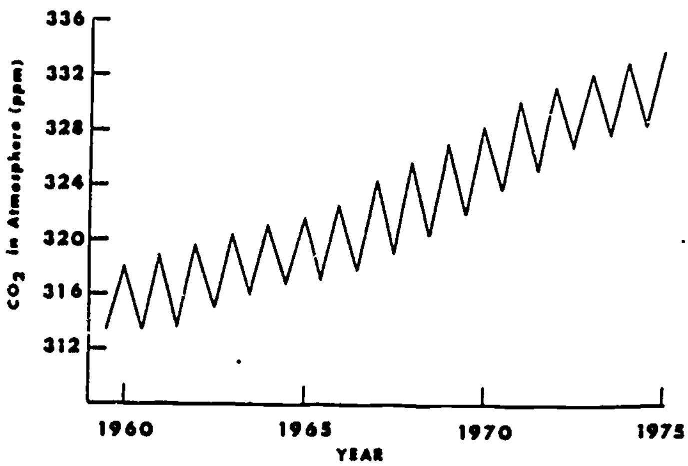


Courtesy of Dr. Art Kadama, University of Hawaii School of Public Health

What increases atmospheric carbon monoxide levels in the first place?

Deforestation, energy consumption, and industrialization are the main culprits. Global carbon emissions resulting from fossil fuel consumption alone have increased more than three-fold since 1950. Some believe that the action of termites following in the wake of the destruction of tropical rainforests could be producing enough carbon monoxide to account for the rise in atmospheric concentrations. In any case, since the turn of the century atmospheric carbon monoxide concentrations have increased 45%, from 240 ppm to 350 ppm.

The following graph shows the steady increase of atmospheric carbon dioxide in recent years. The graph also reflects seasonal variations. Carbon dioxide levels increase each winter when more fuel is burned for heat land light. Levels decrease each summer when plant photosynthesis is greatest. Note that the rate of increase is on the rise; atmospheric carbon dioxide levels are growing exponentially.



From Mauna Loa Observatory as reoported in EPA Journal, December 1986.

Is there no hope?

The following table shows that at least in the case of these three indicators, air quality in the U.S. has improved as a result of increased awareness and air quality legislation.

IMPROVEMENT OF AIR QUALITY:

1970 → 1977 (in U.S.)

SULFUR DIOXIDE	↓ 30 %
PARTICULATES	↓ 17 %
CARBON MONOXIDE	↓ 10 %

How do scientists know what atmospheric levels of carbon monoxide were 100 years ago?

Glacier ice contains a record of past climatic and atmospheric conditions. The falling snow traps air and as the snow gradually changes into ice, the air is compressed into bubbles. The relative concentration of O16 and O18 oxygen isotopes in glacier ice also preserves a record of past temperatures. Studies of Alaska's permafrost show that temperatures in Interior and Northern Alaska have warmed on the average of 4-7 F in the past century.

How significant are global temperature changes?

Very. Human beings can only function when their body temperatures are within a few degrees of 98.6 F. Other plants and animals are equally sensitive. A ten degree rise in temperature could render many parts of the world uninhabitable or displace the current life forms. Global warming could increase the size of the world's deserts and/or melt glaciers and polar icecaps causing sea levels to rise by as much as 100 feet. Since a large portion of the world's population lives in low-lying coastal areas, a global change in sea level of more than a few feet could have huge ramifications.

What other evidence is there of global climate change?

Weather systems have shifted in recent years. In Alaska, for example, winters in the past decade have been significantly milder. Juneau's winters are more like Seattle's, Anchorage's more like Juneau's, and Fairbanks's more like Anchorage's used to be. The Arctic High which accounts for the coldest winter weather has shifted east into the Yukon. Other parts of the United States have experienced much colder than usual winter temperatures. Western Australia has been scorched by huge bush fires. Africa's Sahara Desert is expanding. Ocean temperatures are rising, too. The number and intensity of typhoons in the Pacific has nearly trebled in the past decade, and El Nino is becoming more frequent and persistent.

What is El Nino?

El Nino is the name for the periodic warming of the Eastern Pacific Ocean. The oceans are huge heat reservoirs. They influence all the world's weather and moderate seasonal temperature changes on the continents. El Nino used to occur every decade or two, and last but a season. Now it occurs more frequently and persists for more than a year.

Why is El Nino significant?

It kills temperature-sensitive corals and other sedentary sea life so that whole ecosystems die-off. El Nino dislocates more mobile species. For example, tuna that rarely are found north of the Washington Coast were being caught as far north as Southeast Alaska.

Are air and water pollution related?

Yes, just as in the case of acid rain where changes in air chemistry caused changes in the chemistry of lakes, rivers, and soils, changes in atmospheric chemistry and temperature can cause changes in the oceans.--and vice-versa. Elevated temperatures tend to cause algal blooms which quickly exhaust the dissolved oxygen in water and result in massive die-offs of fish which suddenly find themselves unable to breath. One of the most serious affects of water pollution is eutrophication.

What is eutrophication?

Untreated sewage and phosphorous-rich detergents dumped into water bodies act like fertilizers, rapidly accelerating plant and bacterial growth. These organisms remove so much oxygen from the water that fish and other animals begin to die, and their decomposition further reduces the available oxygen. In some cases, the water body can become completely anaerobic which means that only certain bacteria can live in it.

How is eutrophication prevented?

Treating sewage and avoiding the use of phosphate-containing detergents will in most cases reduce the potential for eutrophication. As with other types of pollution, the problem is largely one of quantity. As long as the quantity of pollutants is small relative to the size of the system into which it is being dumped, natural processes will probably be able to handle the material without becoming overburdened.

Dumping of untreated sewage full of phosphate-rich detergents clogged Seattle's Lake Washington with algae and water plants in the 1950's and 60's. The construction of a sewage system and sewage treatment plants in 1965 enabled the lake to eventually clean itself.

Hazardous Waste's

Competency: Identify the Impacts of Hazardous Wastes

Tasks: Explain hazardous waste terms and principles

What are hazardous wastes?

The Environmental Protection Agency (EPA) defines hazardous wastes as discarded material that may pose a threat or potential hazard to human health or the environment. These wastes can take the form of solids, liquids, gases, or sludges. In order for a material to be regulated as a hazardous waste, it must be on an EPA hazardous waste list or have one of the following characteristics:

- ignitable: flash point <140 F
- corrosive: pH <2 or >11
- reactive: ie. with air or water; explosive
- toxic: must meet specifications of EPA toxicity tests

How are toxic wastes properly managed?

Proper management of toxic wastes entails a great deal more than careful disposal. Other waste control strategies include:

- avoidance: the amount of hazardous material generated must be minimized
- recycling: waste should be transferred to industries that can use it with or without reprocessing
- separation: hazardous materials should be separated from non-hazardous components to minimize volume and reduce handling, transportation, storage, and disposal costs

What are the typical disposal methods?

Chemical treatments include neutralization, precipitation, oxidation, reduction, and solidification (to prevent leaching).

Biological treatments include landfarming, trickling filters, aerated treatment lagoons, and stabilization ponds. These are particularly useful for sewage and substances which can be broken down by bacteria and other organisms.

Incineration can be used to detoxify or reduce the volume of certain substances. Incineration can be very tricky, and frequently is incomplete. The EPA operates specially-designed ships, the Vulcanus I & II, which burn extremely toxic chemicals far out at sea.

Underground [illegible] storage and ocean dumping are used frequently, but may only postpone later problems [illegible]ination of water tables and food chains.

Landfills are the cheapest and most commonly used methods. However, they are generally the least desirable, typically only postponing problems and frequently leading to situations where many different compounds, each requiring a unique disposal strategy become mixed into a witch's brew. Soil and water table contamination are typical at landfills.

How much hazardous waste is improperly disposed of annually?

The EPA estimates that 35 million pounds of hazardous wastes are dumped on the ground each year in the United States.

What health and environmental hazards do these wastes pose?

Hazardous wastes enter the various cycles like the water and air cycles. They burn, explode, and can poison via the food chain or direct contact.

What are some of the most common hazardous wastes?

Common hazardous wastes include sewage, heavy metals, fuels, biocides, asbestos, and radioactive materials.

Why is sewage so hazardous?

In addition to household cleaning compounds and solvents and trace amounts of metals, sewage may contain toxic chemicals from local farms, businesses, and industries. But even without these materials, sewage poses a direct threat to human health. Human wastes provides an ideal media for a number of life threatening bacteria which spread diseases such as diptheria and typhus. These biohazards make working in sewage treatment plants one of society's more dangerous occupations.

Why are heavy metals hazardous?

Although human beings need some metals like iron and zinc, most heavy metals are highly toxic. These include mercury, lead, cadmium, strontium, and arsenic. In addition to killing outright, heavy metals cause birth defects and brain damage. The body tends to retain heavy metals--once in, they may remain for life. Cadmium and lead replace calcium so that the victim's bones become so soft that they beak whenever the person moves. Cadmium poisoning syndrome is called "Itai, itai" Japanese for "It hurts, it hurts." Hundreds of Japanese were poisoned by drinking water from the Jinzu River where cadmium had been dumped as a by-product of zinc refining.

Children who eat paint chips or play near busy roadways may be exposed to toxic doses of lead. Fishermen who work with lead-based hull paints can be poisoned by inhalation or absorption through their skin. The improper disposal of car batteries is a major source of lead pollution. One of the most common sources of lead poisoning is water pipe. Until the early 1970's, most water pipe was made of lead. Some of the lead was dissolved by the water which subsequently was consumed by people. In recent years, most water pipe is plastic or copper. Copper pipes contain lead solder which, especially when the pipes are new, is an important source of lead poisoning.

How much lead does society use?

In the mid-1970's 170,000 tons of lead were emitted into the U.S. environment annually. Presently, annual consumption is about half that amount.

What is society doing about lead pollution?

Congress has authorized the EPA to control lead production and use. Rather than try to eliminate all lead-containing motor fuels immediately, the EPA has scheduled a phase-out. At present, 40 percent of the gasoline produced in the U.S. still contains lead. The EPA plan has been criticized by environmentalists as being insufficient, and by industry as being over-zealous and counter-productive. According to EPA's statistics, their program is reducing the amount of lead in the environment.

What can be done to reduce the risk of lead poisoning from drinking water?

Let the water run for several minutes before using it for drinking, especially first thing in the morning when it has bee standing in the pipes all night picking up lead. use cold water for cooking. (Hot water corrodes solder and picks up lead more rapidly than cold.) Install a water filter capable of removing heavy metals.

Does Alaska have heavy metal hazards?

Heavy metal hazards are widespread in Alaska. To date the department of Environmental Conservation has a list of over 600 sites suspected of having hazardous wastes. Many of these sites have dangerously high levels of heavy metals. These include former and active gold mining areas like Juneau, Circle, Fairbanks, and Nome where mercury was used to separate the gold from other materials. Mercury causes loss of motor control, disfiguring paralysis, birth defects, and mental disorders. Nome has the most publicized mercury problem in Alaska. In 1987, after several years of controversy and some officials asserting that there was nothing to worry about, the Department of Environmental Conservation acknowledged that tests revealed soil mercury concentrations as high as 448,000 ppm (44.8% mercury) in a school playground in Nome.

Mercury poisoning is named Minimata disease after a Japanese bay. When a chemical company dumped hundreds of tons of mercury in the bay, hundreds of residents were poisoned after eating fish which had concentrated the heavy metal.

Even lead-free fuels pose many hazards to public health.

What are some of the immediate hazards in handling fuels?

Motor fuels such as gasoline and kerosene pack almost as much potential heath risk as they do energy. In the first place, they are highly flammable and explosive. A cup of gasoline has as much explosive energy as a stick of dynamite. And even seemingly empty gasoline tanks contain enough fumes to explode with deadly results. But motor fuels have subtle health risks, as well.

What are the intermediate hazards of handling fuels?

People who inhale fumes while filling vehicle fuel tanks can be inhaling lead, benzenes, ozone, and other toxins. Fumes can cause pneumonia--in which the lungs fill with body fluids--and eventually death. People who repeatedly splash fuel on their skin may develop allergic reactons, rashes and open sores which take months to heal.

What are the long-term risks of handling fuels?

Exposure to benzene and other aromatic hydrocarbons contained in motor fuels can cause cancer. In addition, absorption of lead and other heavy metals through the skin or lungs can lead to severe heavy metal poisoning. The combined short, intermediate, and long term hazards of handling motor fuels may have something to do with the increasing number of filling stations which require motorists to pump their own fuel.

How do motor fuels pollute groundwater?

Service stations and industry typically store fuel underground in buried tanks. Until recently, almost all of these tanks have been made from metals. Over time, metal tanks begin to corrode.

What is corrosion?

Electrical currents in the tank and/or between the tank and the ground cause a chemical reaction caused corrosion or electrolysis. Basically, the electrical current removes metal from one place and deposits it in another. (Rusting is a form of corrosion.) Eventually, the corrosion will eat completely through the metal, and the tank will begin to leak. In the case of buried tanks, leaks frequently will be slow at first and may not be detected for months or years--often not until someone's drinking water starts to taste like motor fuel.

Have Alaska's groundwaters been poluted by leaky fuel tanks?

Yes. In 1986 motor fuel was discovered in groundwater in the Anchorage suburb of Eagle River, forcing residents to begin a search for a new source of safe drinking water.

What can be done to prevent fuel tanks from corroding?

Although corrosion control engineers can design various strategies to reduce the rate of corrosion, they can not stop it completely. The use of buried fiberglass fuel tanks eliminates the corrosion/groundwater pollution problem. However, fiberglass, like metal, does not last forever; engineers will have to devise a method of periodically monitoring fuel levels in the soil near the tanks to insure that leaks are detected before the fuel enters the water table.

What can be done to reduce the health risks associated with using motor fuels?

Purchase and drive vehicles that use non-leaded fuel. Buy the most fuel-efficient vehicles available and maintain and operate them fuel-efficiently. When refueling, stand up wind of the nozzle.

People who routinely handle fuel can wear protective clothing including respirators and special rubber gloves which are impervious to motor fuels. Equipping pump nozzles with rubber gaskets which reduce the amount of fumes escaping from the tank while it is filling may be of some benefit. Presently, the EPA is studying this problem.

What are biocides?

Although biocides could conceivably be any products that are toxic to any form of life, for the present purposes biocides are defined as those compounds manufactured to control pests. These include fungicides, herbicides, insecticides, and pesticides.

What is so hazardous about biocides?

Since they are designed to be toxic, it's not surprising that biocides pose health hazards. A number of their characteristics present serious health problems. Many of them are readily absorbed through the skin, lungs, and/or digestive system. These chemicals frequently cause respiratory distress and impair the function of the liver and other vital organs. Some, like DDT, breakdown into equally or more hazardous compounds.

How can a relatively small amount of chemical cause so much damage?

In the first place, these are very toxic compounds. In some cases, a little powder or solution splashed on the skin or a little gas inhaled can cause death within minutes--as happened in the methyl cyanide spill in Bhopal, India.

Other toxins are cumulative. They enter the food chain where they become increasingly concentrated as they move up trophic (energy) levels from producers (algae, plants and grasses) to consumers (mice, voles, insects, birds) and finally to predators such as birds of prey and human beings. Chemical concentrations which were in the parts per billion may soar into the parts per thousands with life- and sometimes species-threatening consequences. For example, ospreys, eagles, and orioles were nearly exterminated in the Eastern U.S. as a result of indiscriminate use of DDT and related compounds in the 1950's and 1960's.

When these compounds are used by agricultural workers and others whose native language or lack of education makes it impossible for them to read and/or understand the warnings and directions on the containers, disaster can result. Just as certain species are more vulnerable to a given substance, certain body organs collect these toxins and are more susceptible to damage.

How long do these chemicals remain a hazard?

Many of these compounds are stored in fat tissue. They do not break down for years. Sudden weight loss can swamp the body's kidneys and liver with toxins. Some of these chemicals have a synergistic effect (in which the sum is greater than the parts). In other words, once in the body they work together to cause greater harm than one would expect from the sum of their individual actions.

Why isn't society more careful about biocides?

Sometimes, as was the case with DDT, it takes years for the harmful effects of these compounds to manifest themselves--or for people to notice and convince government to act. In the meantime, the compound may have been hailed as a chemical wonder (as was DDT) and have been used widely and indiscriminately to control mosquitoes, body lice, crop-damaging insects, and bedbugs.

Another reason that society isn't more careful is that there are so many chemicals introduced each year, and the government has the resources to test only a few. At the same time, having invested millions of dollars to develop these compounds, chemical companies are anxious to recoup their investments as quickly as possible, and the only way they can do that is by selling the products. Only later, does society realize that the chemical is an ecotoxin--as is the case with Dioxin.

What is dioxin?

Dioxin, a component of Agent Orange, was used widely as a defoliant in the Vietnam War. Only in the last few years, have soldiers been able to prove in court that it causes cancer, sterility, and birth defects. One town, (Times Beach, Missouri) was so contaminated with Dioxin (mixed with waste oil and sprayed on roads to control dust) that the U.S. government bought it in 1983 from the residents for 33 million dollars and erected a fence around it to keep people out.

What are PCB's?

PCB's, or polychlorinated biphenyls, are some of the most toxic substances known. They were used extensively until the late 1970's in hydraulic fluid, electrical transformers, and plastics. PCB's are scattered across Alaska in old military sites, dumps, and landfills. At the present rate, it will probably be at least one or two decades before all potential PCB-contaminated sites are inventoried, investigated, and cleaned up.

How common are PCB hazards?

PCB hazards are quite common in Alaska. Any electrical transformer manufactured between World War II and 1978 could contain PCB's. Transformers containing PCB's may be rusting away in your community: at the dump, the utility company storage yard, or in someone's warehouse, or home. These transformers could still be in use. PCB hazards may be as near as the fluorescent lights in your home, school, workplace, or grocery store. Until 1978, PCB's were also used in fluorescent light fixture ballast (not the bulb, but the permanent part.

PCB's, Dioxin, DDT, and heavy metals are examples of ecotoxins.

What are ecotoxins?

Ecotoxins are a class of highly toxic compounds which have the following four characteristics:

1) High biomagnification factor: In other words, ecotoxins are concentrated by organisms in the food chain. They usually have low solubility in water and are highly lipophilic (which means they are readily stored in fat tissue).

2) Long persistence: Ecotoxins have long half-lives or else transform into compounds which have long half-lives (half-life is the time which it takes for the material to lose half its toxicity).

3) Human toxicity: Ecotoxins are toxic to humans and other species at the top of the food chain but not to organisms at lower levels of the food chain--or else they couldn't be biomagnified.

4) Pervasiveness: Once introduced into the environment, ecotoxins tend to be widespread.

The ecotoxin concept is important both as a classification tool and as a way of understanding why some compounds are so harmful. One hazardous waste which is not an ecotoxin but which you are likely to encounter in your everyday life is asbestos.

Why is asbestos so hazardous?

From the amount of money the government is spending to clean up asbestos hazards, one might think that there was no more dangerous product known. While it is true that even one small asbestos fiber inhaled can cause lung cancer, government's clean-up zeal may have as much to do with the fact that asbestos' health hazards are better documented than most other products'.

What is asbestos used for?

Early civilizations made clothing out of asbestos. Asbestos has been widely used for more than hundred years as a fire-proof insulating compound. A naturally-occurring rock-fiber, asbestos has been mixed with paint, with concrete for use in water pipes, and pressed into sheets or boards to insulate around heating appliances. Asbestos is highly friable (the fibers readily separate) and as airborne dust it is readily inhaled. Carried into the deepest recesses of the lungs because of their small size, the fibers become lodged and remain until either the victim dies of other causes or the fibers cause asbestosis (lung cancer).

How are asbestos hazards controlled?

Asbestos is either sealed in place to prevent fibers from contaminating the living areas of a building, or all asbestos-containing materials and debris are removed. Once air quality has been restored--as indicated by air monitoring devices--people are allowed to reoccupy the structure.

Who can do asbestos abatement work?

Working in asbestos removal requires specialized training about asbestos hazards and proper protective clothing and management procedures. All asbestos-removal workers in Alaska must be certified by the State of Alaska. Another class of materials closely controlled by the government is radioactive waste.

What hazards do radioactive materials pose?

Relatively low levels of exposure to radioactive materials can result in mutations and cancer. High levels of exposure--such as those experienced in reactor accidents and nuclear war can kill immediately. Only thirty or forty years ago, low level radiation was considered safe, and shoe salesmen used x-ray machines to determine customers' sizes. For the past twenty years, however, more sensitive scientific instruments and research techniques have revealed that smaller and smaller doses of radiation harm health. As a result, acceptable exposure levels are continually revised downward (doses considered acceptable are continually made smaller).

Isn't radiation everywhere?

Yes, sunlight contains low amounts of radiation, and every living thing is slightly radioactive. Every part of the earth has some degree of radiation. These are called background levels. Generally, these levels are extremely small. The amount of radiation coming from even low-level radioactive wastes, for example, is thousands of times higher than background levels.

How long do radioactive wastes continue to emit harmful radiation?

Radioactive wastes continue to emit harmful radiation for long after their useful life--sometimes for thousands of years. These radioactive wastes include materials from x-ray machines, nuclear reactors and weapons, and tailings from uranium mines.

How are radioactive wastes disposed?

Thus far, they aren't--which is one reason they are such a problem. Except for plutonium which is turned into bombs, no permanent solution has been found for the problem of radioactive wastes. Currently, wastes are sealed in lead-lined storage containers or buried deep underground in salt mines and other bedrock known for its stability and impermeability (lack of percolating groundwater). However, it's only a matter of time (sometimes only a decade or two) before the wastes begin to corrode their containers and leak. Meanwhile, scientists are doing their utmost to develop a more permanent solution to the problem.

Can't radioactive wastes be treated, the way other wastes can?

Unlike most other toxins, radioactive wastes cannot be cooked, burned, or recombined with other materials in any way which will reduce their radioactivity. Instead, their radioactivity is reduced at a constant rate, much like a clock runs down. These decay rates are measured in terms of half-lives, or the period it takes for half of the mass of the radioactive material to disappear.

The Atomic Energy Commission, the federal agency responsible for promoting and regulating atomic energy, uses 20 half-lives as the minimum period a given type of highly radioactive material should be stored until it can be considered safe. Radioactive isotopes such as strontium 90 and cesium-137 have half-lives of 28 and 30 years. In other words, they would have to be isolated for between 600 and 1000 years before they could be considered harmless. Even if a safe storage system were discovered, some mechanism must be developed which would insure that radioactive waste storage sites would remain secure from anarchists, extremists, and enemies of the government. This in itself is a monumental task for a society which rarely can plan for periods longer than a year.

How big a problem is hazardous waste disposal?

In 1977, the EPA regulated 367.2 million metric tons of hazardous wastes generated in the United States, and that did not include radioactive wastes or materials whose hazards had not yet been recognized. By 1985, more than 800 sites had been put on EPA's Super-fund clean-up list--and that number was expected to grow to 2500--with clean up costs of at least 40-50 billion dollars.

These numbers only suggest the size of the problem. More often than not, hazardous waste dump-sites are only discovered when people are stricken by unexplained illness.

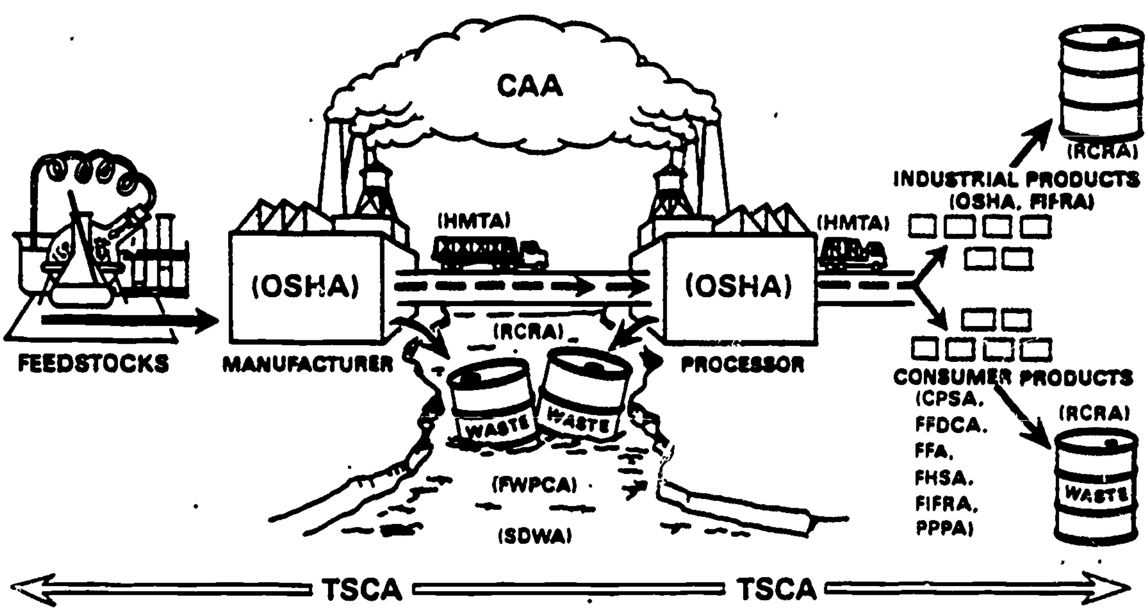
Meanwhile, industry is producing ever increasing quantities of hazardous wastes. Of all the wastes disposed of, only about 10 percent are disposed of in an environmentally sound manner. More than three quarters are dumped into sewage systems and water bodies, onto the ground, or in unlined landfills, and another ten percent are burned illegally.

How can hazardous wastes be better managed?

Congress has passed "cradle to grave" regulations. However, thus far, the creation of hazardous wastes seems to be outpacing society's ability to control them. In the end, the only solution will likely be to severely limit--if not dispense with--their production.

The following diagram shows EPA's current authority to manage hazardous wastes.

LEGISLATIVE AUTHORITIES AFFECTING THE LIFE CYCLE OF A CHEMICAL



• KEY •

CAA = CLEAN AIR ACT	HMTA = HAZARDOUS MATERIALS TRANSPORTATION ACT
CPSA = CONSUMER PRODUCT SAFETY ACT	OSHA = OCCUPATIONAL SAFETY & HEALTH ACT
FFDCA = FED. FOOD, DRUG, & COSMETIC ACT	PPPA = POISON PREVENTION PACKAGING ACT
FFA = FLAMMABLE FABRICS ACT	RCRA = RESOURCE CONSERVATION & RECOVERY ACT
FHSA = FED. HAZARDOUS SUBSTANCES ACT	SDWA = SAFE DRINKING WATER ACT
FIFRA = FED. INSECTICIDE, FUNGICIDE, & RODENTICIDE ACT	TSCA = TOXIC SUBSTANCES CONTROL ACT
FWPCA = FED. WATER POLLUTION CONTROL ACT	

What can the average consumer do about hazardous wastes?

Consumers can do a great deal about certain hazardous wastes, escpecially those common in households. Consumers can avoid buying and using many of these compounds. When they have to buy these products, they should only buy as much as they need. Consumers should read product labels before they purchase the products--maybe the list of ingredients, the directions, and the cautions will send them searching for a less-toxic substitute. They should follow all directions and warnings when transporting, storing, applying, and cleaning up after using these products.

What do the labels mean?

The EPA requires that pesticides be marked according to their toxicity. DANGER means highly poisonous. WARNING means moderately poisonous. CAUTION means least harmful. Do not use any product marked RESTRICTED USE; this label indicates that the product should be sold to and used by only people trained and certified in its application.

Are there other sources of information about household hazardous wastes?

Yes, the EPA, the League of Women Voters, and numerous other organizations have information on hazardous wastes. A household hazardous waste kit can be obtained by writing or calling:

League of Women Voters of Massachussets
8 Winter Street,
Boston, MA 02108
617-357-8380

or EPA toll-free: 1-800-424-9346.

The Resource section also includes other materials on hazardous wastes.

Noise Pollution

Competency: Identify Noise Pollution Risks

Tasks: Explain hazards of noise pollution
Explain hazard reduction methods

Noise is another health hazard that has health implications which frequently are ignored until it is too late.

How can noise damage health?

Noise can:

- cause mental illness
- cause pupils to dilate, making it hard to focus eyes
- cause ear, nose and throat irritations
- make you so tired you make mistakes on the job
- aggravate ulcers
- make you grouchy
- make hands clammy becuase blood vessels tighten
- cause hypertension
- cause cold feet...poor blod supply
- cause headaches from high blood pressure or anxiety
- cause chronic noise fatigue from loss of sleep
- result in poor speech from bad listening conditions
- trigger a heart attack: shorten your life
- cause irregular heart beats
- give you jumpy nerves
- make you fail in school (make it too hard to hear and think)

What are the common sources of noise pollution?

Noise pollution is everywhere. Grace Slick, the lead singer for Jefferson Airplane/Starship, once said, "Everything we do either makes noise or smells." Think about all the things which make noise. If you really listen, you can probably double or treble the length of the following list in just a few minutes.

Common Sources of Noise Pollution

Household

- stereos, radios, TV, alarms
- appliances: dishwashers, washers, dryers, vacuum cleaners
- doors, lawnmowers, chainsaws
- gunfire

Vehicles

- inadequate mufflers
- excessive acceleration/deceleration
- warning devices: horns, backup bells, and buzzers
- squeaks & rattles
- stereos
- sirens
- aircraft

Work

- power tools
- computers
- copying machines
- telephones
- hammering
- sawing
- heavy equipment

Why does hearing deteriorate with age?

Some deterioration is probably a natural response to aging. However, a great deal of it is probably due to exposure to various noises over the years. Hearing damage is cumulative--it adds ups, slowly robbing you of your ability to hear different frequencies of sound.

Why don't people wear hearing protection devices?

What? I can't hear you?

WHY DONT PEOPLE WEAR HEARING PROTECTION DEVICES?

OH! That's a good question. Either people don't understand the risks, or they think they don't care. Hearing and seeing are some of life's greatest pleasures, yet many people expose their hearing to irreparable damage. Some people may think not wearing ear protection devices is macho. Some may think it wastes time. People who have dangerous jobs may think its safer not to wear hearing protection. Ninety-nine percent of the time, these people are wrong.

Impacts of Communications

Competency: Identify The Technological Impacts of Communications

Tasks: Explain how a village or town changes with the introduction of telephones
Explain how the introduction of television changes a community
Explain the impact of satellite communications

What is a community?

A community of people is a group of individuals living in a specific place and frequently sharing common goals, interests, and conditions. A community can be as small as a fish camp, a village, or as large as Anchorage or Los Angeles, California. Indeed, some people talk of the global community, on the assumption that all the world's people share basic characteristics and the same planet.

How can a telephone change a community?

Answering that question requires knowing something about a community which has no telephones, no telephone connections from house to house or to the rest of the world. To obtain information about each other and to socialize, residents of such a community have to actually meet face to face, in their homes, at the store, post office, school, church, etc. If they needed help they would have to summon it, either by sending someone or some signal. With a telephone, they could keep up on local news and summon help without leaving their home.

In other words, a telephone enables them to "go out" and "bring the world in" without ever leaving home. Telephones simultaneously reduce and increase isolation, for there is more to communicating than just speaking and hearing voices.

Similarly, telephone communication with the world beyond the village facilitates the exchange of information between the smaller community and the larger.

How does television change communities?

A great deal of research has been done on how the introduction of television changes rural communities. Like the telephone, the television facilitates and impairs communication. Instead of a single voice entering the home, however, television brings groups of people, actors, and advertisers. The viewer has little chance to interact with these guests. In other words, the information flows in one direction. There is much less give and take with a TV set than there probably would be if the neighbors came over.

To varying degrees TV displaces former activities and ways of life. For example, it can reduce the amount of time people spend interacting with others. And if the neighbors do come over and the TV is left on, conversation will be harder to maintain--because television programs are designed to capture the viewer's attention.

Television brings entertainment, ideas, and salespersons into the home. Although the same things are introduced into homes by printed materials such as newspapers and weekly news magazines, there are obvious differences between print and electronic media.

In addition to conveying information, television is probably the world's most powerful marketing tool. It turns viewers into consumers and imparts new tastes and demands.

When television reaches a bush village for the first time, it is as if one version of the 20th Century--that which is current in the boardrooms of Madison Avenue (the street in New York City where many of the nation's largest advertising firms are located) and in Hollywood, California (where most movies and programs are conceived and or filmed) suddenly is competing with the world views which predominate in that village.

Someone unfamiliar with life in the big city may, on the basis of watching a few or even many shows, acquire a rather distorted impression about what life in the world beyond rural Alaska is really like. For example, a viewer might begin to believe that a person without lots of money, mansions, sports car, and beautiful mates has somehow failed. Although the viewer's village may have similar status symbols (for example, the size and quality of one's cabin, boats and vehicles, parkas, dog team, and meat cache), the symbols also vary in important ways. For one thing, they reflect local transportation costs and the poverty or wealth of the local environment. Viewers who adopt the values and behaviors of the people on television screens are likely to find themselves in an awkward limbo between the old world and the new. Sometimes this can be funny; however, just as often it leads to tragedy--in the form of alcohol and drug abuse, violence to others, and suicide.

The images of the outside world brought into the home can destroy the fabric of traditional communities. Native stories and legends are lost when youth would rather watch cops and robbers and cartoons on TV than listen to elders. When elders have no one to tell stories to, the traditional language dies. And by similar processes, traditional hunting, fishing, and crafts are lost. Many times these ways of living are lost because viewers assume that if the people on television do so well without stalking caribou or whales then so can the people in the villages. It is easy to forget that the people on television are only actors, actors living in big cities with few opportunities or need for subsistence hunting and gathering and other aspects of traditional Native American lifestyles. Yet, certain aspects of these lifestyles may be as important to the survival of the larger society as the survival of the larger society is to the traditional culture.

When young people begin to think that the old way has no value and the new way is closed to them, despair can set in. Rather than having the old social structure to turn to for guidance and the reassurance that the old way of life is still open, in many cases there is only the TV, reinforcing the message of change and more change and deepening the feelings of failure and helplessness.

Are all aspects of television negative?

No. Because what happens in one part of the world affects what happens in other parts of the world, it can be very important to keep up with local, national, and world events. Television and radio news programs make it easier to keep up with current events. Television also offers a number of valuable educational programs. Finally, in some parts of the world, television programs are broadcast in the native language of the local people. Such programs offer a means of keeping traditional languages alive. In Greenland, for example, television is seen as less of a threat to Eskimo culture because the programming is locally controlled, lack the violence and commercials associated with U.S. network television, and frequently offers locally produced, Eskimo-language programs.

Computer Impacts

Competency: Identify Computer Impacts

Tasks: Explain the Impacts of Computers on Health and Society

What is a computer?

A computer is a machine which is able to perform complex operations with information. These operations include manipulating numbers and large quantities of text and other types of data. Invented during World War II, the first computers were enormous, slow, and weak compared to anything on the market today.

What are some of the health impacts associated with using computers?

Widespread use of mini-computers and word processors is so recent that the implications for public health are not yet understood. Like other household appliances, computer monitors (CRT screens) emit various types of low-level (VLF & ELF) radiation which may over long-periods of exposure interfere with the body's own electrical field and cause glandular changes. This radiation may interfere with the normal development of fetuses. Monitors routinely give operators eye strain and fatigue. Many of these problems can be minimized by anti-glare/anti-radiation/anti-static filters.

The plastics used in computers emit aldehydes which irritate the upper respiratory tract and may be linked to sexual impotence. Exposure hazards can be minimized by purchasing metal cased computers and assuring adequate ventilation.

What are some of the benefits of computers?

The proliferation of computers is changing nearly every aspect of our lives. Computerized cash registers connected to optical scanning devices speed up operations at supermarket checkout stands--while at the same time facilitating the job of the persons responsible for keeping inventory, restocking shelves, and ordering.

The proliferation of word-processors makes it possible for managers and executives to do a great deal of their own writing, reducing the number of clerical and secretarial jobs.

Computerized banking means that customers can obtain cash and transfer funds 24-hours a day. Credit cards and the computerized systems of which they are a part make it possible to order almost anything at any time of the day or night from almost anywhere in the world equipped with a telephone or two-way communication system.

Computers enable scientists, researchers, engineers, and architects to manipulate huge amounts of data very quickly--opening up whole new methods of inquiry and investigation.

Computer-aided drafting and design (CADD) enables engineers and architects to compare various design options or change a design with relatively little effort and expense. Computer aided manufacturing (CAM) and robotics improve qualtiy control and reduce labor costs.

All these computer applications tend to increase the productivity of individual workers several fold. This increases cost-effectiveness and profitability.

Computers help fight crime. They generate statistics which show how crime changes from hour to hour, day to day, and year to year. Their data-management ability keeps track of evidence and reveals patterns that help solve crimes.

Equipped with a computer, a modem, and a subscription to a data base, a rural Alaskan has access to as much or more information than most libraries contain. For example, a modem gives a person access to airline schedules and reservations, stock market developments and transactions, scientific information, books, etc.

Computers also make it much easier for people to write books, articles, letters, and term papers.

Computers can help preserve Native heritage. For example, they have been used to record Native Alaskan stories and languages and have been used to write Tlingit-English dictionaries.

What are some of the social problems associated with computers?

In many cases, computers displace unskilled, semi-skilled, and even highly skilled workers whether they be assembly line workers, craftspersons, or office workers. These people often face long periods of unemployment and/or retraining.

Computers can be used by criminals to intercept cash transfers and steal trade secrets.

Their ability to manage data threatens privacy and liberty. In the hands of over-zealous law enforcement officers or tyrants, computers can rapidly turn a democracy into a police state. For example, all credit card and computerized transactions and phone calls leave an electronic record of a person's whereabouts, movements, habits, and tastes.

In the hands of terrorists, computers could be used to threaten national security or possibly even gain control of international financial or weapon systems.

Rights to Know

Competency: Understand Your Rights-to-Know About Exposure to Hazards

Tasks: Explain "Worker's Right To Know"

What Is "Right To Know?"

By now you should be aware that the workplace is potentially full of hazards to your health and safety. In order to protect workers, the Congress and the Alaska Legislature have passed numerous laws which guarantee your right to know what hazards you face in the workplace.

Do these laws guarantee that the work place will be safe?

No, that responsibility lies with the employer. It is the worker's responsibility (to him/herself) to make sure that the employer runs a safe workplace.

What can the worker do to help make the work place safer?

Workers can correct certain unsafe conditions and report others to their supervisor. If the supervisor does not correct the situation, the workers can file a complaint with the State Department of Labor.

Another thing which workers can do to insure safe workplaces is to become hazard "experts." By always being on the lookout for hazards, they can make the work place much safer. They can learn about hazardous materials, and how to recognize and properly dispose of them. They can learn how to read Material Safety Data Sheets (MSDS).

What is an MSDS?

The federal government and the State of Alaska requires that all hazardous materials have a Material Safety Data Sheet. This should either be on the container or posted on a bulletin board in the workplace. The data sheet identifies the:

- product, manufacturer and manufacturer's phone number
- hazardous ingredients
- physical data related to degree of hazard
- fire and explosivity
- health hazard data (rarely mentions long term risks)
- reactivity
- spill or leak procedures
- special protection information
- special precautions

In order to know more about poisoning/exposure symptoms and long term health effects, workers will have to consult an occupational health reference manual.

What exactly are employers required to do?

As of 1984, when Governor Sheffield signed the Alaska Right To Know legislation, employers are required to:

- post information relating to workers rights under this law
- conduct a safety education program for each new work assignment, informing you of the:
    a) location and properties of hazardous substances
    b) known or suspected health effects
    c) nature of any operation that could result in exposure to hazardous or toxic substances
    d) necessary handling or hygienic precautions
    e) location, use, and limitations of personal protective equipment

Worker Right To Know legislation is a very positive step and a powerful tool for workers concerned about their health and safety. However, in the end, management and worker commitment to establishing and maintaining a safe environment offer the greatest hope of having a healthy workplace. In order for that to occur, workers and managers must become fully informed about the machinery, processes, and substances which they use.

Why should workers learn about hazards and assert their rights?

Our society is based on the principle that individuals will take responsibility for their own health and safety. Congress enacts laws to protect workers from the worst abuses, but no law or set of laws can protect every citizen from every potential health and occupational hazard. As insurance rates skyrocket, employers are coming to realize that a safe workplace is more profitable than an unsafe workplace.

Although most employers and managers are concerned about worker safety, even these individuals face other pressures (production quotas, deadlines, profit margins) and sometimes may compromise on the job safety in order to satisfy their employers, stockholders, and creditors. Only informed and assertive workers stand a chance of protecting themselves from those employers and managers who yield to such pressures.

Commercial Fishing

Commercial Marine Species

Teacher Page

Competency: Identify the harvesting and processing of marine products

Tasks: Identify lifecycles and habitats of commercial marine species

Introduction

This lesson could take up to six days, depending on the depth and number of species you wish to cover. The lessons are arranged as follows:

Lesson 1: Salmon Life Cycle and Habitat
Lesson 2: The Five Pacific Salmon
Lesson 3: All About Halibut
Lesson 4: Bottom Fish are Booming
Lesson 5: Crabby Crustaceans
Lesson 6: Other Species

In this section the student learns primarily about the biology and availability of each marine organism. The harvesting and processing are covered in a later section.

Overview

Commercial fishing is an easy field to enter if you want to be a crewmember, but requires substantial investment for the actual fisherman. A commercial fisherman is really a small businessman, and must deal with licenses, permits, taxes, marketing, etc. Many fisheries in Alaska are limited, which gives the fishermen a better chance of making a living at fishing, but money is required up front for the permit.

The fishery that is undergoing a tremendous growth period at this time is the Gulf of Alaska bottom fishing industry. Since foreign fishermen are no longer allowed to fish in the gulf, Alaskans can gear up for this fishery, which has tremendous potential, plus a burgeoning market.

Resources

"Salmon Science", Centralized Correspondence Study, P.O. Box GA, Juneau, Alaska 99811 (This is a text-workbook which gives a general coverage of biology and harvest techniques for salmon.)

Alaska Fish and Game Wildlife Notebook Series, (These information sheets discuss the biology in detail for many Alaskan species. There is one sheet per animal. Material is of a high school reading level.)

Sea School, Alaska Fisheries Series, Alaska Department of Education. This excellent videotape series comes with a teacher's guide which summarizes each program, gives additional background information, and provides some student worksheets. They can be used in this section when you study the marine species, or some can be used in lessons 7 - 10, when fishing methods are discussed. Use the videotapes as follows:

Lesson 1: Program 4: So the Salmon Will Always Return
Lesson 3: Program 8: Halibut Rush
Lesson 4: Program 5: Joint Venture
Lesson 5: Program 2: King Crabber
Lesson 6: Program 3: The Herring Chase
Program 6: Fishing Impossible

Alaska Fisheries Development Foundation, Inc., 508 West Second Avenue, Suite 212, Anchorage, Alaska 99501. These people have developed an excellent videotape which discusses how pollock is turned into surimi. This is "White Gold: The Alaska Pollock Blues," and is appropriate with lesson 4.

Salmon Life Cycle and Habitat

What are the five kinds of Salmon?

Here is some general information about our Alaskan salmon. You might already know that there are five kinds, or species, of salmon that live in our Alaskan waters. Salmon are known by different names in different areas, but some commonly known names for our five salmon in Alaska are:

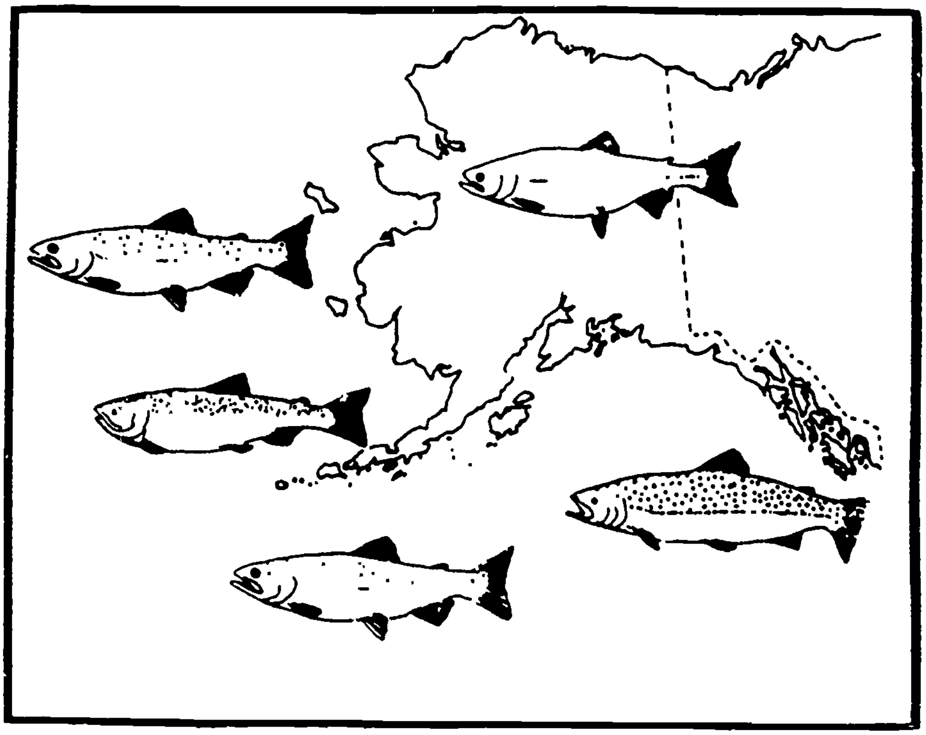
Pink, or Humpy

Chum, or Dog

Coho or Silver

Sockeye or Red

King or Chinook



The five species of Alaskan salmon are members of a large family of fish known as Salmonidae. The genus name for salmon is Oncorhynchus, a name formed by combining two Greek words, ***onco***, meaning hook or barb, and ***rhyno***, nose. Scientists were probably thinking about the hook-nose that spawning male salmon develop when they came up with this name. Each of our five salmon are known by the same family and genus names, but they have different species names.

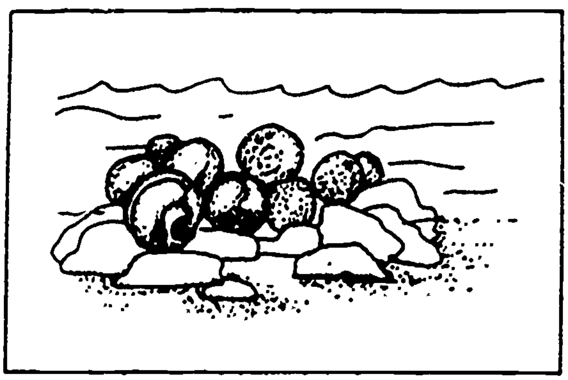
Here are the scientific names for our salmon:

COMMON NAME	GENUS NAME	SPECIES NAME
Pink:	Oncorhynchus	gorbuscha
Chum:	Oncorhynchus	keta
Coho:	Oncorhynchus	kisutch
Sockeye:	Oncorhynchus	nerka
King:	Oncorhynchus	tshawytscha

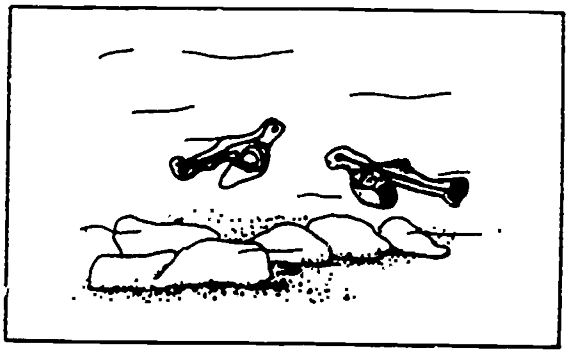
Sometimes the genus name is abbreviated as *O.* Remember that the O. stands for the genus Oncorhynchus, and the names after them are the species names. The scientific names for each of the five species were given during the exploration of Siberia, and reflect Native names for the fish.

What is the life cycle of a salmon?

Salmon hatch from eggs in the gravel of streams and lakes. The pea-sized eggs, a pink or pale orange color, were laid into shallow gravel nests, called **redds**, by female salmon a few months before. The incubation period of a salmon egg depends on the temperature of the water, but most eggs are deposited in their redds in late summer or fall and hatch during winter.



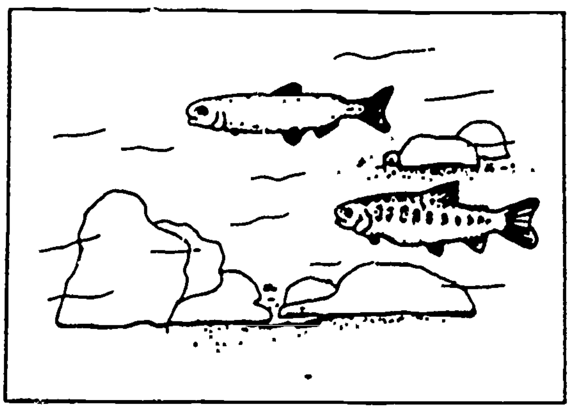
The newly hatched salmon do not emerge from their nests immediately, since the gravel affords them some protection from lurking predators. At this stage of their lives they are called ***alevins*** (pronounced ail'-luh-vins) or ***sac-fry*** because of the large yolk sac that remains attached to their bellies. This yolk sac provides the food and nourishment they need to continue growing and developing. Since they have no need to forage for food, they can stay hidden in their redds, safe from predators.



By spring or early summer, however, the yolk sac has all but disappeared. Hungry little salmon, called ***fry*** at this stage of their lives, wriggle through the gravel and begin their lives as free-swimming fish. The fry begin eating small insects and tiny plants and animals that live in the stream. They are still small themselves, about an inch or so long.

They must be wary of the many hungry predators, like trout and char, which gobble up many salmon fry in fresh water. Those fry that move quickly to salt water are faced with other predators, like the huge-mouthed sculpin or Irish lord. From above, gulls and quick kingfishers also take their toll of young fish. To survive, a fry must be alert, fit, and lucky.

Fry of most species have distinctive black, vertical markings on their sides called ***parr marks***. In fact, some people call these baby salmon ***parr***.



Pink and chum salmon fry move to salt water during their first summer of life. Sockeyes, cohos, and kings, however, spend between one and three additional winters in fresh water before they undergo the changes that allow them to survive in salt water. When this happens, they are known as ***smolts***. Most smolts are three to four inches long. Because of their length, they are sometimes called ***fingerlings***.

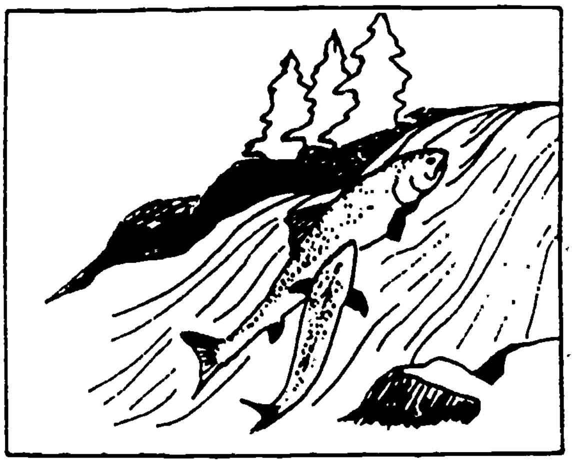
For awhile, they will live at the mouth of their stream or nearby in shallow bays with streams flowing into them. These places where salt and fresh water mix are called ***estuaries***. There is plenty of food in the estuary, and smolts may double or even triple their weight before swimming westward into the Gulf of Alaska or Bering Sea.

When salmon reach the ocean, they begin to eat greedily. They eat small fish, then larger and larger ones. They grow rapidly and become bright and silvery. Biologists believe they swim in regular patterns around the northern Pacific Ocean.

After one to six years of feeding and growing in the ocean, salmon become mature and are ready to ***spawn,*** or reproduce. They begin migrating toward the Alaska coastline and somehow find their way to the very stream in which they were spawned two or more years ago.

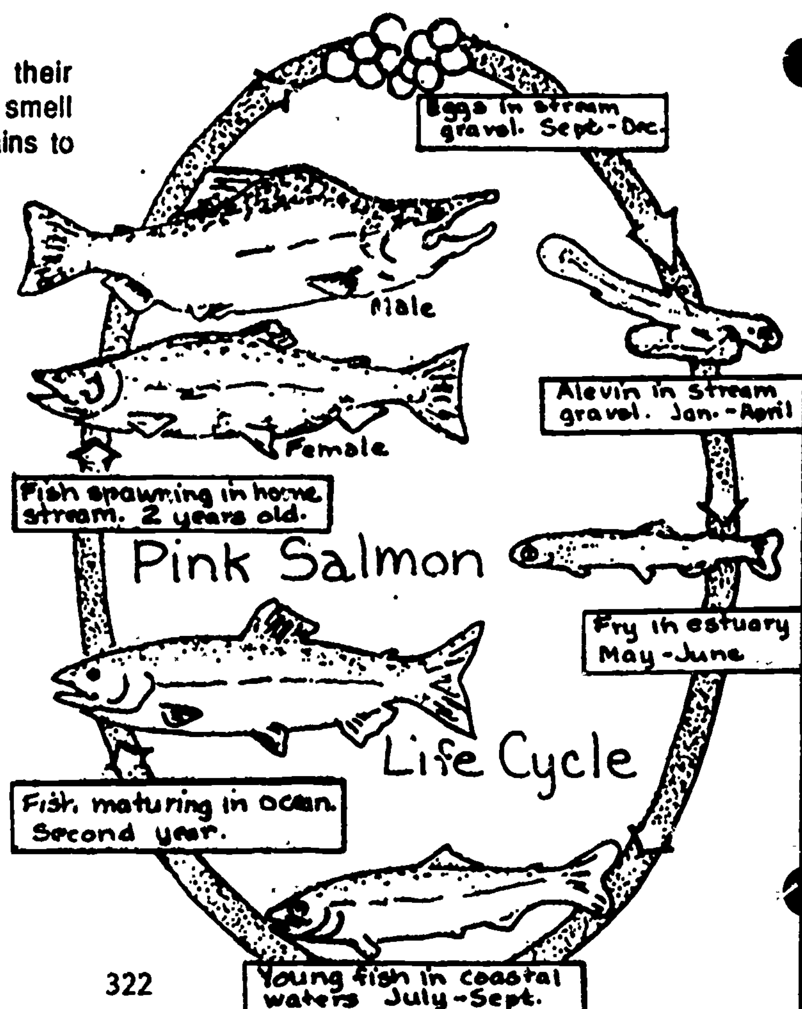
How do spawning salmon change?

Ocean salmon are bright silver. As salmon travel up freshwater streams to spawn, the various species will turn color from silver to shades of copper, brown, red, or green. Generally, both males and females stop feeding when they reach fresh water and live on the fats stored in their bodies.



The shape of spawning salmon changes too, especially the male's. The upper jaw develops a hook that prevents the fish from closing its mouth, and sharp teeth appear in both upper and lower jaws. In some species, a hump develops behind the head. Other spawning males develop large dog-like teeth. The graceful, streamlined saltwater fish becomes a fierce-looking, dramatically colored creature.

Fisheries biologists think salmon find their way to the stream of their birth by the smell of the water, but this question still remains to be completely answered.



The Five Pacific Salmon

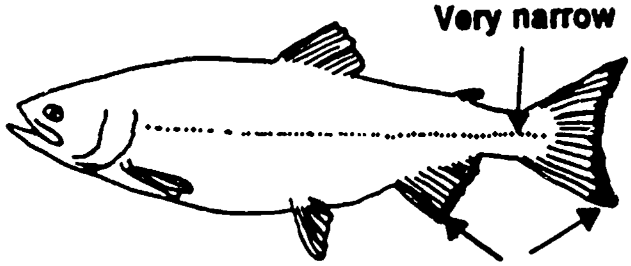
Being able to tell the similarities and differences between the five kinds of Pacific salmon is a very important part of being a commercial fisherman. Because each salmon type requires different gear types, different fishing vessels, and different methods of fishing, knowing your quarry is essential for becoming a successful fisherman.

Chum Salmon

O. keta
Range: Southeastern to the Arctic Ocean
Fishing methods: Gillnet
Seine
Quantity of annual Alaska salmon harvest:
7.0% by fish
12.3% by weight

Chum salmon are the most widely distributed of the Pacific salmon. In arctic and northwestern Alaska, they are a traditional source of dried fish for winter use. They are also known as ***dog*** and ***calico*** salmon.

Chums are about the same size as sockeye and coho salmon, ranging from 7 to 18 pounds and 25 to 27 inches in length. In their ocean coloration, these three species look much alike, except that chums' eyes and scales are larger, and the inside of their gill covering is white instead of black. In the ocean, chums are metallic greenish-blue on top with medium-size black speckles.



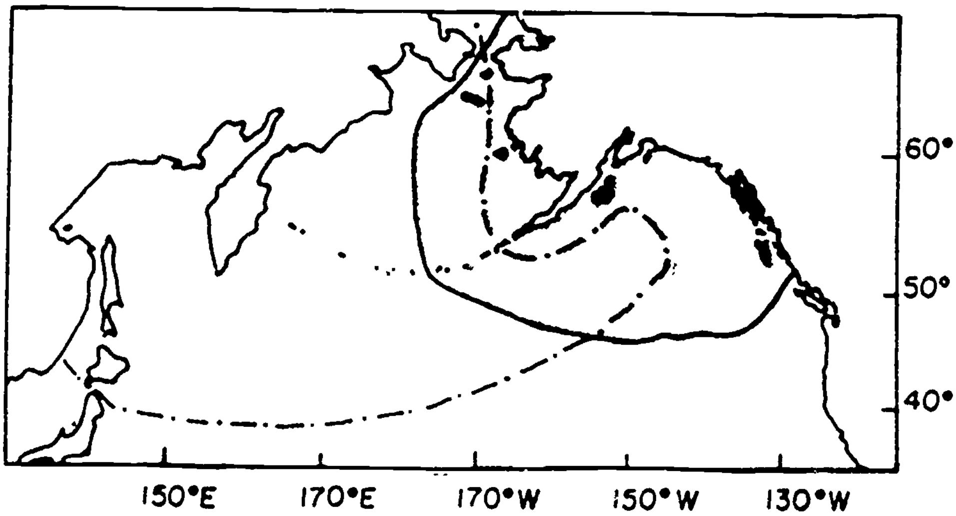
Chum or Dog

As they approach their spawning streams, however, they change color. Chums develop distinctive vertical bars of green and purple ranging from dark in the males to pale in females. This coloration is the reason chums are often called ***calico*** salmon.

The males develop a hooked snout and very large teeth. This may account for chums' other nickname, ***dog*** salmon, although some people believe the name originated because Alaskans fed chum salmon to their sled dogs.

Chums do not remain in fresh water after emerging from their nests. Chums migrate to salt water almost immediately, where they spend two to five years before returning to spawn and die.

Chum



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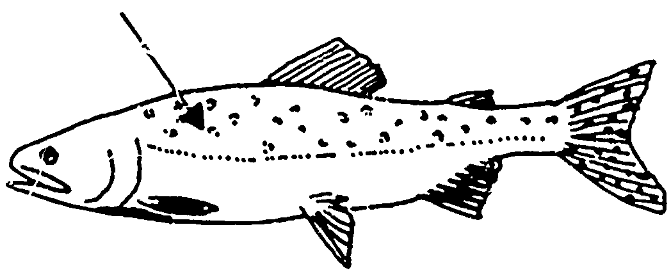
In the commercial fishery, most chums are caught with purse seines and drift gill nets, but fishwheels and set gill nets harvest a portion of the catch. Chums are also caught occasionally while trolling. Fishermen usually concentrate on chums as they school before entering the streams where they were hatched.

Pink Salmon

O. gorbuscha Range: Southeastern to the Arctic Ocean Fishing methods: Gillnet Seine Troll Quantity of annual Alaska salmon harvest: 61.6% by fish 45.5% by weight

Pink salmon are the smallest and most abundant of the five species of Pacific salmon found in North America. They also have the shortest lifespan. Pinks are often calld ***humpbacks*** or ***humpies*** because of the large hump that develops on the backs of adult males before spawning. Pinks are called the "bread and butter" fish in many Alaskan coastal fishing communities because of their importance to commercial fisheries and thus to local economies.

Pink salmon have an average weight of 3.5 to 4 pounds and a length of 20 to 25 inches. Adult pinks in the ocean are bright steely blue on top and silvery on the sides. They have large black spots on their backs and their tail fins, and their flesh is pink.



Pink or Humpback

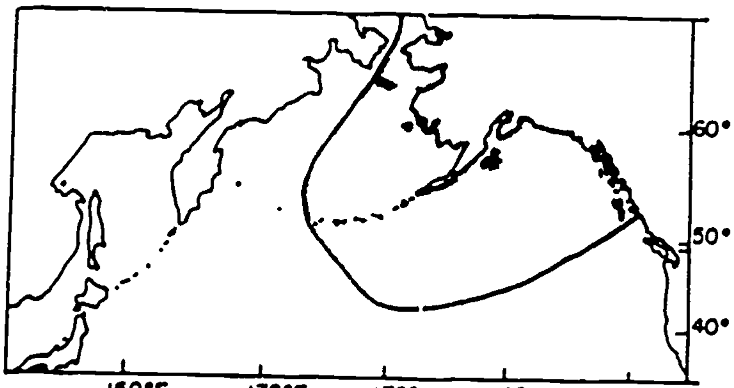
As the fish approach their spawning stream, the brightness of the males is replaced by brown/black above and a white belly. Females become olive green with dusky bars of patches above and a light colored belly. By the time males enter the spawning stream, they develop their characteristic hump and hooked jaws.

Most pinks spawn within a few miles of the coast, and some even spawn in intertidal areas at the mouth of streams. Adults enter spawning streams between late June and mid-October. Different runs of pink salmon with different spawning times often occur in adjacent streams, and sometimes within the same stream.

Juvenile pinks are entirely silver, without the dark, vertical bars, called parr marks, found on other salmon species. They migrate to salt water almost as soon as they emerge from their gravel nests, much like chum salmon.

Pinks almost always mature in two years, which means that odd-year and even-year populations are essentially unrelated. When odd-year pinks are spawning, all the even-year pinks are at sea.

Pink

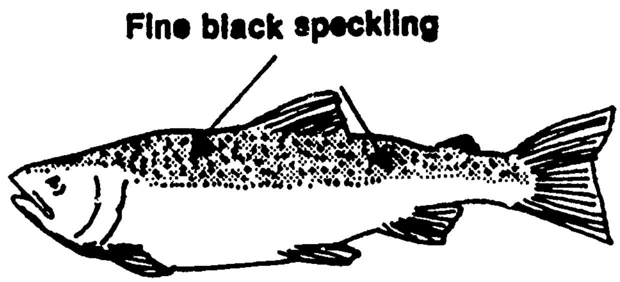


Years ago, fixed and floating fish traps were used to catch pink salmon, but these traps were prohibited after 1959. Now, most pinks are taken with purse seines and drift or set gill nets. Some pinks are occasionally taken by trollers, but their low price makes trollers avoid them, if possible. Since there are so many of them, seiners and gillnetters can make good money by catching them in good quantity.

Sockeye Salmon

O. nerka
Range: Southeastern to Nome
Fishing methods: Gillnet
Seine
Quantity of the annual Alaska salmon harvest:
27.0% by fish
34.2% by weight

Sockeye salmon are abundant and probably the most valuable salmon to the commercial market. In their spawning colors, sockeyes are the most brilliantly colorful of all salmon. They are commonly called *red* salmon in Alaska and ***bluebacks*** in parts of the Lower 48.

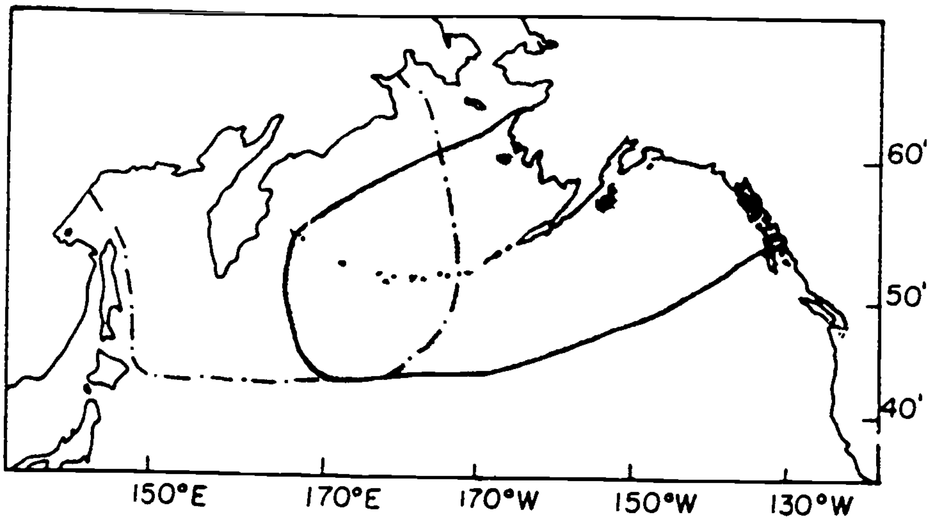


Red or Sockeye

Although sockeyes can exceed 15 pounds, most are closer to 6 pounds with a length of about 25 inches. In the ocean, sockeyes have a deep green/blue back, silver sides, and white bellies. In fresh water, however, their backs become flame red and their sides a darker red. Their heads become olive green from the gills forward. Males develop humped backs and a hooked upper jaw.

Young sockeyes are recognized by their dark, mottled green back, which blends to an iridescent green and silver on the sides. They have six to ten dark, oval parr marks.

Unlike most other salmon, sockeyes spend a portion of their lives in lakes. Sockeye fry migrate to lakes shortly after they wriggle out of their redds and spend the next one or two years there. Then, they migrate to salt water and spend two to four years eating and growing before returning to their home streams and lakes to reproduce.



Red

Sockeyes are sought by sport fishermen as well as commercial fishermen. At the Russian River on the Kenai Peninsula. Alaska has the world's only system where sockeyes will strike a fly. This fishery is very popular. Sockeyes are also important as a subsistence fish, and are caught by beach seining.

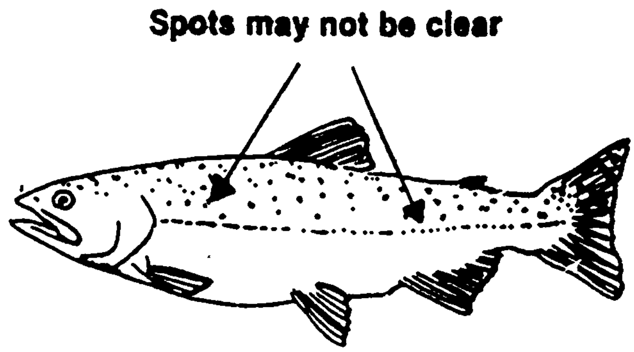
Commercial fishing for sockeyes is done by drift gill net, purse seine, and set gill net. Alaska's Bristol Bay is the largest sockeye-producing area in the world. Many other sockeye runs were greatly reduced by early over-fishing and have yet to recover. Biologists find it hard to raise sockeyes in hatcheries because they are easily infected by a fish disease called IHN.

Coho Salmon

O. kisutch
Range: Southeastern to Nome
Fishing methods: Gillnet
Seine
Troll
Quantity of annual Alaska salmon harvest:
3.9% by fish
6.1% by weight

The second largest species of salmon, cohos are known for their aggressiveness and their ability to live in various rearing environments. Cohos are also known as ***silver*** salmon. They average about 10 pounds and 29 inches, although they can grow over 35 pounds and 35 inches.

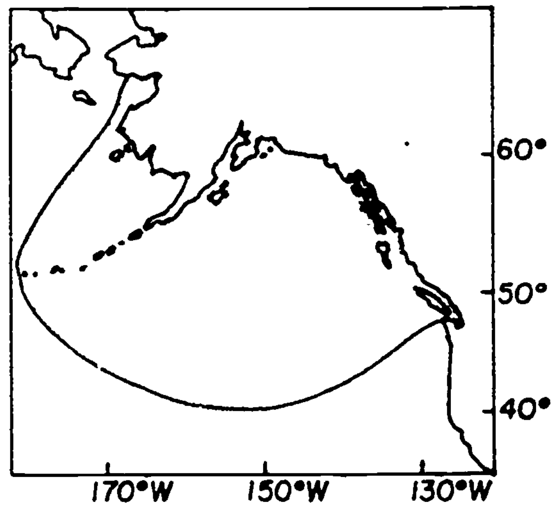
In the ocean, cohos are bright silver with a metallic blue cast to their back. Small spots decorate their backs and top half of the tail. Silvers are often confused with king salmon, but can be identified by the lighter shading to their gums. As spawning approaches, silvers turn reddish with the females often darker than the males. Males and females may show a pronounced hooked nose.



Silver or Coho

Cohos enter spawning streams from August through November. Adults school in pools, ponds, or lakes until ripe, then move into shallow tributaries with clean gravel riffles to spawn.

Young cohos have parr marks evenly distributed above and below the lateral line. They quickly establish individual territories in their stream and defend them against other fry by nipping and other aggressive displays. Cohos will spend up to three winters in fresh water before migrating to salt water. They usually spend another year in the ocean before spawning.



Coho

Some anglers seek cohos in streams, but cohos are the major marine sport fish in Alaska and a mainstay of the commercial trolling fleet. They are also caught by commercial seiners and gill netters.

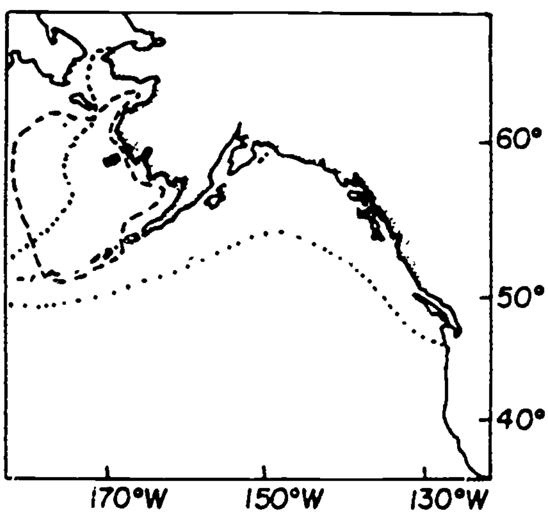
King Salmon

o. tshawytscha
Range: Southeastern to Nome
Fishing methods: Gillnet
Troll
Seine
Quantity of annual Alaska salmon harvest:
0.5% by fish
2.1% by weight

The largest and least abundant of the Pacific salmon, the king salmon is also Alaska's state fish. King salmon are also known as ***chinook*** and ***tyee*** salmon. Kings commonly weigh more than 30 pounds.

In the ocean, kings have silvery skin and scales. They are dark greenish to blue-black on top of the head and back. Many small, black spots are on the back and upper sides and on the upper and lower halves of the silvery tail. Kings look a lot like cohos, but their teeth emerge from black gums. For this reason, kings are sometimes called ***blackmouths.***

Kings spend from two to six years feeding in the ocean, and consequently, the sizes of spawning kings vary considerably.



King

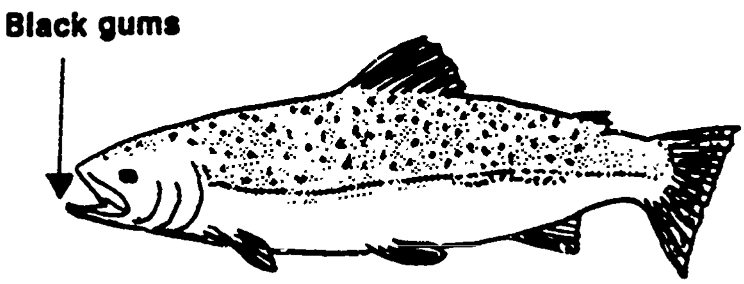
Kings spawn in rivers. Some of them travel more than 2.000 miles upstream to find their spawning grounds. Colors of spawning kings range from red to copper to black. Males are more deeply colored than females. Males also develop ridged backs and hooked noses.

Juveniles in fresh water are recognized by their well-developed parr marks, on either side of the lateral line. Young kings stay in fresh water until the following spring, when they begin moving to the ocean.

The king salmon is the most highly prized fish in Alaska. Anglers eagerly seek kings in salt and fresh water. Kings are also taken by Eskimo and Indian subsistence fishermen. Kings are harvested commercially in Southeast, Bristol Bay and the Arctic-Yukon-Kuskokwim regions of the state.

Alaska Department of Fish and Game regulates the fishery so that most are taken with troll gear, and a smaller number are taken with gillnet gear. King salmon are the premium fish of the trollers, and bring the most money per pound of any of the five species of salmon. Trollers not only take kings in the summer seasons, when they are most numerous, but in the winter they troll for the feeder kings that feed deep in the waters of the ocean.

There are two races within the king species, and each has a different color of flesh. Red kings are the most desirable in the commercial market, and bring premium prices. White kings have whitish flesh, and bring a smaller price, although the quality and flavor is just as good, and actually preferred by some.



King or Chinook

All About Halibut

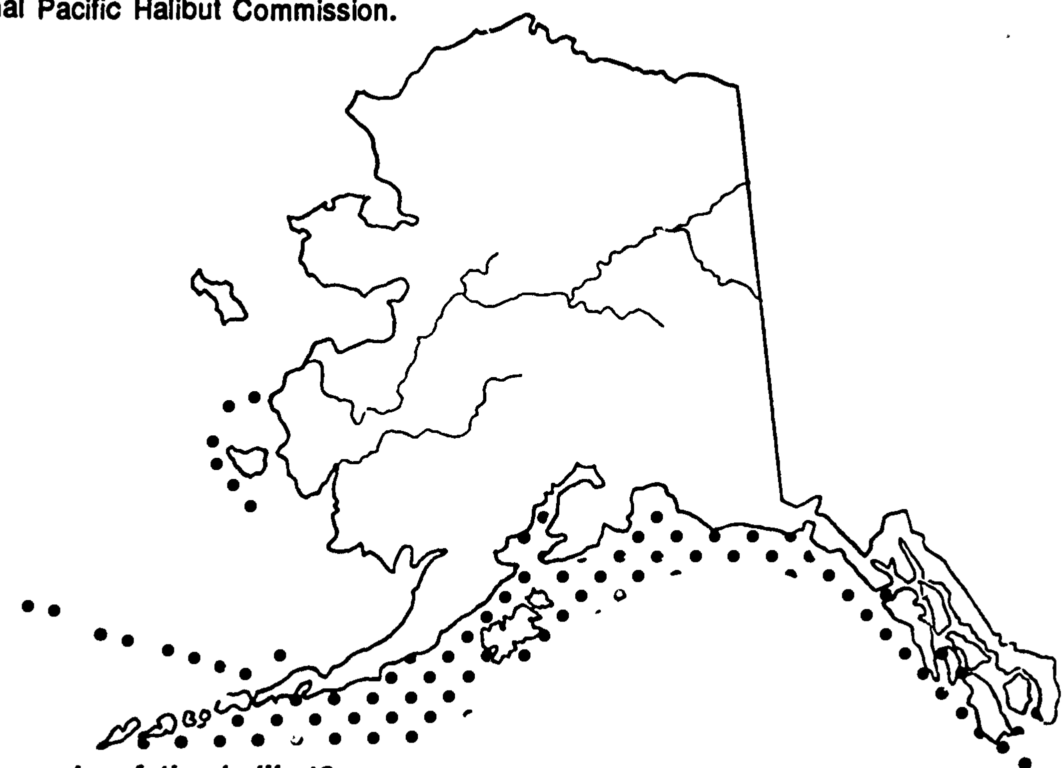
What is a halibut?

The Pacific halibut (Hippoglossus stenolepis) is a bottom-dwelling flatfish. It is more elongated than most flatfishes, being about three times as long as it is wide. After the larval stage, halibut have both eyes on their dark or upper side. Like other flatfishes, halibut can change the color of their skin to adapt to their surroundings. This is called ***protective coloration.*** The underside of a halibut is white. To predators from below, this causes them to resemble the sky above. To a predator swimming above the halibut, their mottled skin color mimics the sea floor, making them hard to see.

Halibut have small scales embedded in the skin. They are the largest of all flatfish. The largest ever recorded for the northern Pacific was a 495-pound fish caught near Petersburg.

Where can you find halibut?

The halibut is a Pacific Ocean fish that appears from the southeast panhandle of Alaska through the Bering Sea. Halibut fishing takes place all along the Pacific Coast, and is regulated in part by the International Pacific Halibut Commission.

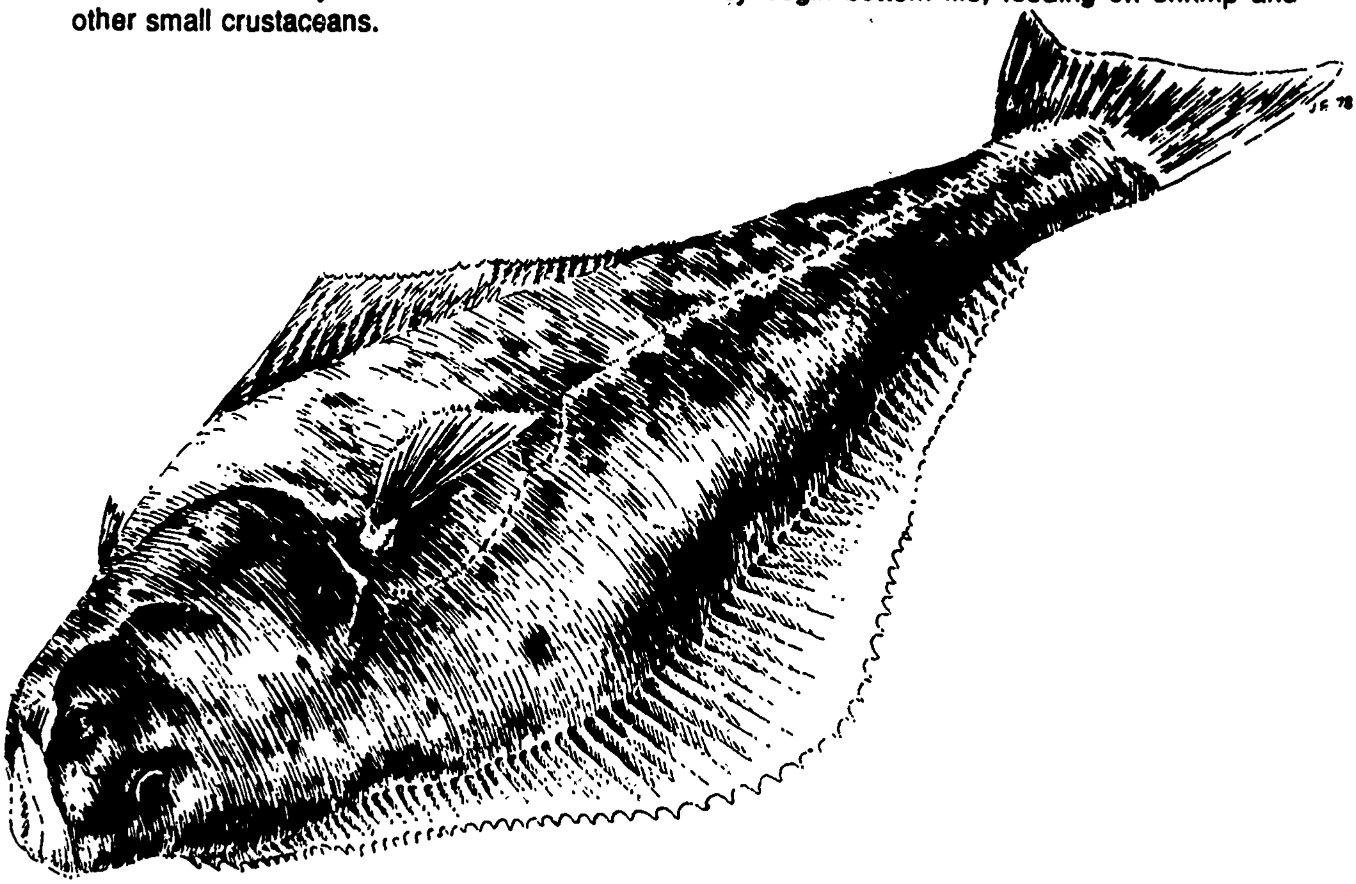


What is the life cycle of the halibut?

Unlike salmon, halibut can spawn more than once in their lifetime. They live entirely in salt water, and do not spawn in streams, rivers, or lakes. Halibut usually return to the edge of the continental shelf to spawn. Spawning takes place from November to March. Males are sexually mature at seven or eight years of age while females mature between the ages of eight and twelve. Their growth rate varies depending on locations and habitat conditions.

Each adult female lays two to three million eggs annually, depending on her size. The fertilized eggs hatch after fifteen days. They become part of the ***plankton*** of the sea, the free floating larvae and microscopic animals on which many other larger animals depend for food. Because the eggs and larva are free-floating, they may travel hundreds of miles.

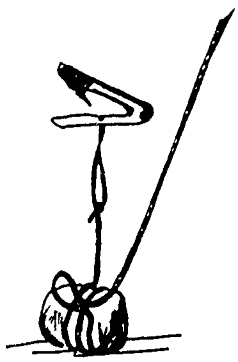
During this free-floating stage, many changes take place. The most noticeable is the migration of the left eye to the right side of the fish. This prepares the halibut for a life on the sea floor bottom. During this development time the juvenile halibut rise to the surface and are carried to shallower waters by the ocean currents. Then they begin bottom life, feeding on shrimp and other small crustaceans.



Juvenile halibut will stay on the inshore grounds from one to three years. Then they move offshore, where they live and feed during times when they are not spawning. Halibut can live a long time. The oldest recorded female was 42 years old and the oldest male was 27 years of age. (How old were the halibut that ***weren't*** caught?)

Halibut are very strong swimmers, so they can catch and eat many varieties of fish, including cod, turbot, and pollock. They also eat crab and shrimp. They sometimes leave the ocean bottom to feed on fish that live in the upper layers of the ocean, like herring. Commercial fishermen often use frozen herring, octopus, or other fresh fish for bait.

Halibut, like salmon, have provided subsistence for Pacific Coast Native groups. There is much folklore surrounding the halibut. Each halibut hook was carved with special designs to bring good luck and large fish. The halibut were next to salmon in importance in the Native economy.



Commercial fishing for halibut began in 1888 in Washington state by three sailing ships from New England that fished off the coast. The transcontinental railroad had been recently completed, and there was a way to get halibut to the large East Coast markets. Soon, company-owned steamers carrying several smaller fishing dories took over the halibut fishing.

Today, most commercial halibut fishing off Alaska and Canada is done in owner-operated vessels. The method of fishing for halibut is called ***longlining***. Longlining generally consists of gear called ***skates***. They are long groundlines to which baited ***ganglons***, or leaders are attached. The longlines are set, then checked some time later for the halibut that have been caught on them.

Who controls the halibut fishery?

Since halibut occur over such a wide area of the west coast, the International Pacific Halibut Commission has been designated by the United States and Canada to oversee the West Coast halibut fishery. Members of this commission meet yearly to review research, check the progress of the commercial fishery and make regulations for the next fishing season. The management of commercial halibut fishing is intended to allow a maximum sustained yield of halibut.

The commission sets catch limits by area and establishes season opening and closing dates. Vessels over 5 net tons, with the exception of trollers, must be licensed by the IPHC. In addition, all vessels that fish for halibut in Alaska require a Commercial Vessel License granted by the Alaska Commercial Fisheries Entry Commission, and skippers need an Interim Use Permit for fishery and gear. Commercially caught halibut must be over 32 inches in length. Halibut caught in trawl nets or pots are not legal, and must be released.

Bottom Fish are Booming

What are bottom fish?

Bottom fish used to be known as scrapfish by commercial fishermen. Now that major markets are developing for this group of fish, it is important to know something about them. They include blackcod, Alaska pollock, Pacific cod, rockfish, and various flounders, soles, perches and other cods. Sometimes this group of fish is also called groundfish, because they often live and feed near the bottom of the sea.

All of these fish have white meat, and can be eaten fresh or frozen, or processed in a variety of ways. They are even used as the basis of surimi, a fish paste that can be made into products that resemble crab legs, scallops, and other fish products.

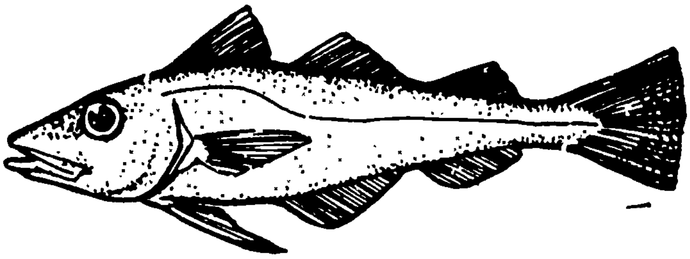
Blackcod are also known as sablefish, and are related to rock fish and ling cod. They have two instead of three dorsal fins, and their gill cover has a black lining. Blackcod have no barbel, (like a tiny beard) under their chin. They are caught by longline in Alaska, and by nets in most other places. Some blackcod are caught by pots in Southeast Alaska and trawlers in the Gulf of Alaska and Bering Sea.

Blackcod spawn in January and February, and their eggs float with the tides until they hatch. They live in deep water, and can reach a length of three feet, but the ones you catch in salmon waters will only be 10 to 20 inches long. These cod travel together in schools, and often migrate 2,000 or more miles in a period of years. They are used fresh or frozen, and are often lightly smoked.

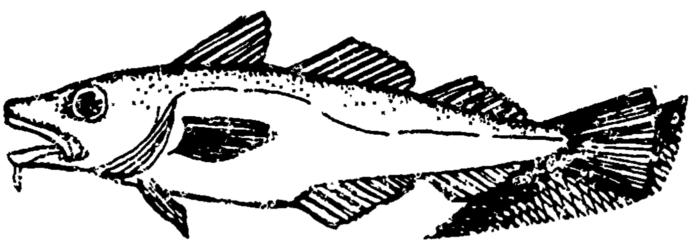
Alaska Pollock is a member of the cod family, and is also known as walleye pollock, whiting, big-eye cod or Alaska snow cod. Growing to a length of three feet, the pollock is a small-scaled fish with large eyes and a lower jaw that projects beyond the upper jaw. It is olive-green to brown on the back with silvery sides, a white belly and dusky black fins. It has only a tiny barbel, or none at all. The anus is located below the space between the first and second dorsal, or top fins.

Satellite photos have picked out huge schools of pollock four miles wide and 20 miles long. The fish mature and are ready to spawn when they are three or four years old, and may live to the age of 12 to 14 years, if they aren't caught by Gulf of Alaska fishermen! Scientists have found that the nursery area for Bering Sea pollock lies far from shore at a depth of 30 to 100 feet. In this area, tiny new fish are below the wind-churned surface with its cold water and above the saltier waters below. They are within reach of the phytoplankton which grow in fantastic numbers, and they grow rapidly on this plentiful diet. In fact, unlike the rest of the codfich family, they never change their diet, but continue to feed on the small plankton of the open ocean.

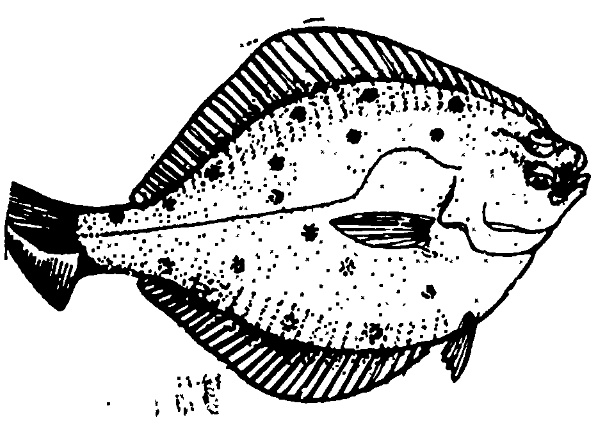
They are harvested in abundance from the Bering Sea and the Gulf of Alaska. This is the only species which is processed in commercial volume for the production of frozen surimi. There are other important codfishes in this family, like hake and tomcod.



Pacific cod is one of the most abundant whitefish species in the Bering Sea. This cod and its relative, the grey cod, is a very abundant and fast-growing fish that can live in depths of up to 300 fathoms. The Pacific cod is brown or grey with a long barbel. The anus is located below the second dorsal fin. This cod spawns in winter and its eggs sink. Females are mature in two to three years, and may produce as many as 3 million eggs. Cod follow a regular pattern of moving to deeper water in winter and to shallower water in the spring.



Yellowfin sole is a very numerous member of the sole family, which also includes Petrale sole, English sole, Dover sole, rock sole, turbot, and starry flounder. These fish are all members of the righteye flounder family. They are flat fish, like halibut, but not usually so large. All are slow growing and live from 10 to 25 years. Their skulls are not evenly shaped, and they have both eyes on the same side of their head. Their blind side is pale, and they often have the ability to change the color of their skin on the side which contains the eyes.



Alaska rockfish, genus Sebastes, is a family of fish with many names, colors, and varieties. You have probably heard of rock cod, red snapper, and sea bass. These are a few of over 40 species present in our waters. Only about 15 of these spacies are caught for the commercial market. Rockfish live in the deep rocky areas of the sea, often aroung the reefs. Most fish commercially caught in Alaska come from the Gulf of Alaska. These fish, in contrast to cod, are slow maturing and can live as long as 50 years. There is concern by some scientists that the supply will never meet the demand for rockfish, and since they grow so slowly, the population may decline rapidly as more Alaskans fish commercially for them.

Wh' Is bottom fishing a booming industry?

One of the last great fisheries in the world is Alaska's bottomfish resource. Since the 200 mile limit Fishery Conservation and Management Act was passed in 1976, American fishermen have been gearing up to take advantage of this resource that was formerly exploited by foreign fishermen.

The bottomfish industry is catching hold quickly, now that the market for whitefish is being expanded, both in the United States and also in Pacific Rim countries. Most bottom fish caught in the Gulf of Alaska by Alaskan or foreign fishermen end up on dinner tables or in processing plants in other countries. Often the fish is shipped back to the U.S. in frozen blocks which are bought by fast-food restaurants such as McDonald's, Burger King, and Skipper's for fish dinners and fish sandwiches. Much of the fish is also sold in grocery stores for packaged, frozen fish sticks.

In addition, new local markets for fresh bottom fish are opening up. Many fishermen long-line in the winter for bottom fish, and get a very good price for the fresh fish. Often the markets are supermarkets or restaurants within an easy flying radius, and the fishermen fly their fish directly to the market. That's fresh fish!

The biggest potential for Alaska fishermen lies in the Gulf of Alaska groundfish harvest. Most fishing is done by trawlers, and crewmembers often work 12 weeks on and three weeks off, mending, trawling, and hauling in the nets without stopping. Although the work is long and hard, lasting 24 hours a day for the entire year, there is much profit to be made.

In 1986, 136,000 metric tons of bottom fish worth $55.2 million were caught in the area by American fishermen. Three times that many fish were caught in joint venture operations, where Americans fish for the foreign fish processing ships. Since the 1987 season will be the first year that no foreign fishing will be allowed in the Gulf of Alaska, this leaves lots of room for Alaskan fishermen. Foreign fishermen caught 475,000 metric tons of bottom fish in the gulf during 1986. Since they will no longer be allowed to fish there, this amount of fish can now be caught by Alaskan or American boats.

Crabby Crustaceans

What kind of creatures are crabs?

Crabs are members of the phylum Arthropoda, which means ***joint-legged.*** This is a good description of these marine animals, because their joints are readily visible on the outside of their legs. The animals in this phylum (unlike us) have ***exoskeletons*** (outside skeletons), and their muscles and body tissues are inside these skeletons. We call this exoskeleton the shell. The crab's head, neck, and chest are made of one piece, called a ***cephalothorax***. On this piece are two eyes on stalks, which allows the crab to see in all directions.

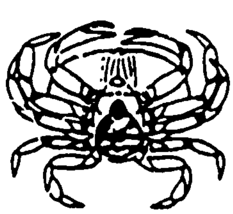
Using their eight legs, crabs can walk in any direction. In addition to their numerous legs, they also have two ***pincers,*** which they use to tear their food into smaller pieces (and to pinch you if they can!). As you know, these pincers also protect them from their enemies. They are so powerful they can even break a person's finger. Crabs will sometimes fight among themselves, and if a leg of pincer breaks off a new one will grow back.

Crabs are primarily ***scavengers***, and sometimes ***predators***. They eat old and dying marine life, but when they can catch them, they also eat fresh clams, worms, small fish and other small marine life.

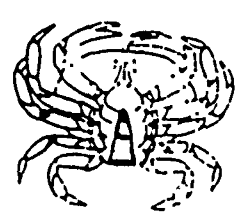
Since they have an exo (outside) skeleton, they must ***molt***, or shed their shell in order to grow. They usually molt once or twice a year. The new shell grows under the old one. Then the crab splits its seams, and backs away from its old shell. While the new shell is soft and flexible, the crab pumps water into the shell to inflate it to the proper size. While the shell is hardening, the crab will often bury itself in the sand.

How can you tell male from female crabs?

Female and male crabs may be easily distinguished by looking at the shape of the abdomen, a shell flap on the underside of the body. The female has a wide apron (abdomen), while the male has a narrower, triangular-shaped apron. The ability to sex crabs quickly and accurately is important to commercial fishermen, since crabbing regulations most often specify that only males may be harvested.



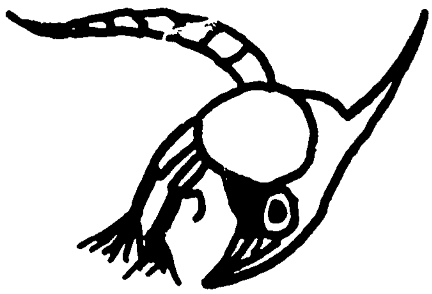
A FEMALE CRAB



A MALE CRAB

What is the life cycle of a crab?

Crabs undergo a complicated life cycle, which often starts with the migration of adults to shallower water in spring or summer. To mate, the male grasps a female that has recently molted and is in the softshell condition. The female crab carries her eggs in a brood pouch on the abdominal flap. This mass, which in some species includes about two million eggs, incubates for up to a year. The eggs hatch into crab larvae, which become part of the freely drifting minute plants and animals called ***plankton.*** These larvae look nothing like a crab, but resemble tiny mosquito larvae. Many of these larva are eaten by fish and other marine life.



After varying periods of time, the free-swimming larva lose their ability to swim, and settle on the bottom. After numerous molts and several years to grow, the crabs become mature. Some adult crabs can live to be 20 years old.

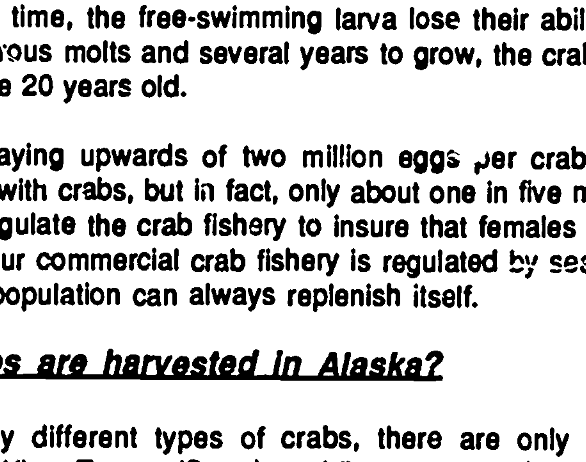
One would think that laying upwards of two million eggs per crab for several years would overpopulate the ocean with crabs, but in fact, only about one in five million eggs grow up. That makes it important to regulate the crab fishery to insure that females are given a chance to lay their eggs. In Alaska, our commercial crab fishery is regulated by season, by size, and by sex, to insure that the crab population can always replenish itself.

What kinds of crabs are harvested in Alaska?

While Alaska has many different types of crabs, there are only three species which are commercially harvested: King, Tanner (Snow), and Dungeness crabs.

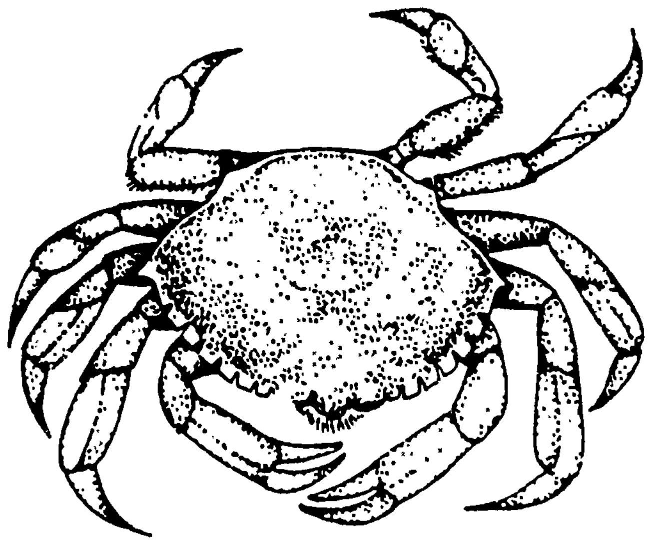
Dungeness Crab

The Dungeness Crab, (*Cancer magister*) named for a small fishing village in Washington state, can be found on the open ocean coase and inside salt waters from Mexico to as far north as Prince William Sound and Cook Inlet.



Range of Dungeness Crab

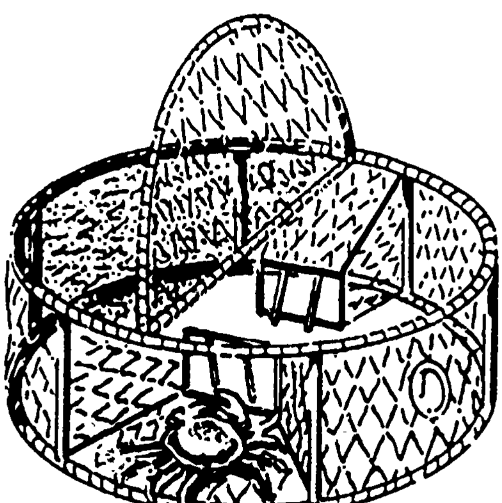
The dungeness crab can be distinguished from king and tanner crab because its legs are smaller and shorter compared to its body size.Dungeness crabs can grow as large as 10 inches, although commercial harvest is limited to hardshell male crabs over 6 1/2 inches in shell width.



Dungeness females can carry up to 2.5 million eggs, which hatch into small larva that take about four months and seven larval molts to develop into a crab-like creature. Crabs are sexually mature at three years, and can be over 6 1/2 inches in shell width and two to three pounds in weight at four years. Dungeness crabs live approximately eight years.

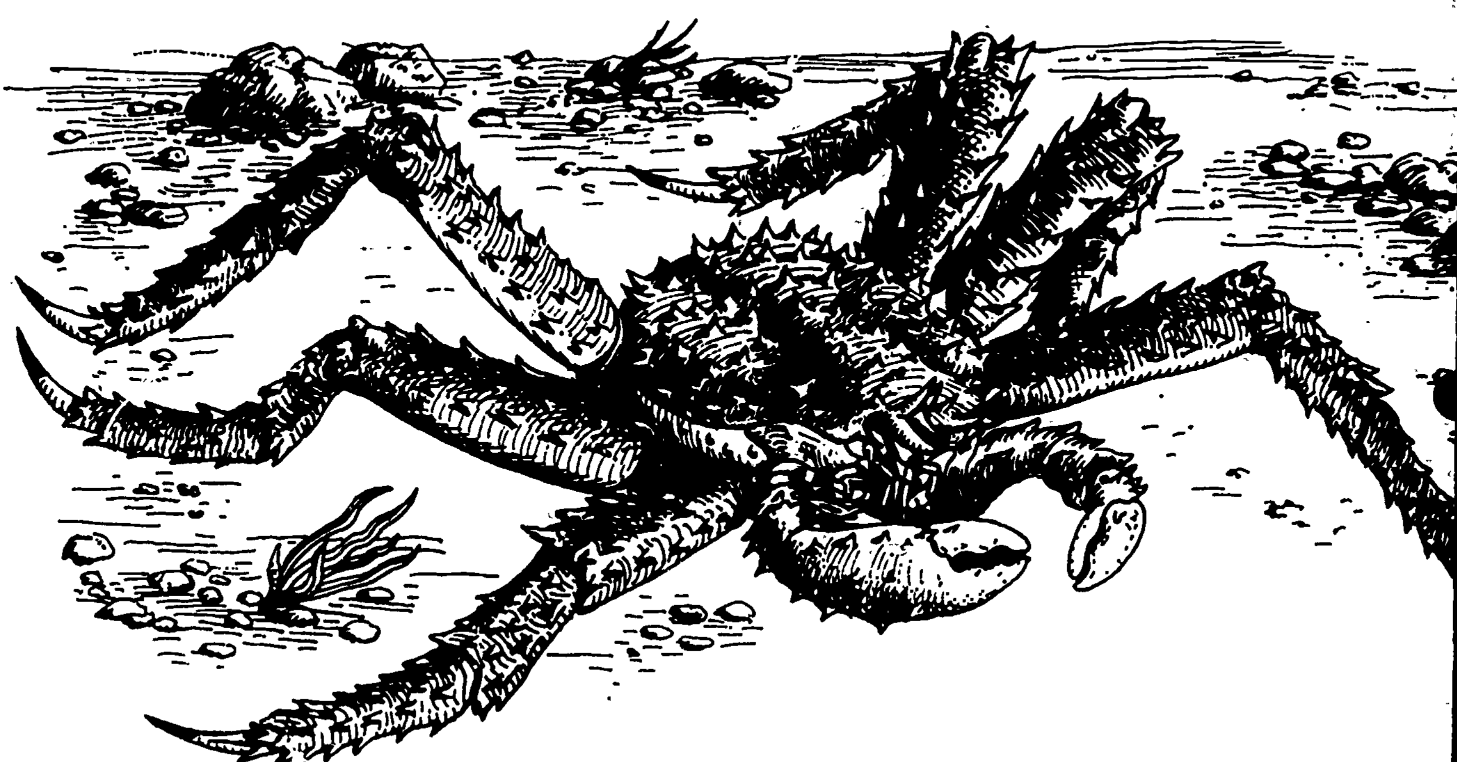
Dungeness crabs prefer a sandy or muddy bottom in salt water, but they can also be found in bays or estuaries where fresh and salt water mix. High concentrations of dungeness can be found in about 10 fathoms of water, but they have been found in depths down to 100 fathoms. Dungeness crabs like to eat, and will eat almost everything that moves or has recently died. They don't seem to like spoiled or putrefied food. They also eat other dungeness crabs!

Commercial fishermen often use halibut and salmon heads, herring and clams for bait. They use a circular wire pot weighing between 50 and 150 pounds. It is about 40 inches in diameter and 14 inches deep. The crabs enter in two tunnels which contain devices to prevent them from escaping.



King Crab

If you were a commercial crab fisherman, and wanted to make the most money, you would probably fish for king crabs. They are the largest and most desirable and marketable of the three kinds of crabs fished commercially. King crabs (*Paralithodes camtschatica*) are not true crabs like the Dungeness crab, but are more closely related to the hermit crab, although much more sophisticated. There are three sub-species which are identified by their color: red, blue and brown king crab. Each sub-species has separate commercial regulations.

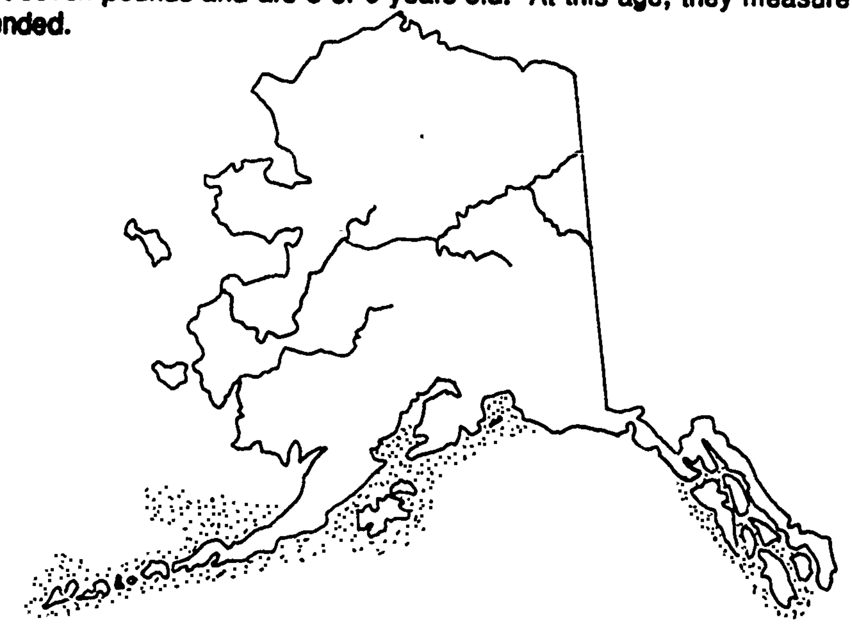


Fleshy abdomens of king crabs are compressed under their bodies and are covered by a series of protective plates. The abdomen of the female is fan -shaped and is used to carry the fertilized eggs until they hatch. The legs and carapace of king crabs are spiny to protect them from fish predators, and they fold behind the body instead of being jointed to fold forward like true crabs.

Female king crabs carry many fewer eggs than do dungeness crabs - only about 240,000. The larva that hatch settle to the bottom after their fourth molt, and no longer can swim. To protect themselves, immature crabs often form pods, which are piles of up to several thousand crabs. This is a defensive behavior, to protect them from their enemies.

Unlike other commercial crab species, king crabs migrate each year. In late winter they move from the outer continental shelf to water depths of less than 40 fathoms, where females molt and are mated. After mating, they move to deeper water to feed for the rest of the year.

King crabs are mature at 4 and 5 years of age. Their shells measure about four inches in length and width. They may grow as large as 24 pounds in 15 years, but commercially caught males average about seven pounds and are 8 or 9 years old. At this age, they measure about three feet with lags extended.

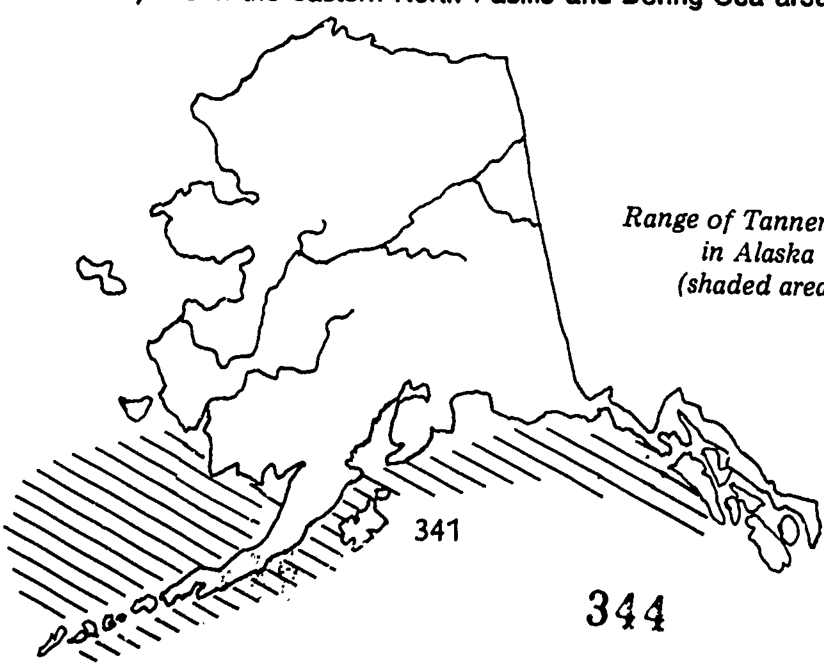


King crabs live in the eastern Bering Sea and along the entire Pacific coast of Alaska including the Aleutian Islands. Kodiak Island has been billed as the "King Crab Capital of the World", and it was here that the initial commercial fishery began. Other important areas fished commercially are lower Cook Inlet, Unimak Pass area, Adak and Atka islands and the eastern Bering Sea north of the Alaska Peninsula. Limited numbers of king crabs are caught commercially in Southeast Alaska and the Shumagin Islands.

Since king crabs are much larger than dungeness crabs, the pots used to catch them are also bigger. They weigh 500 to 700 pounds each, and are six or seven feet square and three feet high. The usual bait is chopped herring.

Tanner Crab

Although some feel that tanner crabs greatly resemble king crabs, they are true crabs. Tanner crabs (Chionoecetes bairdi) live in the eastern North Pacific and Bering Sea areas.



Range of Tanner Crab in Alaska (shaded area)

Tanner crabs are also known by the names snow, spider, and queen crab, but are usually marketed as snow crab. Females mature at five years, and males mature at six years. Tanners may live to an estimated maximum age of 14 years. Males of commercial size usually range from 7 to 11 years of age and vary in weight from two to four pounds. Tanner fishermen use pots similar to king crab pots.

The favorite food of tanner crabs is mollusks (clams and their relatives) and other crustaceans that are either dead or dying. They themselves are eaten by free-swimming and bottom fish and man. Although their migration patterns are not very well understood, the sexes do separate for much of the year, moving in to the same area during reproductive season.

Other Species

What are some other ocean species that are harvested commercially?

Most Alaskans know that the largest fisheries in the state are the salmon, bottomfish, halibut, and crab fisheries. As markets develop, however, there are other important animals and plants that can be fished commercially. Some of them are abalone, clams, various kinds of seaweeds, shrimp, goeduck, herring, herring roe, and bait fisheries.

How are fishing and farming different?

New fishing techniques and equipment are constantly being developed and used, not only on fishing vessels, but with the quarry themselves. Salmon hatcheries have become very important in supplying more fish for the commercial fishermen. In fact, the commercial salmon fishermen are part of the aquaculture associations that run many of the hatcheries, and the 3% salmon enhancement tax fishermen pay when selling salmon goes directly to the support of these hatcheries.

Hatcheries enhance the numbers of commercial fishing stocks by ensuring that more of the salmon eggs hatch and grow to adulthood. Hatchery fish still migrate to the Pacific Ocean pastures, and return to the stream of their origin, just like wild fish. Commercial fishermen have more fish to catch, and the extra fish that don't get caught and return to the hatcheries can be harvested in other ways.

Now enterprising Alaskans have a new idea of starting fish farms, like those in Norway, British Columbia, and the West Coast of the U.S. Fish farms involve penning the salmon from the time of hatching to adulthood, when they would be harvested. This technique for supplying fish is not commercial fishing. Fishermen are like hunters, catching wild (and now hatchery-bred) fish for profit. Salmon farms are like ranches of the sea.

While salmon farms provide a fresh product year-round, and not just during commercial fishing seasons, the fishermen fear that these farms will cut into their market. Most commercial fishermen are against salmon farms for this reason. At present, there is no licensing or permit system to allow fish farms in Alaska, but this will be an item of much discussion and debate in the near future.

Most of the species mentioned are still being commercially fished, but some other species are being farmed. Oysters can't complete their life cycle in Alaska, because of the frigid waters, but there are oyster farms being operated in Southeast Alaska, and they may become more important as the oyster farming areas of the lower 48 become polluted and less productive. Another factor in the development of these farms is the new techniques being used by airlines to fly fresh marine products to market. This makes the products more desirable to the merchants and the consumers, and increases the demand for them.

What kinds of shellfish are harvested commercially?

Shrimp: One of the most important shellfish to be harvested commercially is shrimp. There are five species of shrimp that are harvested in Alaska:

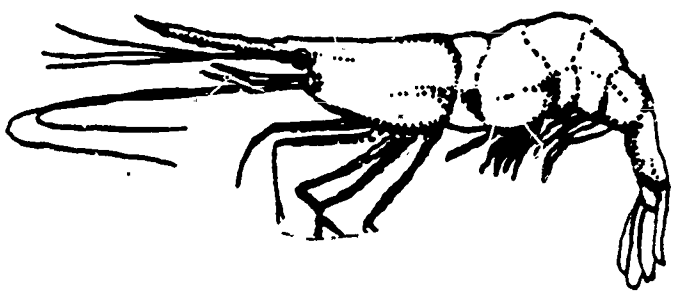
Pink shrimp are the basis for the commercial trawl shrimp fishery in Alaska. More than 80% of the trawl-caught shrimp are pinks. They are found around the globe, but are most concentrated in the Gulf of Alaska. Pinks are uniformly light to reddish pink, and along with humpies, are the smallest of the commercial shrimp. They are usually marketed as cocktail or salad shrimp.

Humpy shrimp are usually harvested along with pink shrimp, but not in as great numbers. They range from Puget Sound to the Arctic coast of Alaska. Humpy shrimp are about the same size, and have the same color as pink shrimp, but also have a series of reddish dots that form faint striped backwards across the body. Their name comes from a pinched area or "hump" halfway down their back.

Sidestripe shrimp are also caught in small numbers along with pink shrimp. They range from the Bering Sea to Oregon, and are medium sized shrimp, slender with long antennules. A light pink in color, sidestripes earn their name because of the presence of irregular white bands running along the length of the abdomen.

Coonstripe shrimp are slightly larger sized shrimp that are fished for with pots. They can be found from the Bering Sea to the Strait of Juan de Fuca, and are usually sold as fresh frozen shrimp. Coonstripes are stocky shrimp with large heads and a series of dark bands on both their legs and body.

The grand-daddy of all shrimp, often called a prawn, is the ***Spot Shrimp.*** This is the largest shrimp in the North Pacific, ranging from Unalaska Island to San Diego. Fishermen use pots to catch these large, stout shrimp that are washed-out light brown to orange in color. Their name comes from the white, paired spots located just behind the head and just in front of the tail.



Shrimp have a very interesting life history. They reach maturity as males at one to two years, then later turn into females, at two to three years of age. This arrangement, while sounding a bit bizarre, ensures them the greatest opportunity to reproduce and carry on their species.

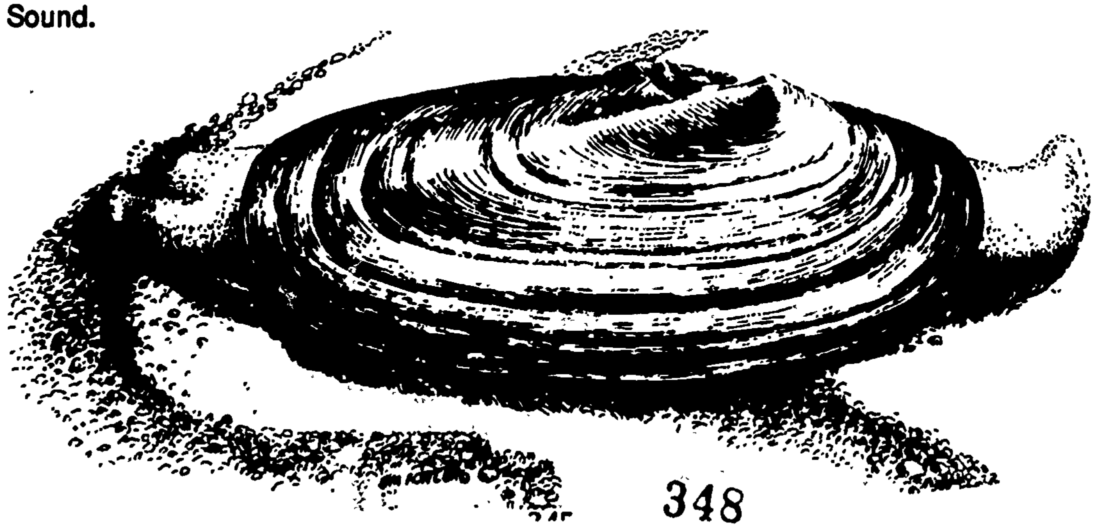
Spawning takes place in late summer or fall, and is somewhat controlled by water temperature. After about six months incubation, the eggs hatch into planktonic, free-swimming larvae in the spring. They molt several times, until by mid-summer they are juvenile shrimp, and settle to the bottom. After spawning, the female carries her eggs on the underside of her abdomen until they hatch. The number of eggs a shrimp lays can range from a few hundred to 4,000, depending on the size of the female.

Shrimp live at different depths and in various habitats. A look at these habitats gives the commercial fisherman clues about where to catch shrimp. Spots and coonstripes can usually be found near rockpiles or on bottoms covered by coral or debris. Pinks, sidestripes and humpies live near muddy bottoms. Pinks occur over the widest depth range (10 to 800 fathoms) while humpies and coonstripes usually inhabit shallower waters of 3 to 100 fathoms. Most spot shrimp are concentrated around 60 fathoms, but can be found anywhere from 2 to 266 fathoms. Sidestripes are usually found in water deeper than 40 fathoms, but can live in 25 to 350 fathoms of water.

Shrimp have an interesting migration pattern. Seasonally, they migrate from deep to shallow waters to spawn. They also migrate from the bottom in the evenings to areas of the water that are closer to the surface, where they spend most of the night. They return to the bottom in the early morning. Shrimp eat almost anything they find on the bottom, like worms, sandfleas, small molluscs, dead organisms, and algae. They are in turn eaten by large predator fish like Pacific cod, pollock, flounders and salmon.

Clams: Alaska has an abundance of clams throughout its 34,000 miles of coastline. Clams have been harvested for centuries by the Alaskan natives, as well as being the main diet for the giant walrus of the Bering Sea. Although there are many kinds of clams, they are also prone to PSP (paralytic shellfish poison), a microorganism that can cause death or severe paralysis to humans eating the clams, although the clam itself is not affected. In recent years, the State Department of Fish and Game has tested beaches in the Cook Inlet and other areas and certified them safe for commercial harvesting of clams. Fishermen use shovels instead of nets to harvest these ocean animals. Commercial razor clam digging operations have been in progress in Alaska since 1916.

The most important clam harvested commercially is the ***razor clam***, a giant, seven-inch shelled bivalve mollusk that frequents surf-swept and somewhat protected sand beaches of the open ocean. Largest concentrations in Alaska are found in the Cook Inlet areas, and in Prince William Sound.



There are two distinct species of razor clams which are harvested, one living higher on the beach than the other, and having slightly different coloration. Razor clams can become sexually mature as soon as the end of the third growing season, and all are probably mature by the end of the seventh growing season. The age of clams can be told by the rings on their shells. Breeding occurs anytime between May and September, usually when the water temperature rises. Females can produce up to 10 million eggs per year. Eggs are discharged onto wet sand and into the seawater. Fertilization occurs by chance, which is why such a large number of eggs is produced. The larvae look nothing at all like clams, and become part of the free-floating plankton for five to 16 weeks. After this period their shells form, and the larvae begin to look like clams, settling to the sandy bottom. The oldest Alaska razor clam recorded was 18 years, but it's possible that they may live even longer than this.

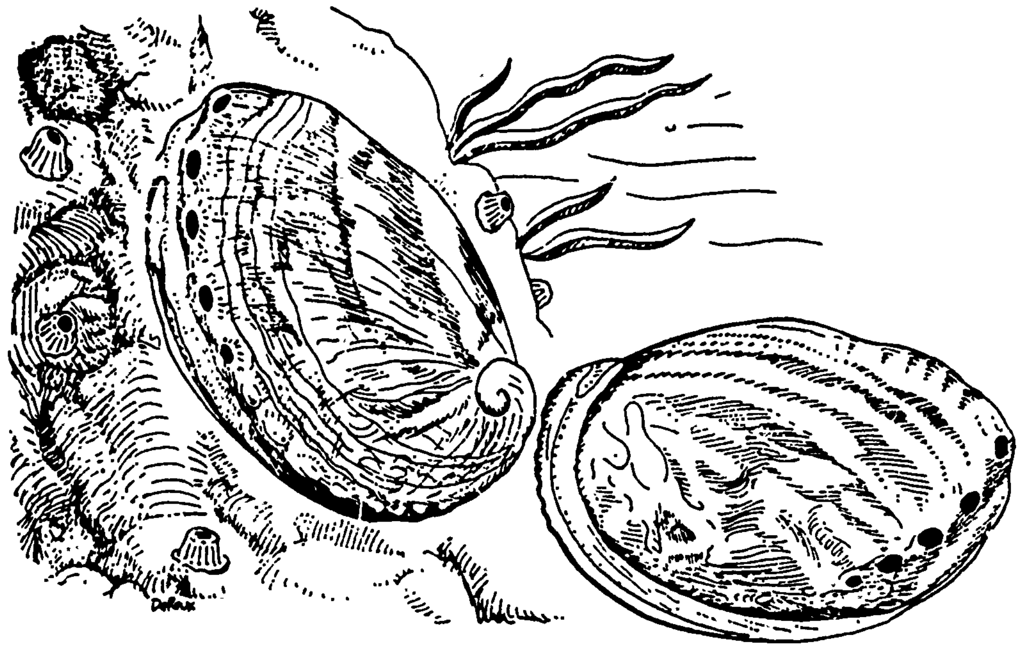
It's possible that some other clams, especially the butter clam could be harvested commercially, but until biologists find an easy way of diagnosing PSP in the clam beds, this fishery will remain for subsistence use only.

Goeducks aren't ducks at all, but giant clams that live near or just below the low tideline. While their shell is six to nine inches long, on the average, their total length, counting shell and siphon can be two to three feet long. The siphon and meaty strips along the sides of the shell are the parts that are eaten for food.They are usually harvested by divers, or by using an air pressure hose to dig them from the sand. Another harvesting method is the hard one, finding the exposed tips of the siphons at extreme low tides, and digging a hole of two to five feet deep to retrieve these monster clams. Most goeducks are harvested in southern southeast Alaska, and the commercial importance of these clams is small at this time.

Scallops look a lot like some clams, and are also bivalve mollusks, but live in beds on the bottom instead of within the sand. They can also swim for short periods of time to escape from predators. They have many jewel-like eyes which can detect changes in light intensity and moving objects. They are mature at age three to four, and are usually of commercially harvestable size at six to eight years, although they can live to age 18. The scallop that is fished commercially is the giant weathervane scallop.

Weathervane scallops are found on sand, gravel and rock bottoms from 25 to 100 fathoms. They feed by filtering microscopic plankton from the water.

The commercial scallop fishery in Alaska began in 1967 in the Kodiak Island waters and has since expanded to the Yakutat area. Sometimes limited stock and depressed market conditions make scallop fishing light. Scallops are fished by dredges. They are rectangular metal frames about 12 feet wide. Steel rings are connected together by chain links and webbing along the top to form the net. Fishing boats usually have two such dredges, weighing about a ton each through the scallop beds. The boats are large, averaging around 83 feet in length, and have booms to haul the dredges. With a large crew, their vessel fishes continuously, and the scallops are shucked, washed, and bagged on ice. Only the round muscle is used, and the rest of the bivalve is thrown overboard.



Abalone: Southeast Alaska is home to the pinto abalone, and a limited commercial fishery has been established in the Sitka area. Abalone are the traditional food of the sea otter, who dive to the bottom, pry them off the rocks, then return to the surface to eat them. Fishermen harvest abalone in the same way, by diving. Alaskan natives along the outside coast have long used abalone as a supplemental food, as a trade item and as decoration on their carvings and ceremonial dress.

The State Department of Fish and Game establish quotas for commercial harvesting of abalone, but more research needs to be done before the biology of the abalone in Alaska is known. We may be taking more that we should, and not leaving enough abalone for reproduction. This is a developing commercial fishery, and divers for abalone haven't made lots of profit as yet. The price of abalone is high, since it is considered a delicacy, but the recovery of abalone meat is small for the expense and effort involved.

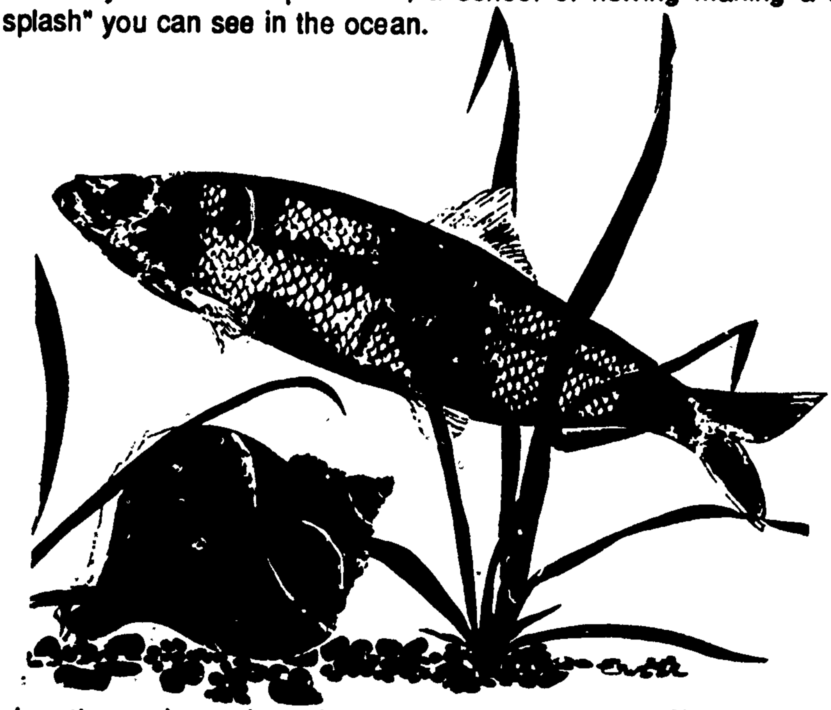
Abalones are marine snails and are related to clams, oysters, mussels and squids. The pinto abalone is one of the smallest species of abalone, growing to six inches in length. The oval shell contains four to six holes and has an exterior of mottled colors and sea growth similar to the surrounding habitat. The inside of the shell is an iridescent mother-of-pearl, and it is this part of the shell that is used for decoration. The shell muscle is the portion that is eaten. It is creamy-white in the center, mottled orange on the sides and a deeper orange on the bottom of the foot.

Abalone are grazers, feasting on all kinds of marine algae, from tiny forms to the giant bull kelp. They live near the outside coast, where they can feel the deep ocean swells. They can be found in thick kelp beds and clinging to cracks and crevices in rocks where surging waves cannot easily dislodge them. They live on the lee side of more exposed islands and rocks. Abalone can be handpicked during extreme low tides but most are found from low-low water to about minus 30 to 40 feet.

What other kinds of fish are harvested?

Herring: There is an island almost within rock-throwing distance of the fishing village of Craig, on Prince of Wales Island in southeast Alaska. Its name is Fish Egg Island. Does that interesting name make you wonder who named it and why? Well, around that island are many kelp beds in the shallow water. Every spring, for hundreds of years, the Tlingit and Haida natives would travel to Fish Egg Island in their canoes to harvest the eggs of herring that spawned in these kelp beds. These eggs are called ***roe***, and are still being harvested today, but in a much different manner.

Herring are considered among the world's most important commercial fishes, and are caught in all oceans. There are more than 180 species in the herring family worldwide. Pacific herring range along the rim of the North Pacific ocean from Mexico to Japan. Mature herring average eight inches long, and are dark green on top and silver on the sides and bottom. While this coloration makes them nearly invisible to predators, a school of herring making a sharp turn may make the "silver splash" you can see in the ocean.



Pacific herring spawn during the spring, when the water turns warmer. They travel from their offshore feeding grounds to the intertidal waters, where they lay their sticky white eggs on kelp and other seaplants. Within a week or two the 1/4 inch-long larvae begin to form. Herring larvae are almost transparent after hatching. They rely on food from a yolk sac for several days, then graduate to solid food - the zooplankton (microscopic animal life) as they drift with the currents.

By the time six to eight weeks have passed, the tiny larvae change into juvenile herring, about 2 1/2 inches long. You hardly ever see an individual herring. These young herring begin to school, and move out from the intertidal waters into the open ocean. Their schools are a million or more fish, which move offshore into deep water, where they remain until they mature, at three to four years. Now that they are adults, they average eight inches long, but can grow to 15 inches. They weigh about 1/3 pound.

Adult herring feed offshore, returning to inland waters to winter, and migrate to their spawning grounds in the spring or early summer, depending on latitude. In California, herring spawn in February. Further north, herring spawn in March in southeastern Alaska, May and June in the Kodiak area, and early July in the Arctic. They seem to concentrate in the same spawning areas year after year. Unlike salmon, herring live to spawn again, returning an average of five times to their spawning grounds. Since females lay about 20,000 eggs annually, each female produces about 100,000 eggs in her lifetime. Of course, very few of these eggs survive to adulthood, since they are eaten by many other fish as well as marine mammals.

Herring play a major role in the food web of the sea. People have harvested herring for many years as well. In Alaska, natives have used herring as food, and still harvest them today. In early years, herring were caught commercially with purse seines or gill nets to be salted down, and later processed into oil for use in paint and soap or into meal for animal food and fertilizer. This market dropped off as cheaper substitutes were found. By the late 1960's, herring were caught mostly as bait for larger fish.

When the herring stocks in the western Pacific were overfished by Japanese and Russian trawlers, they soon moved into Alaska waters to fish for this important food source, and caused our herring stocks to dwindle as well. Today, with the advent of the 200-mile fishery conservation zone, our herring stocks are building back up. Japan, Russia, and other Pacific Rim nations who want herring must now buy it from the American fishermen, opening up a new fishery for Alaskans.

Herring roe is an important luxury food for the Japanese, who eat it as part of their New Year celebration, as well as throughout the year. Today, most herring are destined for this market.

The herring roe fishery is a limited entry fishery, like salmon fishing. Biologists keep careful watch on the herring stocks, and allow only the excess from spawning and subsistence use to be harvested commercially. They determine the seasons and the gear that can be used. For instance, the Bering Sea herring fishery is confined to small gillnet boats that are relatively inexpensive to purchase and operate. That makes is easier for rural Alaskan fishermen to participate in the herring commercial fishery. The seine boats are the most efficient herring catchers, but they are limited to the Togiak fishery in the Bering Sea. Seiners are also allowed in the southeast fisheries.

Since the roe or eggs are the important part of the herring, what happens to the rest of the fish? Alaska has passed a law prohibiting the dumping of herring, except in some areas of the Bering Sea where the fishery is fairly new and there aren't enough processors around to handle the whole herring. Most fish are frozen whole, and shipped to Japan and Korea, where the flesh is used as well as the roe. In Kodiak, Seward, and Petersburg there are reduction plants that make fish meal from the carcasses of stripped herring.

There is another way to harvest herring roe, and that involves collecting roe after it has been deposited on the seaweeds where herring spawn. This way, the herring will live to spawn in other years. Prince William Sound supports this kind of fishery. In previous times, the kelp and seaweed were picked with large rakes, but this destroys the seaweed beds, and stirs up sand and mud, which harm the quality of herring roe. Most harvesting nowdays is done by diving. Divers can selectively choose the leaves with only the best quality and quantity of roe deposited on them, leaving the rest of the seaweed for future spawning.

Is there anything else that can be commercially fished?

New fisheries develop all the time, as markets open up, and there are hungry people willing to buy the product. One such product that is receiving more commercial emphasis in Alaska is seaweed.

Seaweed, you say? Good grief? Who would eat that? Well, if you have ever eaten at a Japanese or Chinese restaurant, you have probably eaten seaweed in some of their delicious dishes. While seaweed is often farmed, there are ways to harvest it in commercial quantities from natural growth. Natives have harvested seaweed for years for their own use. Now that markets are opening up for sale of seaweed, you will be hearing more about the commercial possibilities of this marine plant.

The roe of sea urchins are considered a delicacy by Oriental people, and may someday develop into a commercially harvested product. Similarly, there are fish now that are not considered suitable for commercial harvesting, but times and markets change, and these same undesirable fish may someday be the basis for a thriving commercial market. Be alert to these new markets, and how to break into them. You may become a leader in the field.

How to Troll Fish
Teacher Page

Competency: Conduct Line Fishing Duties (A)

Tasks: Explain harvesting methods for common non-vertebrate and vertebrate marine species
Define line fishing terms
Explain principles and techniques associated with various line fisheries.
Work riggings such as nets, slings, hooks, cables, booms, and hoists.

Introduction

This lesson will acquaint the student with the method of troll fishing for salmon. The last task is a proficiency task which requires actual experience aboard a trolling vessel. A short explanation of the skills which should be addressed with actual experience is included. Only those riggings which pertain to trolling will be discussed in these lessons.

Resources

Centralized Correspondence Study, P.O. Box GA, Juneau, Alaska, 99811, "Salmon Science", pages 37 -41

How to Troll Fish

What kind of fish are caught by trolling?

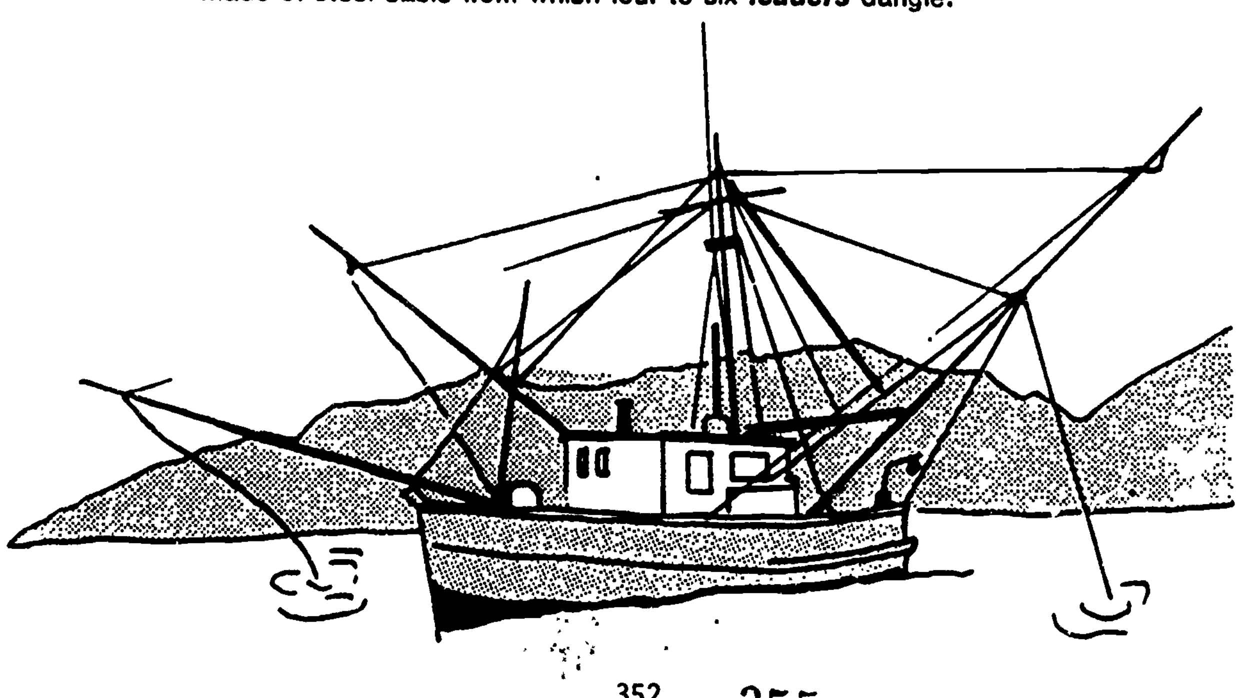
Trolling is a fishing method used for Chinook, coho, pink, and sometimes dog salmon. Sometimes halibut can be taken by trolling as well. Since Chinook bring the most money to the fisherman, they are the most sought-after by trollers. Coho are the second choice for trollers, and are often called their bread and butter fish. Occasionally, dog salmon can be caught by trolling, and trollers often attempt to avoid catching pink salmon, because they bring in so little money for the time and effort invested. Red salmon cannot be caught by trolling, since they usually feed on marine plankton and small crustaceans. They won't bite on lures that resemble fish, or on herring themselves.

What kind of equipment does a troller use?

Trollers are the only commercial salmon fishermen and women who do not use nets. Their fishing is done with poles, lines and hooks. Trollers use either herring or artificial lures to bait their leaders. The vast majority of trolling of any kind is done in Southeast Alaska. Salmon trolling vessels range from small skiffs of 12 feet to large vessels of 75 feet, but the majority are from 36 feet to 48 feet. Usually trollers fish alone, but sometimes there are two persons on board, the captain and the ***deckhand***, who is sometimes called a ***boatpuller***.

What are hand trollers?

Hand trollers are trollers who crank their lines in by hand. Hand trollers are permitted to use either sport poles or hand gurdies. They often use two to four heavy duty sport fishing reels lashed to their boat if they fish with a skiff or with a somewhat larger boat. Since sport poles allow a fish to be played, it is often easier to catch large salmon with sport poles rather than risk having them break your leaders on the hand gurdy. Usually, hand trollers with larger boats use two ***hand gurdies,*** which are large brass fishing reels, each having 50 to 100 fathoms of ***line*** made of steel cable from which four to six ***leaders*** dangle.

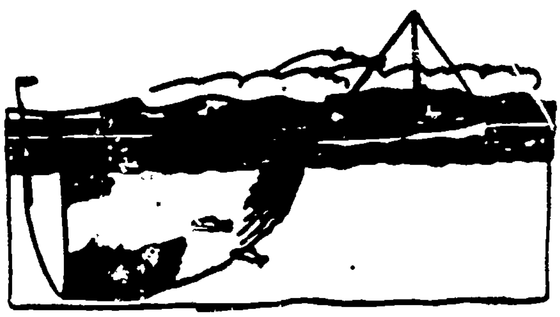


Trollers who use heavy-duty sport poles and small skiffs often catch as many fish as do the more powerful hand or power trollers, since they can maneuver in close to shore, and near kelp beds, where the giant kings may be lurking. Regulations allow them to use as many as four poles at a time, and when the fish are biting, this keeps them extremely busy!

Trollers with larger vessels usually use hand gurdies. If hand gurdies are used, the vessel often has two long poles mounted midships on the boat that are extended at a 45 degree angle from the boat. These hold the cables out away from the boat, making it easier to maneuver, and covering more fishing area. The poles are hinged, so when they are not needed, they can be pulled up until they stick straight up into the air. Each cable is anchored at the bottom with a "cannonball", a heavy weight that holds the cable almost upright as it is dragged through the water. At intervals of two to four fathoms are two small brass sleeves a foot apart. A baited leader with a line snap on the end is attached between these two sleeves. Hand trollers can attach as many leaders as they want to the cable, but usually they use five to seven. (Remember, they have to crank these up by hand!)

What are power trollers?

As you might suspect, ***power trollers*** pull their lines by the use of hydraulic gear, making trolling a much easier job. In most areas of Alaska, power trollers may use up to four lines to which multiple leaders can be attached. Power trollers usually use larger vessels, and have two sets of poles, one amidships, and one set near the bow, from which their lines are suspended.



Limited entry permits for hand trolling are not as expensive as permits for power trolling, because hand trollers fish less gear, and consequently catch less fish and make less money. Power trolling permits cost more, but are worth more in income, since so many more lines and leaders may be used.

Fish on!

That's the cry you often hear when a salmon has struck on a sport fishing expedition. But how do you know the fish is there when using a hand gurdy? Since the steel pole is much too heavy to dip when a strike occurs, the line is attached to a spring and a bell at the top of the gurdy pole. When the bell rings, you know you have a strike. Sometimes you even have more than one strike at once! The troller usually stands in a large pit at the stern of the fishing boat and cranks the strike in by hand or by power. When the fish is sighted, the troller uses the back side of the ***gaff hook*** to stun the salmon, then turns the gaff to hoist the unwilling fish aboard.

Of course many times the catch is nothing but scrap fish, sharks, jellyfish, or ***shakers***. Shakers are undersized salmon that must be released. You have to use great care in doing this without harming the fish, because the object is to let the fish go to grow larger. Here's where your knowledge of salmon becomes especially useful, since the regulations often call for release of kings under 28 inches, but cohos smaller than that are legal catch. If you can't tell the difference at once, while the salmon is still in the water, you might lose money.

As soon as the fish is on board a sharp rap on the head quiets it before the hook is removed. A thrashing fish could bruise himself or lose scales, and thus be of lower quality and bring less money to the fisherman. The fish is bled, then gilled and gutted. Special care is taken to rekmove all of the ***bloodline***, blood that is next to the backbone, which is the kidney area of the salmon. Then the salmon is ***iced*** down. Ice will be carefully packed in the body and head cavity, and the fish will be laid on a layer of ice is such a way that the body cavity can drain freely. Plenty of ice is used, so no fish touches another fish, and all liquids drain away from the fish.

Fewer fish are caught by trollers than by net fishermen. Generally, less than 5 per cent of the total Alaska catch of all species of salmon are caught by trollers. However, troll-caught fish are the premium quality salmon of the marketplace and always bring higher prices than net-caught fish, which may have become bruised and discolored from the catching procedure. Good trollers make every effort to deliver the highest quality fish to the buyers, since they are known by the fish they sell.

Salmon with no blemishes, perfectly cleaned with no extra knife cuts, and correctly iced are number one fish, and bring the most money. Number two fish bring less per pound, and are those fish that show marks or scale loss, or haven't been correctly cleaned. Buyers prefer number one salmon, because they usually sell troll-caught fish in the fresh market, or flash freeze them to be sold later to restaurants and retail stores that want premium salmon.

How to Purse Seine

Teacher Page

Competency: Conduct net fishing duties (A)

Tasks: Define terms associated with various net fisheries
Explain principles and techniques associated with various net fisheries
Operate and maintain seine equipment such as purse seine, haul, drag, or beach seine and power skiffs
Insert and attach hoops, rods, poles, ropes, floats, weights, beam runners, other boards, and cables to form, reinforce, position, set, two, and anchor net as required
Haul net with appropriate gear

Introduction

This is the second lesson in the series on harvesting methods. If purse seining is used in your area it would be a good lesson to teach. It is most desirable to gain the actual experience, if boats are available. However, this lesson will give students the basic idea.

Resources

Alaska Sea Week Curriculum Series: VI, Fish and Fisheries, Alaska Sea Grant Report 83-7. Pages 89-90 and Worksheet 4E discuss purse seining. Use Worksheet 4E with the students.

"The Herring Chase", Sea School, Alaska Fisheries Series, AEIDC, 707 A Street, Anchorage, AK 99501. Although this 15-minute videotape concentrates mainly on the fishery itself, it shows how a purse seiner is used during a herring sac roe opening.

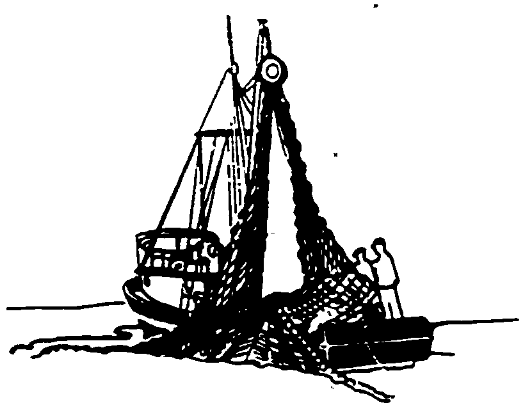
How to Purse Seine

What kind of fish are caught by purse seine?

Purse seining is a net fishery used for catching some kinds of salmon as well as herring. Since seiners make their money from the quantity, not the quality of the fish they catch, they tend to fish for salmon that can be caught in large schools. Pink salmon are the mainstay of purse seiners, although chum and coho salmon are also caught in smaller numbers by purse seiners. Small numbers of reds and kings are also caught by purse seiners.

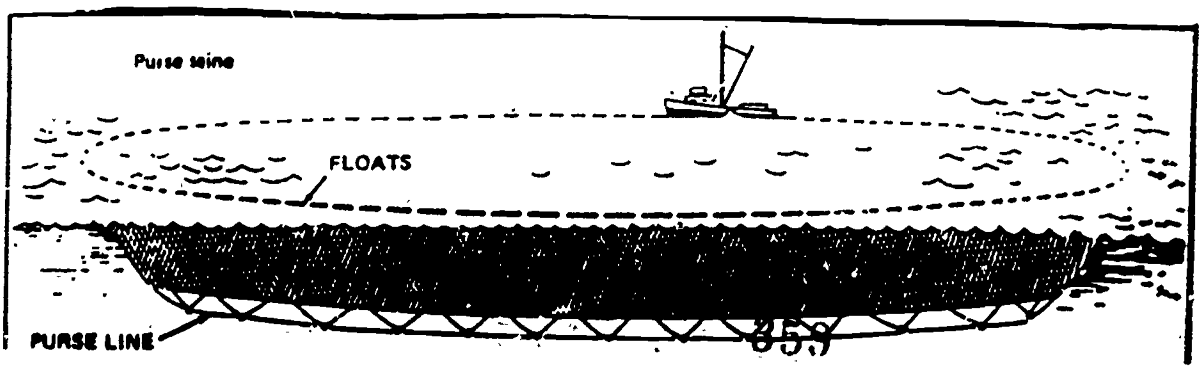
What kind of equipment does a purse seiner use?

In Alaska, purse seine vessels are one of the largest boats to fish for salmon, even though they may be no longer than 58 feet in overall length. A seiner has a long ***boom*** that forms a "V" with the mast of the boat. This boom hangs over the work deck. At the top of the "V" is a ***power block*** that looks like a large pulley. The power block is used to pull the loaded net onto the vessel. Before the invention of the power block in the early 1950's, the net was pulled in by hand. You can imagine what a back-breaking job this must have been!



Another essential ingredient to purse seining equipment is the skiff, or *jitney*. These use very powerful inboard engines, and are usually made of steel or aluminum. When the seiner is not fishing, these skiffs are usually pulled onto the stern deck along with the unused net.

The seine net itself is regulated by the Alaska Department of Fish and Game to certain lengths and widths, depending on the area fished. Most purse seining is done in Southeast Alaska, where the seine nets must be between 150 and 250 fathoms long. Prince William Sound and Bristol Bay play less prominent parts in this type of fishery. In Prince William Sound the net must be between 125 and 150 fathoms long.



To unload the fish from the net, purse seiners use brailing nets or suction if there are too many fish to lift the net aboard. A ***brailer*** is a large power operated dip-net, up to 4 feet in diameter, and 5 to 6 feet deep. It has an 8 - 10 foot handle, which is used to guide the brailer into the loaded seine net. When it is filled, a line connected to its hoop and running through an overhead block lifts the net aboard. To empty a seine net by suction, a device that resembles a large vacuum cleaner is used.

What is a purse seine?

Sounds like a pocketbook, right? Well, that's something like what a purse seine is. Instead of hanging a net to catch the fish as they try to pass through, the purse seine net is used to encircle entire schools of fish.

The captain uses a fathometer or video echo sounder (colorgraph) to locate the school. The boat lays the net, while the jitney holds the end of the net. The jitney and seiner head toward each other to close the net into a large circle. Now the school of fish are surrounded on the sides by the net. After the fish have been surrounded the bottom of the net is drawn tight, or ***pursed.*** With the bottom of the net closed, the school of fish has nowhere else to go, and all that remains is to load the fish aboard the seiner.

How do you get purse seining experience?

Purse seining, like all other Alaska salmon fisheries, is regulated by the Alaska Commercial Fisheries Entry Commission through Limited Entry permits for all salmon and some herring fisheries. That means only a certain number of seiners are allowed to operate within the state. To get a job on a seiner, you must be familiar with the vessels that operate out of your area. If you know or are related to a skipper that is an excellent way to get a start, because its not often that you see ads in the newspapers for jobs on fishing vessels.

There could be five or six persons on the crew of a seiner. The captain usually directs operations from the flying bridge. The skiffman runs the skiff. On deck are usually two deckhands who pile the web on the deck, another who stacks the cork line, and one who stacks the lead line. Since the crew must also eat, one crewmember doubles as the cook. There is more chance of getting a job on a seiner than on other salmon boats, since the crew is usually larger.

One good thing about working on a seiner is the relatively short season. If you are going for a herring fishery, your fishing will be limited to a day or so in spring, starting in March for Southeast and later for points farther north. If you seine for salmon your fishing is limited to specific days in July and August and maybe September. There is a quota of salmon that may be caught by purse seiners, and the Alaska Department of Fish and Game regulates openings by checking the number of fish caught and the escapement numbers for each stream. Openings are set in the spring, but may vary because of these catch and escapement numbers

Your pay is set by crew share. That's the percent of gross vessel earnings settled on before fishing begins. Crew shares on seine boats are often 7 to 10 percent of the gross. Like all fishing, your pay is a gamble. It all depends on how well each member of the crew does his/her job, and the runs of fish.

How to Gillnet

Teacher Page

Competency: Conduct net fishing duties

Tasks: Explain harvesting methods for common non-vertebrate and vertebrate marine species
Define terms associated with various net fisheries
Explain principles and techniques associated with various net fisheries
Operate and maintain net fishing equipment such as dip, diver, gill, hoop, lampara, pound, trap, reef, trammel, and travel nets
Insert and attach hoops, rods, poles, ropes, floats, weights, beam runners, other boards, and cables to form, reinforce, position, set, two, and anchor net as required
Haul net with appropriate gear

Introduction

The primary objective is to explain harvesting methods. Other tasks refer directly to gillnetting. Some tasks can be easily accomplished in a classroom; the last three require a fishing vessel and actual experience to accomplish.

Resources

Centralized Correspondence Study, P.O. Box GA, Juneau, Alaska 99811, "Salmon Science", pages 37 - 41.

Alaska Sea Week Curriculum Series, "Fish and Fisheries", worksheet 4D.

FAO Fishing Manuals, Mending of Fishing Nets, Surrey, England, 1978

"So the Salmon Will Always Return", Sea School, Alaska Fisheries Series, AEIDC, 707 A Street, Anchorage, AK 99501. Although this 15-minute videotape concentrates mainly on the fishery itself, it shows some Bristol Bay gillnetting as well.

How to Gillnet

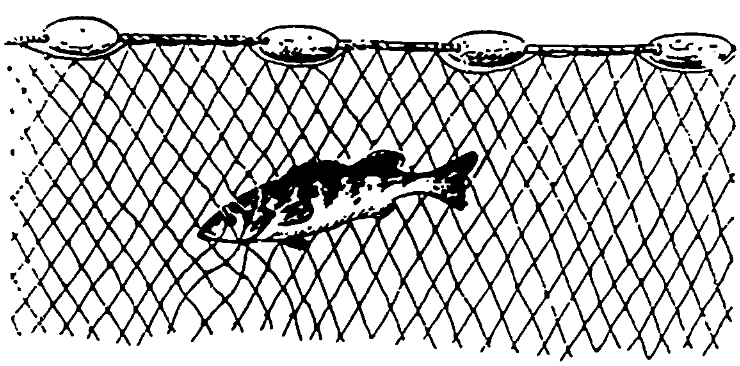
What kind of fish are caught by gillnet?

Gillnet fisheries concentrate primarily on returning runs of salmon and herring as they near their spawning grounds, although they can also catch kelp, sea lions, drifting logs, seals, and even killer whales at times. More Alaska salmon are caught in gillnets than in any other fishing gear. Gillnetting is a limited entry fishery in Alaska, and is closely managed by the Alaska Department of Fish and Game. Like the other Alaska fisheries, regulations are set by the Board of Fisheries to decide when and where to fish, and what kind of gear can be used.

The most valuable salmon fishery in the world is the Bristol Bay sockeye gillnet fishery. Since sockeye don't ordinarily bite on lures, the most efficient way to catch them is by netting them. The Yakutat gillnet fishery concentrates on red and coho salmon. Other fish that form the basis of the gillnet industry are the pink and dog salmon. In western Alaska, except for the Togiak area fishery, all commercial herring fishing is accomplished by small gillnetters.

What kind of equipment does a gillnetter use?

The basis of the equipment for this type of fishing is, of course, the gillnet. In Alaska, gillnets are usually no longer than 300 fathoms, and 150 fathoms in Bristol Bay. They are nets that catch fish by their gills as the fish attempt to swim throuth them. Mesh size and the length and width of the net are determined by regulations of the Alaska Department of Fish and Game. Different size meshes are used for different species of fish. For instance, a pink or sockeye salmon net may have a mesh size of four or five inches. A mature king salmon cannot get his head far enough into a four-inch mesh net to get caught. Small, immature fish will be too small to get caught in this size net, and will swim right through it.



There are two kinds of gillnetting. ***Setnetting*** is the method of fastening a gill net to shore at one end and anchoring it in the water at its other end. For this type of gillnetting, no boat is necessary if you wait until the tide is out to pick your net. Other times, a small skiff is used to tend the net. Setnetting is one fishery that doesn't require a large investment. An open skiff, an outboard and less than 50 fathoms of gillnet gear are the basic items required. Many set net sites are hereditary, and are used for generations by the same family.

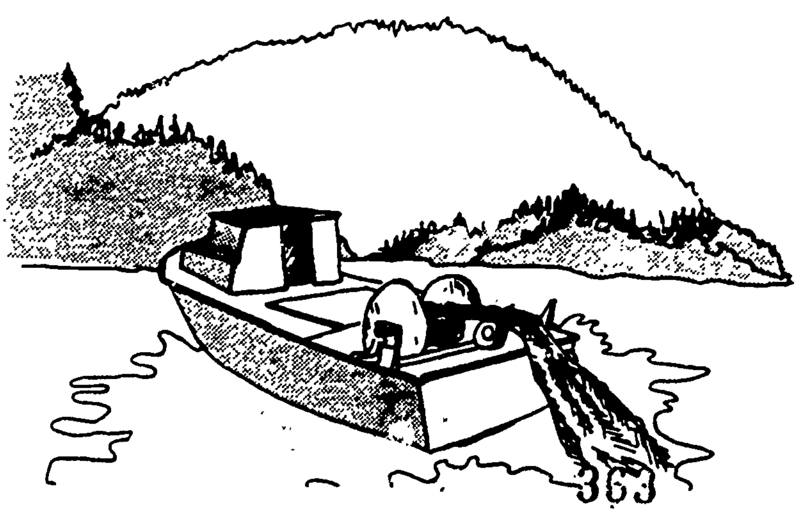
Drift gillnetting is the method of setting the gillnet from a boat, then letting the gill net drift free while the fisherman keeps constant watch from his boat to see if the corks are bobbing. Gillnetting may be carried out at a one-person operation, but most often a gillnetter will have a partner. Usually a gillnet boat will have a large reel on the stern to help pull in the net. Sometimes this reel is is mechanized, and is called a power roller. Gillnet vessels in Bristol Bay may be no longer than 32 feet, but there is no size limit in other parts of Alaska. Most gillnetters outside Bristol Bay are in the 32 to 42 foot range.

In both kinds of gillnetting. a cork line keeps the upper edge of the net floating and a lead line keeps the net vertical by holding down the lower edge. Drift nets, in addition, have large floats or buoys at each end.

How does gillnet fishing work?

Whether drifting or setting the net, the length of time the net is allowed to fish before it is checked and the catch removed depends on the person fishing the net. If the individual corks along the top of the net are bobbing or being pulled under water, the net is catching fish. Fishermen have to be careful not to leave their nets too long, because netted fish tend to sink, and the net plus the fish could all be lost.

To ***pick*** the net, the fish are removed from the net as it is being hauled in. If a reel is used to pull the net, it is most efficient to have one person on each side of the net, using gloves or a short hooked tool to release salmon tangled in the net. If a setnet is being picked, the fish are removed by moving along the net with a skiff and pulling any entangled fish to the surface. Picking fish from a gillnet requires much skill and speed.



Gillnetters usully catch many more fish than do trollers, and don't usually have time to clean their fish. Some gillnetters carry their fish on ice in their holds, but most of them deliver their catch daily to a fish tender. Some setnet fisheries deliver fish to buyers who land small planes on the beach, and fly the freshly caught salmon directly to cold storage markets in the nearest community. Sometimes, if the run is very large, the gillnetter will deliver every few hours, because they catch too many fish to be held on their boat.

Gillnetters sometimes line their holds with cargo nets. When they get to the tender, they just lift the net up and it is emptied onto the deck of the tender. Then the nets are returned to the catcher vessel. The cargo net system reduces the number to times a fish must be handled, and preserves the quality.

Unlike troll-caught fish, most gillnetted fish end up in cans, since they are often bruised and torn from the net. In addition, they lose scales in their struggle to escape the net. Since the fishermen don't always clean the fish, they also are of a slightly lower quality than are troll -caught fish.

The gillnet fishery for herring is a fast and furious business, involving mostly drift gillnet or seine nets. The openings are very carefully controlled by the Alaska Department of Fish and Game, and last for very short periods of time. The herring that are caught are usually offloaded with suction tubes directly from the skiffs or vessels that caught them.

How do you get gillnetting experience?

Since drift gillnetters often need a second crewmember, it is possible to sign on to a vessel, but setnetting experience is harder to get, because setnets are often tended by families. If you don't know someone in your community who needs a deckhand, your best bet is to try the docks in your area. Remember that speed and efficiency are very important, and don't forget that crew license.

In order to have your own gillnetting operation, you must hold a Limited Entry Permit for a particular gillnet fishery, which is a large investment, and have an additional substantial investment in your vessel. The type of vessel you need depends on the area where you fish. Gillnets themselves are not cheap! They can cost from $3500 to $5500. At that price, it is very helpful to know how to mend nets and keep all your gear in good repair.

Pot and Trawl Fishing
Teacher Page

Competency: Perform pot and trawl fisher duties (A)

Tasks:
- Define pot fishing terms
- Explain pot fishing techniques
- Rig boat and deploy gear such as pots, floats and markers
- Tie marker float to line, attach line to pot, fasten bait inside pot, and lower pot into water
- Retrieve gear and remove catch
- Hook marker float with pole and haul up pot
- Remove catch or dump catch on deck
- Measure catch with fixed gauge
- Place legal catch in container and return illegal catch to sea
- Rig and lower dredge (rake scoop with bag net attached), drag dredge behind boat to gather marine life from water bottom, and hoist it to deck by hand using block and tackle

Introduction

Use this lesson if pot fishing or trawling are used in your area. The first two tasks can be adequately covered in a classroom setting, but the other tasks require actual experience. This lesson will acquaint the student with the general principals of these fishing methods only.

Resources

"King Crabber" and "Joint Venture" , Sea School, Alaska Fisheries Series, AEDIC, 707 A street, Anchorage, AK 99501. These 15-minute videotapes show pot fishing and trawling, respectively.

Alaska Sea Week Curriculum Series: VI Fish and Fisheries. Worksheet 4H has models of pots and trawls to construct.

Pot and Trawl Fishing

What marine organisms can you catch with these methods?

Pot fishing is used in Alaska for the shrimp and crab fishery. The three kinds of crab fished commercially in Alaska -- king, tanner, and Dungeness, are fished for by pots. Since the crabs differ in size, the pots that catch them are different as well.

Bottom trawling is used in Southeast to catch pink and other small shrimp. In the Gulf of Alaska waters, trawlers catch bottom fish like sole, flounder, rock fish and turbot, and midwater fish like pollock, black cod, lingcod, and Pacific cod as well. Of the five families of fish caught by trawlers, the Pacific cod is the most important. Trawlers may not harvest crab, halibut, salmon or herring, and trawling is restricted in some areas and at some times to protect juvenile halibut or where crab pots are in use.

What kinds of equipment do trawlers use?

So shrimp are your favorite food? You think you would like to trawl commercially for shrimp? Well, you will need a large boat, since the trawls themselves are cumbersome and heavy. Many of the boats fishing for shrimp out of Kodiak, which is the major shrimp port on the Pacific coast, are 70 - 80 feet long. The trawl you will use for shrimp is called an ***otter trawl.*** It is 70 to 130 feet long. The net is held open by two huge doors. These doors are heavy wood or metal plates attached by bridles at an angle which causes them to be pushed away from the vessel as it moves. This keeps the net open.

Another type of trawl used on the sea bottom is the ***beam trawl***, where the net is held open by a stiff and heavy beam. This fishing method is suited to rough bottom, and is often used in Southeast Alaska.

What if you want to join the growing bottomfish trawling fishery in the Gulf of Alaska? You will probably use an otter trawl, along with a very large boat. These trawlers operate in rough weather, dragging heavy trawls through the water. They work 24 hours a day, week in and week out. The work is hard, but can be rewarding. Many of these trawlers have participated in joint venture operations, where they fish for foreign processors.

How does trawling work?

The otter trawl is shaped like a funnel from 70 to 150 feet long. At the open end are two ***wings*** of net that have the huge ***doors*** attached to their ends. These doors are attached to lines running to either side of the stern of the vessel. As the vessel drags this net slowly through the water, all the fish in its path are caught in the net, and move to the pointed, closed end of the net, called the ***cod end.***. After dragging the net for two to four hours, the net is pulled aboard and the cod end is unloaded onto the deck. After the net is again let out, the fishermen sort and ice down the fish they caught. Then they do it over and over again 24 hours a day.

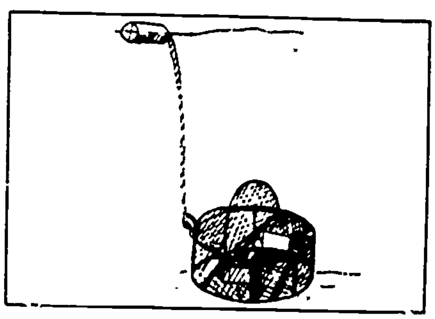
If the trawler is fishing for a joint venture operation, they can detach the cod end of the net, and transfer net and all to the processing ship. This alleviates the need for sorting and icing on the trawler itself. That job is done by the processor. Sometimes trawling is done by two vessels, one pulling each side of the net. In this case, the doors aren't used, since the vessels themselves hold the net open.

What kinds of equipment do pot fisheries use?

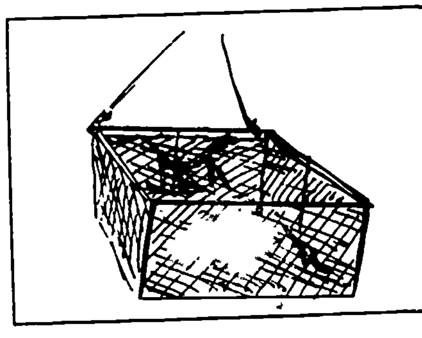
Maybe your goal is to fish commercially for crab. Then you will need to know all about the vessels and pots used for crabs. Crab fishing is a very dangerous occupation, especially in the Gulf of Alaska. Fishermen use large, stable boats for crabbing because they often fish in foul weather and because they need storage room for all the pots and the huge seawater tanks used to keep the crabs alive.

Although there can be lots of profit in crab fishing, the risks are large also. Since the commercial crabbing seasons are in the winter, the chance of hitting ocean storms is very great. Boats can ice up, or go down and crew members can be washed overboard in heavy seas. They can be hit by the heavy crab pots as they are swung aboard.

Dungeness are fished in small round pots approximately 30 inches in diameter, 12 inches high and covered with stainless steel mesh. The pots weigh about 80 pounds each. Polyproplene line of half inch diameter connects each pot to a plastic buoy which marks the location of the pot by floating on the surface. Each buoy must be labeled with the name or initials of the fisherman. The crabs enter through a webbed tunnel to get the bait of dead herring, squid, or fish heads. Once in the pot, they can't get back out, and are caught. Much of the Dungeness crab fishing is done in Southeast Alaska, where the danger is not quite so great. Dungeness crabs are smaller than king and tanner crabs, and don't usually bring as much money per pound.



King and tanner crabs are fished with rectangular seven-by-seven-by-four-foot steel pots with nylon or steel webbing. You need a strong winch to pull these pots, because they can weigh 500 to 700 pounds when filled with crab. Like Dungeness pots, they have a tunnel through which the crabs enter, but cannot leave. Both kinds of pots are attached by a line to a float at the water's surface. The lines may be 600 to 1,000 feet long for the king crab fishery.



How does pot fishing work?

Crab and shrimp fishermen bait and set a whole string of pots. For instance, Dungeness crab pots are set out about 75 yards apart and in a line for several miles. A Dungeness crab boat may fish 100 to 200 pots. After leaving the pots for a period of time, they are pulled with the use of a power block. The crab are sorted, since undersize males and all females are illegal, and must be thrown back unharmed. The crabs that are kept must remain alive until sold, so they are put into seawater holding tanks.

Pot fishermen in protected areas like Southeast Alaska can usually find their pots by use of landmarks around them. However, if you fish for king crab in the Gulf of Alaska, you see nothing but ocean. To locate the pots, most skippers use Loran-C, which can locate a precise area. After marking the location where pots are set on the chart, the skipper can return to the exact location when the pot is emptied and rebaited.

The Alaska Department of Fish and Game regulates the crabbing fisheries. The Dungeness season runs from December to August. The king crab season is usually August through January, and then tanner crabs are caught from January to June. Whether the seasons are opened, and the length of the openings, are controlled by the estimates of the crab populations made by Fish and Game biologists. Many fishermen use their boats to fish in a number of fisheries. Often Dungeness fishermen switch to salmon in June, since they may make more money at this fishery.

Rules and Regulations
Teacher Page

Competency: Identify the harvesting and processing of marine products

Tasks: Explain importance of following state and federal fishing regulations

Introduction

In Alaska, fishing is closely intertwined with the political process. The rules and regulations are legislated, and implemented by the Department of Fish and Game, Commercial Fish Division. Other agencies which have jurisdiction over Alaska waters are the National Marine Fisheries Service, and several international agencies which deal primarily with halibut and salmon.

Resources

Three state agencies that would be invaluable as resources are:

Alaska Department of Fish and Game, Commercial Fisheries Division, P. O. Box 3-2000, Juneau, Alaska 99802. The "Finfish Regulations" would be especially useful to have.

Office of Commercial Fisheries Development, Alaska Department of Commerce and Economic Development, 333 West Fourth Avenue, Anchorage, AK 99501

Alaska Commercial Fisheries Entry Commission, Pouch KB, Juneau, AK 99811

The following booklet is rather dated, but still might be of help to your students:

Rodger Painter, for the Legislative Council, 1981, "So...You Wanna be a Fisherman..."

Rules and Regulations

How can you become a crewmember?

When you first start fishing, it will probably be as a crewmember on someone else's boat. Besides having knowledge of fish and fishing techniques, the only other thing you must have is a ***Commercial Fishing Crewmember License.*** These can be purchased at many fishing supply stores, or from a state office for the Alaska Department of Revenue. The cost is $30 for Alaska residents, and $90 for out-of-state crewmembers.

The fishing license you buy is good for one season, and makes you eligible for the Fishermen's Fund, which insures commercial fishermen who are injured on the job. The Fishermen's Fund is supported by 60 percent of your commercial fishing license.

The next thing to do is find a job with a fishing vessel. The best way to hire on is to know the boat owner. If you don't have a spot on a boat already, the next best thing is to go to the fishing port before the opening, and scout the docks.

What if you own your own boat?

You've evidently crewed on the right boats, and now have enough to buy your own fishing vessel. Good for you! Before you can fish, you must have several permits and licenses. Both individuals and their vessels require permits to commercial fish in Alaska.

Limited Entry Permit:

This permit system was first begun in 1974 to control the number of fishermen permitted to take salmon commercially. Limited Entry permits were given out to people who fished for a living. A point system was set up. Points were given for number of years in the fishery, amount of money invested in gear, degree of dependence on the fishery, and some other details.

Fisheries governed by limited entry include all salmon fisheries, as well as most sac roe herring fisheries in Alaska. There is discussion of limited entry permits for some shellfish harvests, and a limited entry permit for halibut has been under discussion by the North Pacific Fishery Management Council.

For many fisheries in Alaska, you need either a ***Limited Entry Permit*** or an ***Interim Use Permit.*** The Commercial Fisheries Entry Commission grants these permits for a certain area, gear type, and fish species. This permit gives you the right to participate in a certain fishery. You can't lease your permit to anyone, and you must be present when the permit is being used. This insures that the permits can't be controlled by fish processors or other non-fishermen.

Once a fishery has been limited, the only way a new fisherman can join is through buying a permit at market value from a fisherman who wants to sell the permit. Finding the right permit can be difficult, since fishermen are not required to notify the state when a permit is offered for sale. The best way to locate available permits is by asking around the docks, reading the classified sections of newspapers catering to fishermen, checking with the Commercial Fisheries Entry Commission or by contacting the few businesses specializing in selling permits.

Some of the permits are very expensive, and rural residents, especially, sometimes have trouble coming up with the purchase price. To help Alaska residents buy permits, the Alaska legislature has established several programs to provide loans to fishermen, like the Fishermen's Revolving Note and Mortgage Fund and the Alaska Commercial Fishing and Agriculture Bank.

Your permit is a card, with your permit number on it. In addition, your vessel also has a commercial license under your permit. You are required to display the vessel license on the boat, and to paint your permit number in 12-inch high numbers where it can be easily visible.

Limited Entry Permits are renewable annually. If unrenewed for two years, Limited Entry permits revert to the Commercial Fisheries Entry Commission. Limited Entry permits may be bought and sold by individuals, with approval of the Commission, and may be inherited.

What are fish tickets?

No matter what kind of commercial fishing you do in Alaska, your fish must be accounted for on fish tickets. When you sell your fish, you will show the buyer your permit card. The fish buyer records the weight and numbers of fish purchased, species, vessel license number, date and area in which the catch was made. You get a copy of this fish ticket, and a copy is sent to the Alaska Department of Fish and Game. These tickets help the Department to regulate the amount of fish taken.

Vessel Documentation

Fishing vessels of five net tons or more require Coast Guard documentation. These documents are issued by the Coast Guard's Marine Inspection Office, Vessel Documentation Branch. There are several types of documents. A "registered vessel" can operate in trade with foreign countries and in fisheries. An "enrolled and licensed" vessel is one over 20 tons, and a "licensed vessel" is between 5 and 20 tons. There are some fees to pay for documentation, and the documentation must be renewed each year. Most fishing vessels do not require Coast Guard inspection and certification before documentation.

In addition to documentation, some fisheries require that boats be inspected by the Alaska Department of Fish and Game before fishing can begin. The commercial fishing regulations published by the Department tell the types of boats that require inspection.

How does Alaska manage its commercial fisheries.

The Alaska State Department of Fish and Game manages the fish and game resources of the state. Heading the Department is a Commissioner appointed by the Governor for a five year term. The Commercial Fisheries Division manages all commercial fishing to waters extending three miles offshore -- "the three-mile limit".

Their first priority is salmon. The goal is to have "sustained yield management". To do this, the Department staff keep data on numbers of fish returning to spawn, and estimated size of the yearly catch. They make recommendations for management of the fish to the Board of Fisheries. In this way, the Commercial Fisheries Division makes sure that the fish return in enough numbers to reproduce and maintain their numbers from year to year.

The State Board of Fisheries is made up of seven Alaskans appointed by the governor. Usually, the members represent most of the fishing areas of the State. The function of the board is to decide on fishery regulations. They hold two statewide public meetings each year, in the fall and spring. They also hold regional meetings in these areas: Upper Yukon-Kuskokwim Arctic, Western Alaska, South Central, Prince William Sound, and Southeast. Another way the Board gets input from Alaskans is by setting up Advisory Committees. There are over 50 combination fish and game advisory committees through the State, made up of people familiar with the fish and game resources of their areas.

It is during the statewide and regional meetings that the Board hears testimony and discussion, then makes decisions about fishing regulations. Their decisions determine when and where you can fish, how many fish you can take, and what gear you can use, among other things. Anyone can make suggestions about fishing regulations, but the proposals usually come from the Department of Fish and Game, from the Advisory Committees throughout the State, and from other interested parties.

The fishing regulations are published in pamphlets or booklets each year. It is the responsibility of the fishermen to know the regulations. You can get copies of the regulations from the Alaska Department of Fish and Game, and from many authorized fishing supply stores. It is important to be familiar with the regulations, since Fish and Game personnel can inspect your boat at any time, and could levy fines or seize your vessel if you are in violation of the regulations.

How is fishing controlled beyond the three-mile limit?

The State of Alaska has control of all fishing within the three-mile limit. Beyond this limit, from three to 200 miles out, fisheries are managed by the Federal Government, through the National Marine Fisheries Service. This agency is part of the U. S. Department of Commerce.

In Alaska, the 200-mile zone corresponds roughly to the outer continental shelf -- the feeding ground for bottomfish. There are some four dozen species of bottomfish, including pollock, sole, flounder, cod, and others. Also included within the 200-mile limit are shellfish such as crab, shrimp, clams and scallops, herring, halibut, and even salmon.

The Fisheries Conservation and Management Act, which created the 200-mile limit in 1976, also set up eight Regional Fisheries Management Councils. The North Pacific Fisheries Management Council is the only council dealing with a single state, Alaska. It develops management plans for the Alaska fisheries. These fisheries are broken down into management units such as Bering Sea herring, Gulf of Alaska groundfish and halibut. Each of these units has a plan which determines the strength of the resource, then estimates the allowable catch. Under these plans, it is determined how many fish American fishermen are geared up to take. Then what fish are left over can be taken by foreign fleets, under permit.

Two international agencies also take part in controlling the Alaskan fisheries. The International North Pacific Fisheries Commission is based in Vancouver, B.C. Canada. It was established by convention among the United States, Japan, and Canada. This commission oversees fisheries and recommends management procedures for the North Pacific outside the U.S. and Canadian 200-mile zones.

The International Pacific Halibut Commission is based in Seattle. It has overseen the West Coast halibut fishery since 1923. The commission sets catch limits by area and establishes season opening and closing dates. Vessels over 5 net tons, with the exception of trollers, that want to fish for halibut commercially must be licensed by the IPHC. License applications are available from the commission or from U.S. customs officers.

Boating Safety and Seamanship

Teacher Page

Competency: Use good boating safety and seamanship
(A) Perform vessel emergency procedures

Tasks:
Explain the basic terms and principles of seamanship
Describe boating laws
Explain basic knot techniques (include splicing)
Observe the rules of the road
Explain navigational aids and charts
Use navigational aids, tide and current charts and equipment
Explain how to use nautical equipment such as compasses, sextants, dividers, radar, fathometers, sonar, loran, barometers, and CB and marine radios
Recognize changes in weather conditions
Maintain adequate safety margins in regards to weather and sea conditions
Obtain a current weather forecast
Follow safe boating practices
Explain emergency procedures for: fire, collisions, capsize, foundering, man-overboard and personal injuries.

Introduction

This competency will be discussed in three lessons:

Seamanship
Navigation
Safe Boating Practices

Resources

The following is a partial listing of the many reference books which are often found aboard fishing vessels. Much information is available from governmental and educational agencies. Good contacts are University of Alaska Sea Grant and Cooperative Extension Service, Alaska Vocational Technical Institute, U. S. Coast Guard, Seventeenth District, State of Alaska Department of Fish and Game, Commercial Fisheries Division, and the Alaska Seafood Marketing Institute.

Boating Skills and Seamanshop. U.S. Coast Guard Auxiliary This is the text for a basic course offered by the Auxiliary which is a must for everyone who uses vessels of any type on inland or ocean waters.

Chapman Piloting. Elbert S. Maloney, Hearst Marine Books, New York, The basic reference for navigation rules and techniques, which is carried on many vessels.

Fish Finding Techniques. Dennis Lodge, Alaska Vocational Technical Center, P.O. Box 615, Seward, Alaska 99664

Safety Notes for the North Pacific Fisherman, Marine Advisory Bulletin No. 3, University of Alaska Sea Grant.

The Alaskan Fisherman, Seventeenth Coast Guard District, Juneau, Alaska 99802

Alaska Marine Communications Handbook, Seventeenth Coast Guard District, Juneau, Alaska 1984

Nautical Chart Symbols and Abbreviations, Chart No. 1, Department of Defense, Defense Mapping Agency, Hydrographic/Topographic Center, Washington, D.C. 20315

Ocean and Inland Operator, License Preparation Course, Marine Education Textbooks, 124 North Van Ave. Houma, LA 760360-5895

Seamanship

What is seamanship?

Seamanship is defined as skill in sailing or working a ship, or the ability of a good seaman. What makes a good seaman? And what do you have to know to work a ship? In developing a good sense of seamanship, there is **no substitute for experience**, but there are some things you can learn beforehand that will help.

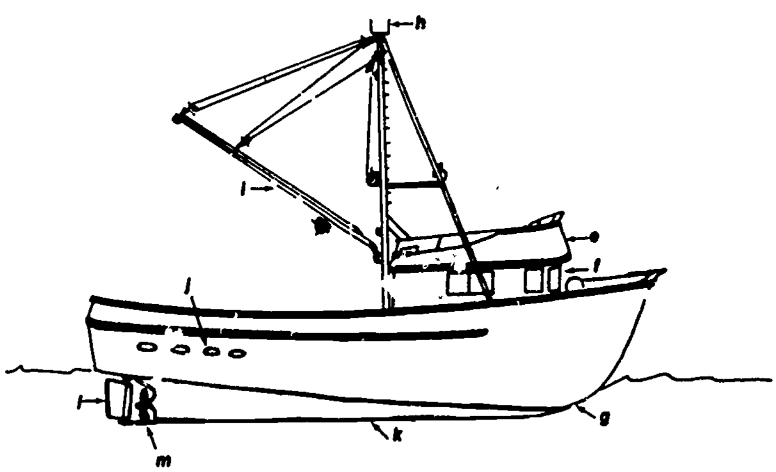
What are some basic seamanship terms?

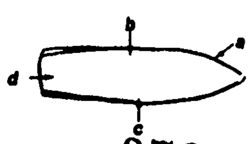
These are a few of the common terms for the principal parts of a vessel:

Hull: The body of a vessel without the cabin or other superstructure.
Bow: Forward part of the vessel (forward).
Stern: The after part of a vessel, or the back end (aft).
Transom: In smaller boats, this is the stern that is cut off flat, at right angles to the boat's centerline.
Bottom: The surface of the hull below the waterline.
Gunwale: The top edge of the hull.
Topsides: The outer surface of the hull between the bottom and the gunwale.
Bilges: The lowest internal spaces within a vessel's hull.
Bulkhead: A wall, or vertical partition aboard a vessel.
Portside: The lefthand side of the vessel facing forward.
Starboard side: The righthand side of the vessel facing forward.
Hatch: An opening in the deck to enter the spaces below.
Head: The bathroom.
Galley: The kitchen.
Bridge: The command center of a vessel.

Whew! That's a lot of terms. Here they are, pictured on fishing vessels:

a. Bow
b. Port
c. Starboard
d. Stern
e. Flying Bridge
f. House
g. Hull
h. Mast
i. Boom
j. Scuppers
k. Keel
l. Rudder
m. Propeller





Commercial fishing boats come in many various sizes and shapes. Usually the larger vessels will have displacement, or deep-draft hulls, which sit deeply into the water. Displacement hulls often are more affected by currents than by wind. Many smaller fishing vessels will have semi-displacement or planing hulls, which cause the boat to sit higher in the water, and to be more affected by wind than by current.

Some terms that describe the dimensions of a vessel are:

Beam: The width of a vessel at its widest point.
Draft: The vertical distance from the waterline to the lowest part of the vessel.
Freeboard: The minimum vertical distance from the waterline to the gunwhale.
Length: The distance along the centerline of the vessel from the bow to the stern.

The other parts of vessels are their fittings and running gear. These basic terms apply to all vessels:

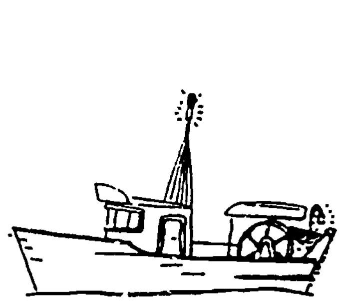
Line: Any rope used aboard a vessel.
Cleat: A deck fitting to which lines are secured.
Chock: A deck fitting through which lines are passed.
Helm: The steering apparatus of a vessel, sometimes called the **wheel.**
Rudder: The vertical blade underwater that steers the vessel.
Fenders: Any crab buoys, tires, or bumpers that protect the sides of the vessel.

Years ago, commercial fishermen in the Bristol Bay red salmon fishery used small double -ender sailing skiffs for their day of fishing. Nowadays, almost all fishing vessels use engines of some kind for their power. Here are the basic types of engine configurations used on fishing vessels:

Outboard: A vessel propelled by an outboard engine that is bolted onto the transom.
Inboard-outdrive: A vessel propelled by a marine engine within the boat that is connected to a rudder-propeller combination built into the transom.
Inboard: A vessel propelled by a marine engine within the boat that is connected through a steering box to a rudder and propeller(s) below the stern.

Outboard

Inboard-Outdrive



Inboard

Many handtrollers and setnetters who use skiffs in their work will use outboard engines. Slightly larger vessels will use inboard-outdrives. Usually, power trollers and any net fishermen use inboards, because they tend to have larger boats and need the extra power.

What are some of the basics of boat handling?

In order to know how a boat handles, you have to know how and why vessels behave as they do. Each boat, just like her skipper, is an individual. **Know your boat!** What kind of hull does she have, and how does it handle in all kinds of water and all conditions of weather? How does she handle with fishing gear out, or with a load? What are the limitations of the engine? Again, there is no substitute for experience, but certain aspects of handling are good to know before you start gaining experience.

The **propeller** and the **rudder** are the two principal devices that control the vessel. Propellers are right-handed or left-handed, depending on the direction of their rotation. When the propeller is viewed from aft, looking forward, and it turns in a clockwise direction when the boat is traveling forward, it is called a right-handed propeller. If it turns in a counter-clockwise direction, it is called a left-handed propeller. You can also identify propellers as right-handed or left handed by looking at them closely. Usually they are stamped "RH" or "LH" on the hub of the propeller. Propellers are often called **screws**, because their twisted surfaces resemble a screw.

In most marine engines, the flywheel turns counter-clockwise, and is called a left-handed engine. It requires a right-handed propeller. If your vessel is propelled by one engine, it is probably this setup, and it is referred to as a **single-screw** vessel. If your vessel is propelled by two engines, it is called a **twin-screw** vessel. The best arrangement for twin-screw vessels is to have the tops of the prop blades turn outward for better maneuvering qualities. In this case, the port (left) engine would have a left-handed propeller, and the starboard (right) engine would have a right-handed propeller. Twin-screw vessels are much more maneuverable at low speeds than single-screw craft, because varying amounts of power can be applied to each propeller separately, and there is a propeller on either side of the centerline, giving them greater turning leverage.

On outboard engines or outdrives, the rudder portion is the lower unit and shaft housing of the propeller, and the whole apparatus turns in the water as the wheel or engine handle is turned. They are very responsive and easy to maneuver.

In inboard engine setups, the propeller stays stationary, and the rudder is moved to steer the vessel. Generally, boats designed for low speeds have large rudders, and higher speed boats have smaller rudders. The rudder is placed directly behind the propeller, and twin screw vessels most often have twin rudders.

The first thing to remember when steering with a rudder is that when it is turned from the centerline, it moves the stern first, and then the bow changes direction. At low speed maneuvering, like in harbors or when approaching or leaving fish tenders, it is the combination action of the rudder and the propellers that produce the desired direction. But don't forget the wind and current! If you are knowledgeable of the effects of wind and current on your boat, they can be used for your benefit, assisting in your low speed maneuvers. Remember that wind has more effect on shallow-draft vessels, while current has more effect on deep-draft vessels.

Another handy thing to remember is the effect of right-handed propellers in single screw vessels. When moving forward, the propeller action initially forces the stern to starboard. When backing a right-handed single screw, the stern swings to port.

Twin screw vessels are often maneuvered at low speeds by using just the propellers, with the rudders centered. Without touching the wheel, but alternately putting the propellers in the forward or backward positions, the vessel can be much more easily maneuvered than a single -screw boat.

What Is marlinspike seamanship?

This kind of seamanship is named after a pointed instrument that is used in separating the strands of a rope when splicing. It is the art of handling and working all kinds of rope. (Of course, on a fishing vessel, there is no rope, only line!) You buy **rope**, and when you use it on your boat, it is **line**.

First of all, what kinds of line are most appropriate for your fishing vessel? Rope can be made from **natural** fiber, **synthetic** materials like nylon, dacron, or polypropylene, or **wire**. Wire rope is used where exceptionally large loads are used. Rope is usually measured by its diameter.

Most natural fiber rope used for boats is made from Manila, a fiber mainly obtained from the Phillipines. Manila is strong and durable with a minimum amount of stretch. With the improvements made in synthetic ropes, manila is not used much anymore. Nylon and dacron rope are much stronger than comparable sized Manila rope. You can get the same strength in a smaller diameter rope. Another good thing about synthetic rope is its resistance to rot, mildew, sunlight and salt water, all things which effect Manila rope.

Since **nylon** rope stretches, it is used where strength and stretch go together, as in mooring lines or towing lines. Nylon rope doesn't stay permanently stretched, but shrinks back to normal length when the load is lifted from it. New types of **polyester** ropes are being manufactured all the time, and they can be made with various textures as well. Some kinds of polyester ropes are polypropylene, Dacron, Kevlar, and Kodel. Polyester rope doesn't have as much stretch as does nylon rope, so it is a good rope to use where you don't need as much stretch. Another quality that makes it especially useful for crab pots is its ability to float.

Another factor to consider about rope is that there are different methods of construction. The oldest method of construction is **three-strand** rope. Each of the three strands is made of many smaller fibers that are twisted to the left (left-hand lay). When these three smaller strands are twisted together to form the rope, they are twisted to the right (right-hand lay) with some amount of tension. Because of this tension, and because of the opposing lays, the rope tends to stay twisted, or **laid**. Almost all rope is right-hand laid.

Braided rope is a more recent invention, and each type has special purposes. Single-braided rope can't be spliced, and is usually smaller diameter. It is used for small jobs on a vessel. Double-braided line has a braided core inside a braided cover, and is very flexible, since it is made with lots of small fibers. It makes very good dock lines, since it coils evenly and doesn't usually kink.

Before you buy rope for your boat, you must determine the **strength** and **size** needed for each job aboard. Study the characteristics of each available **type**, then determine which size and type is best for each line on your vessel.

How do you prepare the rope for use on your vessel?

When you buy your rope, it will usually have tape on the ends to prevent it from unlaying, or untwisting. Often synthetic rope will be melted on the ends, which also prevents it from unlaying. You can't leave your expensive rope like that, or it will be ruined before you know it. So what do you do? You **splice** the ends. Splices are used to join two lines together, for finishing off the end of the line, or for forming a loop in the end of a line.

In order to splice your rope, you need a sharp knife, a large marlinspike or fid for separating the strands of laid rope, and small cord or matches to seal the ends. If you are using natural fiber line the small cord is used to finish off the end after splicing. Matches, or some other heat source, like the galley stove can be used to melt the ends of synthetic line when your splics is finished.

How do you use lines?

So, now you have your lines made, but what kinds of knots are best to use aboard your vessel? There are many different knots, and the trick is to know when to use each one. Here are a few of the more popular knots:

The **square knot** is used so often on boats that it is often called the sailor's knot. It is used to join lines of equal diameter together. Don't use it when you expect a great load on the line, however, because it will tighten, and you'll never get it undone!

The **sheet bend** or becket bend is also used to tie two lines together. It will hold two lines of different diameters, and is relatively easy to untie even after holding a strain for a long time.

Use a **clove hitch** when you want to tie a line temporarily to a pile. It will last for short periods of time, and is easy to untie, if it hasn't gotten too wet. Sometimes a half hitch is added to make it more secure.

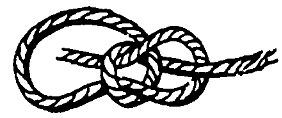
The **bowline** is a very special knot because it is easy to tie, will not slip or jam, and is as easy to untie as is is to tie. What it does is to form a secure loop at the end of the line. The loop can be tied around a piling or post, or any other object where you want to secure the line.

The **figure eight** is used as a stopper knot. Put it in your line to keep it from running out of a block, grommet, or other opening. You could also use it temporarily in the end of a line to keep it from untwisting.

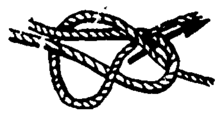
Two half hitches are used like a clove hitch, although the clove hitch is more popular. Use two half hitches when you need the knot for a longer period of time than a clove hitch.

Probably the most common procedure in docking a vessel is **belaying to a cleat.** This one is used a lot! First lead the line in one round turn around the base of the cleat. Then form at least one figure eight around the horns of the cleat, finishing off with a half hitch. Sounds simple, but it takes some practice. Try it and you'll see.

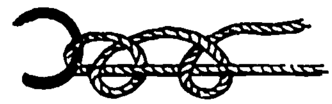
FIGURE EIGHT
Use to keep the end of a line from unraveling or as something to hold onto.



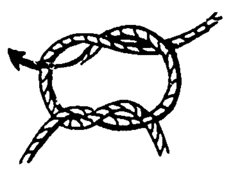
BOWLINE (pronounced bōlyn)
Use to tie a non-slip loop at the end of a line. The bowline does not jam and can be untied.



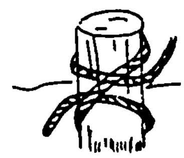
SHEET BEND
Use to tie two uneven lines together.



TWO HALF HITCHES
Use to make a line fast to a piling or a ring.



SQUARE KNOT
Use to tie two light lines of the same size together. (Be sure that the line going into one side on top is going out on top as it comes back through--otherwise it's a granny knot and won't hold!)



CLOVE HITCH
Use to make a line fast temporarily to a piling. (Be sure you push the top and bottom together, or it won't hold!)

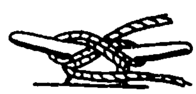


FIGURE EIGHT ON A CLEAT
Use to tie to a cleat. (Make sure the line is wrapped around the base of the cleat first.)

FISHERMEN'S BEND
Use to make fast to a buoy or the ring of an anchor. This knot is also called the anchor bend.

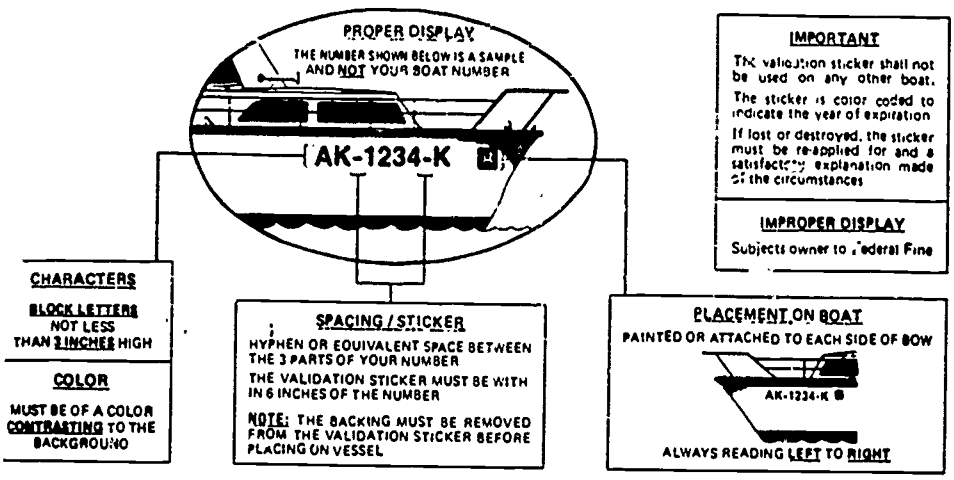
What are some boating laws?

There are two different types of laws which apply to Alaska fishing vessels. One type deals with safety. The other type are navigation rules, and those will be discussed in the next lesson. The Federal Boat Safety Act of 1971 gives the U.S. Coast Guard the mandate for improving boating safety. To do this, the Coast Guard registers all vessels, so they can keep track of them in an emergency, and also makes requirements of safety equipment which must be carried aboard a boat. It is important to know the boating laws, because ignorance will not excuse you from penalty if you break them.

All fishing vessels of the United States must be either documented with the Coast Guard or registered with the state where the vessel is principally used. In Alaska, the Coast Guard takes care of both functions through the Marine Safety Office, 612 Willoughby Avenue, Juneau, Alaska 99801.

Documentation is a form of national registration. Any fishing vessel over 5 net tons must be documented. Generally, a fishing vessel of about 28 to 32 feet in length will usually measure 5 net tons. Net tonnage refers to the cubic volume of the vessel, one ton being equal to 100 cubic feet. Documented boats are named, and do not have to show the Alaska registration numbers. They must be American-built boats. The vessel name and hailing port must be permanently displayed on the stern. The hailing port can be either Juneau, Alaska, because that is where the records are kept, or it can be the place where the owner resides or picks up mail.

If a vessel is less than 5 net tons it must be registered and numbered. Each vessel is required to have a current registration on board whenever it is in use. The number stays with the boat unless the boat is moved to another state. The number must be displayed on both sides of the forward half of the vessel. It can be painted on or attached to the hull.



The Coast Guard makes the requirements on the types of safety devices necessary aboard all fishing vessels. There are different types of personal flotation devices, (PFD, or life preservers) and different requirements for the size of your boat. In general, you must have one PFD on board for every person, and if your vessel is 26' or over, you must also have a ring buoy available on board. Interestingly enough, the Coast Guard does not accept exposure suits as a PFD, so they are carried in addition to regulation PFDs if you desire them.

Another safety requirement is fire extinguishers. The Coast Guard specifies the number and types of fire extinguishers necessary for each size of vessel. Fire extinguishers must be Coast Guard or UL approved for marine use, and must be in good condition. Usually, fire extinguishers are checked every year to make sure they are still serviceable, and recharged if they need it.

Some other safety requirements deal with the engine safety of the vessel. Vessels powered by gasoline engines, except outboard engines, must have an approved flame arrestor on each carburetor. There must be at least two ventilator ducts for every engine and fuel tank compartment of gas-powered vessels. You have probably figured out why these requirements have been made: ***gasoline vapors can explode!***

Your vessel must have approved navigation lights, and dayshapes available for display. Often navigation lights are called running lights. They must be turned on whenever your vessel is underway from sunset to sunrise or when it is foggy or stormy and visibility is restricted. Sidelights are green to starboard and red to port. Masthead light and stern light are white, and are located higher than the sidelights on the centerline of the vessel. In addition, various vessels use various types of lights at night or dayshapes during the day to signify their use at the time. The Coast Guard has all the information you need in order to be in compliance with regulations.

Sound signaling devices are required for vessels 40 feet and over. They must carry a horn and a bell. Smaller vessels aren't required to have both whistle and bell, but they must have some way of making an efficient sound signal. There are certain patterns of sound you must make if you are in fog or visibility is restricted.

Another safety measure, not only for the vessel, but for all life in the ocean is pollution prevention. If your vessel is 26 feet or over, it must have an oil discharge prohibition warning sign posted. You need to have some means of removing oily bilge slops to shore. A Certified Marine Sanitation Device must be installed where toilet facilities are part of the vessel. This treats sewage before it is released.

If you fish in federal waters of the Fisheries Conservation Zone you must also display your official number or state registration number (your Limited Entry number) on each side of the deckhouse. There are size regulations for the numbers: 10 inch-high numbers for vessels smaller than 65 feet; 18 inches high for vessels over 65 feet.

Is that enough regulations? Not quite! You are not required to have a radio on board, but almost all fishing vessels do. When you have a radio, you must follow the regulations of the Federal Communications Commission (FCC) about installing and using your radio. Each radio must have a station license and if you operate the radio, you need an operator permit. The ship station is licensed primarily for the safety of life and property, so distress and safety communication have absolute priority.

Navigation

What is navigation?

All navigation involves two things - determining your vessel's present position, and directing your vessel from that known position to another. Navigation can be of various types. The most familiar are ***coastal navigation***, or ***piloting***, ***electronic navigation***, and ***celestial navigation***. **Piloting** involves directing the movements of your vessel by using visible landmarks ashore, navigational aids and soundings.

Electronic navigation uses a very long-range navigation system (***Loran***) of radio stations operated by the U.S. Coast Guard. A Loran-C receiver on the vessel computes time differences in transmissions sent out by the master station and its secondary stations. Using these transmissions, a vessel can accurately pinpoint its geographic position (latitude and longitude). Loran-C is very useful for commercial fishing, because you can determine your position when no navigational aids or landmarks are visible, and you can return to a position where you previously had good luck catching fish!

Celestial navigation is an historically important and still useful type of navigation that uses vessel position with relationship to the sun and stars. It is very useful when crossing oceans, again, when no landmarks are visible.

Piloting isn't generally considered as complex as the other two types of navigation, but there is less elbow room for mistakes, because there are many other hazards to avoid, like rocks and reefs.

What are rules of the road?

Roads, you say? There are no *roads* in the waters of Alaska! Well, think about it. The waterways are the only means by which some communities are connected. Whenever there are two vessels in the same waterway there have to be some rules to govern how they meet or pass each other. That's what are known as rules of the road.

All Alaskan waters are governed under the International Rules of the Road. These Rules were formalized in the "Convention on the International Regulations for Preventing Collisions at Sea. 1972" and are now commonly referred to as the 72 COLREGS. (Now you'll know what that abbreviation means when you see it!)

What does that mean to Alaskan fishermen? All American vessels sailing in U. S. waters must display the proper lights, shapes and sound the proper signals as required by COLREGS. The idea is that if every vessel captain knows and follows the rules, collisions at sea will be avoided. Even though the rules are international, and usually apply to the open ocean, all sounds, bays, harbors and inlets in Alaska are governed under these same rules. This includes the inside waters of southeast Alaska.

Every type of vessel is required to have certain ***navigation lights*** of specified color, arc and range of visibility, and location. Since vessel captains have memorized these light configurations for all vessels, they prevent collision by identifying other vessels and giving some information about the vessel activities. Lights will show the relative heading of one vessel as seen by another, and will also give some clue about the vessel size, special characteristics, and/or current operations.

The usual navigation lights are as follows:

Sidelights	Green to starboard, red to port, 112.5° arc
Masthead Light	White, 225° arc, higher than sidelights and on the centerline
Sternlight	White, 135° arc, aft and on the centerline

How do you remember which side has red and which green? This is very important in all aspects of navigation. When standing at the helm, and looking toward the bow of the vessel, ***port*** is to your ***left*** and the color of the navigation light on your vessel is ***red***. ***Starboard*** is to your ***right***, and its color is ***green***.

Short words

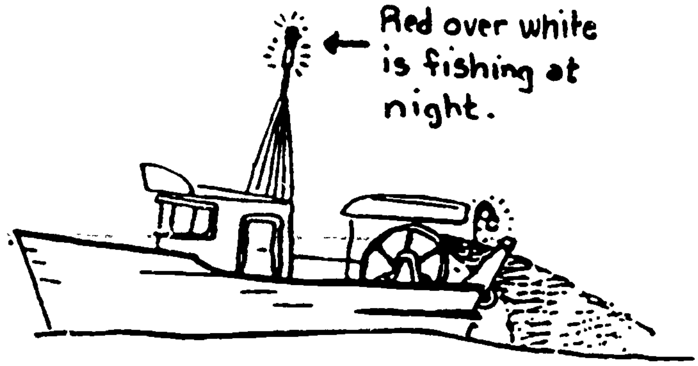
port
left
red

Long words

starboard
right
green

One of the most important pieces of information the navigation lights give is the position of the other vessel in relation to your own. That determines who has the ***right-of-way***. The vessel which has the right-of-way is known as the ***stand-on vessel***, and the other vessel is the ***give way vessel***. The give-way vessel must move out of the way, and the stand-on vessel keeps its same course.

But what if it is daylight? How do you know about the other vessel? Well, usually you can see its position and direction. But there are special situations such as being anchored, unable to maneuver, and FISHING, which require ***dayshapes***. Dayshapes are objects of specified shape, size, color (its always black), and placement on a vessel. Here's an example for a fishing vessel that is fishing in some other way than trawling:



You can see that if you are fishing at night, this little poem will be true:

Red over white,
Fishing at night.

Besides all-round red over white lights you also need a white sternlight plus red and green sidelights if you are making way. If it is daytime, you use two black ***cones***, point to point to show you are fishing. If you have a small vessel of less than 65 feet you can show a ***basket*** in the rigging instead.

Vessels engaged in fishing and displaying the proper lights and dayshapes have tne right-of-way over power and sailing vessels, and may fish in a traffic separation zone (A zone near a heavily traveled area that is like a highway marked on the charts). There are some vessels they do not have the right-of-way over: vessels restricted in their ability to maneuver, vessels constrained by their draft, vessels not under command, or vessels being overtaken.

This doesn't apply to trollers, however. Both power and hand trollers cannot claim the privileges of a vessel engaged in fishing, and may not display the fishing lights or dayshapes. There is also a difference for trawlers. They can claim vessel engaged in fishing privileges, but show green over white light instead of red over white light. There are many more rules that govern fishing vessels as well as other vessels, and a good skipper must know them all in order to follow the rules of the road.

What are navigational aids?

Navigational aids are devices that give mariners their exact position in relation to land and to hidden dangers. They range from lighthouses and buoys to invisible electronic beacons. Even though there are many kinds, they all have one purpose - to aid people on the sea. All aids to navigation except private aids are built and maintained by the United States Coast Guard. There are symbols for each kind of navigational aid that appear on charts. Mariners use charts like maps, to choose a course by using the navigational aids.

How do navigational aids help you find your way?

Navigational aids can help fishermen find the harbor when approaching from overseas, they mark dangers and the best channels to follow, and provide a continuous chain of charted marks for coastal piloting.

The waters of the United States are marked by the ***lateral system of buoyage.*** This is an arrangement of colors, shapes, numbers and light characteristics to show the side on which a buoy should be passed when traveling in a certain direction. The buoys are marked from seaward toward the head of navigation, but since all channels do not lead from seaward, a second system is used for marking buoys. On the Pacific coast buoys are also marked as if you are traveling in a northward direction.

One of the primary means of charting dangers or channels is buoys that are colored a certain way. Here are some of the common buoys:

> ***Black buoys*** mark the left side of the channel if you are traveling in from the sea. Black buoys can also be green. Sometimes they also mark obstructions or wrecks, and you would keep them on your port side if you are traveling in from the sea.
>
> ***Red buoys*** mark the right side of the channel as you are traveling in from the sea. Sometimes they also mark obstructions, and you would keep them on your starboard side as you travel in from the sea.
>
> ***Red and black horizontally banded buoys*** mark junctions in the channel or obstructions, and you can usually pass on either side of these. If the topmost band is black the preferred channel is to keep the buoy on your port side. If the topmost band is red the preferred channel is to keep the buoy on your starboard side.
>
> ***Black and white vertically striped buoys*** mark the midchannel, and you can pass on either side of them.

Another way of describing buoys is by their shape. Buoys can have many shapes, but two are significant:

> ***Nun buoys*** are shaped like cones on the top, and are solid red. They mark the right hand side of the channel if you are entering from seaward.
>
> ***Can buoys*** are cylinder-shaped (like large tin cans) and are painted solid black (or green). They show the left hand side of the channel when entering from seaward.

In any other buoys the shape makes no difference, and sometimes nun or can buoys are used in different places with a different paint pattern than solid red or solid black. In these cases, the paint color is significant, and not the shape of the buoy.

Most buoys also have numbers, and those numbers are shown on the charts as well, so you can always tell from the number of the buoy exactly where you are on the chart. When buoys mark the channel, they are numbered with the smallest numbers starting at the seaward end of the channel. ***Odd numbers*** are used only on solid-black buoys. ***Even numbers*** are used only on solid-red buoys. The numbers increase from seaward and are kept in approximate sequence on both sides of the channel.

So, here you are - approaching a harbor as you return from the Gulf of Alaska. Remember that you keep the red buoys that are often shaped like nun buoys, and have even numbers to your right. You keep the black, can-shaped buoys with odd numbers to your left. Here's an easy way to remember the pattern:

Red
Right
Returning

There are other ways that buoys are marked. Buoys of special importance must be seen at night, so they are lighted or equipped with reflectors. ***Lighted buoys*** can be used in place of nun or can buoys, but they are never used on the buoys themselves. On lighted buoys that take the place of nun or can buoys, black buoys have green lights and red buoys have red lights, or both kinds could have white lights. White lights can be used on any color of buoy, and it is the color and number of the buoy that tells its use. Another way to tell the reason for a lighted buoy is to watch its pattern of flashing. This is called its ***light phase characteristic.*** There are regular patterns that are used for different kinds of buoys.

There is a Coast Guard publication called Light List, Pacific Coast and Pacific Islands, Volume III. This tells the light phase characteristics of every lighted buoy and navigational aid. When you see a light in unfamiliar waters you can check its flashing pattern to be sure it is the light you ***think*** it is.

There are other navigation aids that are not lighted and are not buoys. They are called ***daybeacons*** or ***daymarks***. They can take various shapes, and are usually colored so they stand out from their surroundings. Lots of times they are located on points or reefs, or they can be part of a lateral system of marking channels. If they are used to mark sides of channels they are colored and numbered in the same patterns as nun and can buoys.

Sound buoys work when there is low visibility, like night or fog, and they can be bell buoys, gong buoys, whistle buoys or horn buoys. Each type sounds different from the other so you can tell them apart. Bell, gong, and whistle buoys are rung by the action of the sea. As the buoy moves with the sea, it produces a noise. They don't produce regular signals, and if it is very calm, won't make sounds at all. Horn buoys are sounded at regular intervals by mechanical means.

Of course, there are many other facts to know about navigation aids and the lateral system of buoyage. This is just an overview. Before you would actually be qualified to pilot a fishing vessel you would want to have a much better understanding of navigation aids. A very good source is Boating Skills and Seamanship, by the U.S. Coast Guard Auxiliary.

What equipment is necessary to navigate a fishing vessel?

For piloting, there are a few simple tools that your vessel must have:

Charts of the area in which you travel
A good magnetic compass
Binoculars, 7 x 35 or 7 x 50
Parallel rules or course protractor
Dividers, for measuring off distance
Pencils

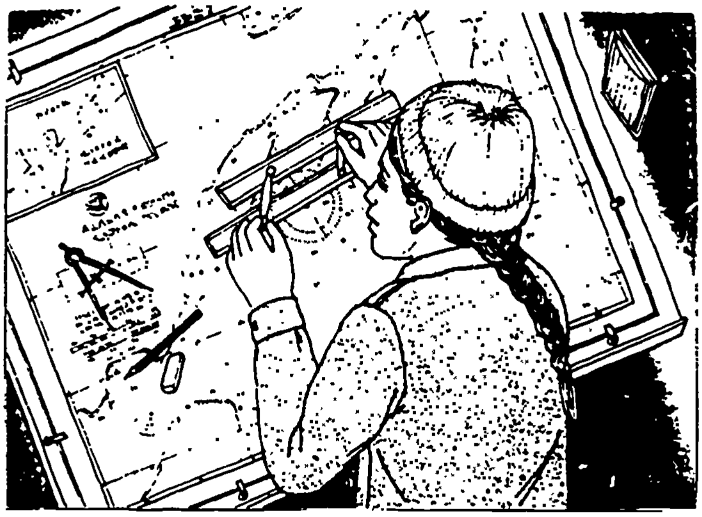
If your vessel fishes in the Gulf of Alaska much of the time, you will want to have a Loran-C receiver available, and learn how to use this electronic navigation system.

How are navigation charts used?

Navigation charts are called ***nautical charts,*** because they show what the bottom looks like in relation to the landforms around it. In addition, charts show the major landforms that would be visible from your vessel. Because they use standard symbols, charts contain as much information as a large book. Some of the items shown on charts are water depths, types of bottoms, prominent features and structures ashore, aids to navigation, and latitude and longitude. Study a chart of your area to find how these items are used to map waters familiar to you.

Charts are used like maps to guide the mariner on the ocean. They are classified according to scale. For navigating harbors or bays, charts with larger scale are used. If you are on the open ocean, charts with smaller scales can be used.

To navigate, compass courses are plotted on the chart, then followed by using the compass heading on your vessel. To set a course on the chart, first pick starting and ending points. Set the parallel rules on these points, and draw a line. Then "walk" the parallel rules to the nearest compass rose. The compass rose shows both true North and magnetic North. By using the magnetic North (inner) scale, you can determine the compass heading for your vessel. Piloting involves setting point to point courses in a sequence from your starting to your ending point, then following these courses with your vessel.



How are tide and current charts used?

Tides and currents are powerful forces that greatly effect the operation of your vessel. Knowledge of tides and currents is essential for safe navigation. This knowledge will help you in anchoring your boat, making fast to a pier or wharf, crossing shoal areas, or navigating narrow, swift-flowing channels.

Tide is the rise and fall of the ocean level. Alaskan waters have two high and two low tides each day, and each tide is usually of a different height. For this reason, the water depth on a navigation chart is figured for the average of the lower of the two low tides. This is called the ***mean lower low water (MLLW).*** When there is a high tide, the water will be higher than described on the navigation charts, and the tide table will tell you how much higher it will be. At times, during low tides that are lower than MLLW, the water level on the navigation charts will be lower than the chart reads.

Tides are predicted on tide tables, and tide tables usually show all the tides for a calendar year. There are two kinds of tide tables in common use. The handy booklet-sized tables called Dot's Fishing Guide, published by Elliott Sales Corp., Tacoma, Washington will tell the local tides for certain areas, like the Juneau area, or the Prince William Sound area. The time and tide differences for adjacent areas are described on correction charts within the tide table book To find the tide for a certain area, you would use the correction charts in conjunction with the tide tables. These tide tables us the 12 hour clock, AM and PM to show times of tides.

A larger book, called Tide Tables: West Coast of North and South America is published every year by the National Oceanic and Atmospheric Administration, a part of the U. S. Department of Commerce. For vessels that range throughout Alaska, or further down the Pacific Coast, this book can be used to find the tides of any of these areas. Since local tides are referenced on much larger areas, it is important to use the correction charts to find the correct tide. These tide tables use the 24-hour clock to report times of tides. The time on a 24-hour clock is always expressed in four digits. The first two digits refer to the hour. The last two digits tell the minutes. With this system, 2:47 A.M. will be 0247, 2:47 PM will be 1447.

Try reading a tide table for your area. Use both kinds, if possible, and see how they report the same tides in a slightly different manner. Look through the booklet or book to find out what other information is included.

Because the tide causes movement of large amounts of water, it can also create ***currents*** in narrow openings or straits, and in the openings of rivers and bays. Currents caused by a rising tide are called ***flood currents***. Currents caused by a falling tide are called ***ebb currents***. Some passages have currents so strong that some boats cannot make way against it. For instance, if the force of a flood current is 6 knots (6 nautical miles per hour, a nautical mile being about 6.076 feet) and your vessel is traveling against that current at a speed of 8 knots, your speed is only 2 knots. If you were going with the current, you may lose control of the boat, since your speed would be 14 knots. The best time to preceed through the area is at ***slack water***, when there is little or no current.

Currents alternate with the tide, but not exactly at the same time. At high tide the current can still be flooding and at low tide the current can still be ebbing. Slack water usually occurs just after high tide and low tide, but there is a lot of variation, depending on your position in the strait or bay. To find the time of slack water, and the current variations, you would use the Tidal Current Tables, Pacific Coast of North America and Asia, published by the National Oceanic and Atmospheric Administration. These tables are in the same format as the tide tables published by NOAA, except they give times and directions of maximum flood and ebb currents and times of the two slacks when current direction reverses. Like tide tables, they are published yearly, and it is important for a set to be present on every vessel.

Obtain a copy of the Tidal Current Tables, and practice reading them in conjunction with the tide tables for your area. This is a skill that takes much practice, and knowledge of how to read these tables is indespensible to the commercial fisherman.

What other references are used for navigation?

Several publications are essential for safe navigation: Tide Tables, West Coast of North and South America, Tidal Current Tables, Pacific Coast of North America and Asia, Boating Skills and Seamanship, Light List, Pacific Coast and Pacific Islands, Volume III, and navigational charts.

There are other references that are valuable sources of information. One of the most used books is Chapman Piloting, Seamanship and Small Boat Handling, which is geared to recreational boating, but has much valuable background information about all kinds of vessel operation. Its four parts cover terminology and legal requirements, seamanship, piloting, and general information.

Because information on nautical charts is limited by space and by the system of symbols used, there are volumes containing additional information, published by the National Ocean Service. The nine volumes of Coast Pilot cover specific areas of U.S. coastal waters. Each Coast Pilot contains sailing direction between ports in its respective area. It describes channels and their depths, dangers, anchorages, harbors, and information on boat supplies, and marine repair facilities. The two volumes used in Alaska are Coast Pilot No. 8 Dixon Entrance to Cape Spencer, and Coast Pilot No. 9 Cape Spencer to Beaufort Sea. Number 8 covers southeast Alaska, and Number 9 covers the waters of northern Alaska. These volumes are updated every two years, and every vessel should have the latest volume on board.

The navigation references published by the U.S. government strive to present information that is as current as possible. Since Coast Pilots are published every two years, and navigational charts are published more infrequently, the U.S. government provides Notice to Mariners on a regular basis. Local Notices to Mariners are issued by the Commanders of the Coast Guard Districts for each area. These weekly publications can be obtained free of charge by request from the Coast Guard, and they discuss items of importance to the safety of marine navigation concerning aids to navigation, channel conditions, menaces to navigation, and special conditions that may affect vessel operation. they are a valuable reference for keeping nautical charts and other publications up to date.

What are some kinds of nautical equipment used for safety and navigation?

The kind of equipment on board your boat depends on what kind of fishing you do. It can range from no equipment to a completely electronic pilothouse that looks like the cockpit of a jet airplane! Since equipment kinds and types vary so much, you should consult the operation manual that comes with each piece of equipment to learn how to use it, then practice using it. Some of the equipment with which you may have to become familiar is listed here:

Compass: The magnetic compass is essential for navigation, because you can match your compass reading with the readings from the compass rose on each chart.

Sextant: This instrument is used in celestial navigation for taking sights on the sun, moon, planets, and stars when on long offshore passages.

Dividers: These are an instrument of two arms joined by a pivot, and are used for measuring distance on a nautical chart.

Radar: Used for marine navigation, a radar set sends out brief pulses of super -high frequency radio waves that are reflected by object at a distance. The distance to the reflecting object is measured by the time it takes for the pulse to go out and the echo to return. Radar sets have a transmitter, antenna, receiver, and some kind of visual indicator.

Fathometers: Also called depth sounders, there are many types of these instruments that use pulses of high-frequency signals to travel from a transducer located beneath the hull to the bottom and back. The time taken by the pulses for the round trip to the bottom and back tell the depth under the vessel, and are shown on an indicator, sometimes called a flasher, a recordor (also known as a papergraph), or a video display screen, which is sometimes called a colorgraph. This use of high-frequency signals is also called **sonar**, or **sound** navigation ranging. If the signal is directed to the bottom, it is used as a depth finder; if it is directed in any other direction (like in the water ahead of the boat) it is used as sonar.

Loran C: Another very important navigation tool, the name **Loran** is derived from **long range** navigation. This is an electronic system using shore-based chains of radio transmitters and shipboard receivers to assist mariners in determining their exact position at sea. Coverage by Loran-C stations extends to most of the Northern Hemisphere. A big advantage of Loran is that it works 24 hours a day in all kinds of weather. The Loran-C receiver measures the microseconds (one millionth of a second) of difference in time it takes to receive a master radio signal as compared to a secondary radio signal. Loran-C lines are shown on all navigation charts, so the charts and the signals can be compared.

Barometer: This is a weather instrument for detecting changes in the pressure exerted by the atmosphere on the earth's surface at a particular point of observation at that time. By regularly logging the barometric pressure, you can detect the pattern of changes, and thus determine if there will be a change in the weather. Normally, falling pressure signals a storm's approach, and rising pressure indicates fair weather.

VHF radio: This marine radiotelephone system is required on commercial vessels. Channel 16 is the distress, safety and calling frequency which should be monitored at all times. There are many rules governing VHF operation, and all radio stations aboard vessels must be licensed by the Federal Communications Commission. Ship stations are licensed primarily for the safety of life and property so distress and safety communication have absolute priority. In addition, the person using the radio must have an operator license.

CB radio: The function of the 27 MHz Citizens Radio Band radio is to provide an individual means of conducting personal or business communication over a 5 - 15 mile radius. No operator permit or operator license is required, but you must have a station license before you can operate a CB radio.

Safe Boating Practices

What does weather have to do with boating?

Weather has a tremendous influence on vessel operation and safety. It determines the channels you can or cannot navigate, the areas where you can fish, your anchorage for the night, and whether you can travel at all. Alaska has especially fierce and violent storms which can appear out of nowhere in a matter of minutes. It is responsible for the loss of many boats due to icing of the superstructure. It is very important for commercial fishermen in all areas to understand and recognize weather patterns and conditions.

As a very broad generalization, it is usually areas of barometric high pressure or winds from northerly directions that bring fair weather. Storms are generally indicated by winds from southerly directions or areas of barometric low pressure. The good commercial fisherman learns all he/she can about weather conditions in the areas fished.

How can you recognize changes in weather conditions?

One of the best ways to recognize weather changes is by sight. There are a number of general weather signs that will tell of approaching bad weather. These signs are not always completely reliable, so they should be verified by other means. Here are some of the signs that are discussed in the U.S. Coast Guard Auxiliary book Boating Skills and Seamanship:

> In the northern hemisphere, with the wind in your face, low pressure will always be on your right hand side.
>
> Fair weather will remain when the winds blow gently from the west or northwest and/or cumulus clouds dot the sky in the afternoon.
>
> Rainy weather, storms, or snow could appear if:
> The wind changes to south and picks up
> Cirrus clouds thicken and lower
> The barometer is dropping
> A ring forms around the moon
> Clouds move in from the west

Besides learning to observe the weather by sight, it would also be helpful to learn how to use other tools that indicate the weather, like ***barometers***, which measure atmospheric pressure in either inches of mercury or millibars, ***anemometers***, which measure wind speed, and ***thermometers***, which measure degrees of temperature.

What are some ways to obtain a current weather forecast?

The most reliable way to obtain a current weather forecast is to listen to the U.S. Coast Guard broadcast over the VHF radio. They obtain the current forecast from the Weather Service and broadcast this forecast at specific times of the day. You are alerted on Channel 16, then asked to switch to Channel 22 for the marine information broadcast, which gives weather information as well as Notices to Mariners. This is usually broadcast twice in the morning and twice in the evening at specified times. Also on the VHF are channels which repeat the taped marine forecasts continuously 24 hours a day. You should know which weather channels can be picked up for each area you fish.

Other ways to obtain broadcasts are from television or radio marine forecasts, or by telephoning the Weather Service for the recorded marine forecast. The marine forecast is also often included in local papers. In harbors, warning boat signals are often posted in the form of flags which indicate small craft warnings, storm warnings, and gale warnings.

What safety margins for weather and sea conditions should you maintain?

Fishing is the most dangerous occupation in Alaska, and a large measure of that danger is provided by the abrupt and fierce changes in our weather. Sometimes the short openings for a fishery will cause fishermen to venture out in weather beyond the capabilities of the vessel. The smart commercial fishermen listens to and heeds the weather forecast. The safety margins are different for different sized and powered boats, so it is important for the fisherman to know how the vessel reacts in all kinds of weather.

What are some safe boating practices you should follow?

The U.S. Coast Guard is very concerned about safe boating, since it is their job to assist mariners in distress. They will inspect your vessel to alert you to any unsafe features or equipment, and they also provide information and literature about boating safety, as well as advice on vessel regulations and equipment required by law. The Coast Guard certifies many kinds of safety equipment necessary on vessels, such as personal flotation devices (PFD), distress equipment, and fire extinguishers. They are the agency you notify if there is a boating accident or death, or in a vessel emergency. Rely on the Coast Guard if there are any questions or concerns you have about the safety of your vessel or crew.

Remember that everything that is done or used on a vessel can affect your safety. ***Know your boat!*** Check your equipment periodically to make sure it is working properly. Use caution when navigating the vessel or when working on deck. Pay attention to your boat handling, and the trim of your cargo of fish. Stay clear of known obstructions and consult your charts and depth sounder often. Know and follow the boating regulations and laws. They are for your own protection.

Although survival or exposure suits are not the kind of PFD required by law, our frigid Alaskan waters make it imperative that you have a survival suit on board for each crew member. These suits have saved many lives of fishermen in Alaska. In almost every case where a vessel sinks, it is the crew with exposure suits on that live to tell of their miraculous escapes!

A float plan is especially important for vessels fishing in Alaskan waters, since ports are often few and far between. Once you are out on the fishing grounds, there is no one to help you in many instances, and if no one knows you are overdue, they won't know to alert the Coast Guard. A float plan simply tells your departure and arrival times, your destinations, your route, alternate plans in case of bad weather, and a description of your boat, persons on board and safety equipment. This can be given to a friend, relative, or someone you know is reliable, and will call the authorities if you don't return on time. Also, don't forget to report in when you return, so the person knows you made it!

How should you react to emergencies?

The first thing you should do occurs before the emergency: every crew member should be familiar with the emergency procedures and distress signals for your vessel. Practice them, and especially practice getting into your survival suits. This is a hard enough job when it's not an emergency.

Some of the emergencies you may experience are fire, collisions, capsizing, foundering, icing, shift in cargo, sinking, man-overboard and personal injuries. The following list shows some of the procedures you may have to accomplish, depending on the emergency.

a. Alert the crew
b. Issue personal flotation and immersion protection devices
c. Administer first aid to prevent shock and control bleeding
d. Administer CPR
e. Launch and operate lifeboat and life raft
f. Close emergency fuel shutoff valves
g. Extinguish fires
h. Act as lookout to keep person in sight who has been lost overboard
i. Secure engine room to prevent spread of fire
j. Send out distress signals
k. Sound abandon-ship alarm, if necessary

This is a general overview of some safety procedures to follow. You can't know too much about vessel safety, so it would be wise to consult other safety materials to learn of other safety precautions to follow on your fising vessel. ***The life you save will be your own!***

Maintaining a Fishing Vessel

Teacher Page

Competency: **(A) Maintain vessels**
(A) Maintain and operate fish processing and preservation equipment

Tasks: Arrange for grid, dry docking, or haul-out
Follow a regular maintenance list

Introduction

This lesson requires actual experience and proficiency on a fishing vessel. The material will give general guidelines for accomplishing these tasks within actual work experience. The fish processing and preservation equipment discussed pertains to that equipment found on a fishing vessel, and not equipment found in a cold storage operation.

Resources

It is most desirable for this lesson to have an actual fishing vessel or equipment on which to work. In the classroom situation, you could bring in certain pieces of equipment.

Try to use repair and maintenance manuals from the vessels and equipment with which the student are gaining experience. Students should be acquainted with the parts of the manual, and the equipment they are maintaining.

Mending of fishing nets, FAO Fishing Manual, Fishing News Books Ltd., 1 Long Garden Walk, Farnham, Sueery, England, 1973. This would be a good resource to teach net-mending. Contact the University of Alaska Cooperative Extension Service for other resources.

Maintaining Fishing Vessels

What are the parts of a fishing vessel that must be maintained?

There are many kinds of fishing vessels, each loaded with the equipment necessary for making a living at fishing. Proper and regular maintenance not only extends the life of your investment, but it assures you the safest fishing possible in the most risky occupation in Alaska. In general, the maintenance of your vessel can be divided into several areas:

Engines, both main and auxiliary
Electrical systems and nautical equipment
Steering gear
Hull
Superstructure
Fishing gear

What is a maintenence list?

Your vessel should have a maintenance list which details each ***task*** to be done and the ***time schedule*** for completing it. Following the list will keep your vessel in prime condition. Here is an example of the kinds of tasks which should be on your list:

Change brushes in auxiliary engines
Change lube oil and fuel filters on auxiliary engines
Determine if motor bearings are excessively worn
Clean electric motor
Repair hoses, valves, connections, gaskets, and tanks showing wear
Determine if const-a-voltage regulator is functioning properly
Determine if drive bolts on air compressors are excessively loose
Tighten panel box fittings to prevent vibration
Clean keel cool strainers, oil coolers and oil strainers in marine gears
Drain water out of fuel traps
Tighten fuel and oil line connections on engines
Inspect day tanks containing fuel for leaks
Lubricate deck and engine room equipment
Wash down vessel's superstructure and decks
Inspect and maintain hull, keel, and rudder assembly
Inspect and maintain fishing gear

Your vessel may have these same tasks, or there may be others to include on your list. In addition, use the manuals that come with each piece of specialized equipment to determine the maintenance schedule you should use. The more maintenance you can complete yourself, the less costly it will be to keep your vessel in top condition.

What about a timeline for maintenance? Many parts of your vessel, like the engines, will require frequent maintenance. Rather than a calendar schedule, engines are usually tuned and maintained after each certain number of hours they are used. Vessels used frequently will usually require more engine maintenance that those that sit in the harbor most of the time. The hull is usually checked yearly, and that is a good time for following all the items on your maintenance list that should be completed yearly. Most fishermen use the off-season for whatever fishery they fish as their maintenance period.

Try making a maintenance list for your own vessel, or the vessel that you are learning on. Include all parts of the vessel, and set the maintenance schedule by using any manuals available.

How do you maintain the hull?

You can choose any free time for maintaining most parts of your vessel, because they are accessible, but unless you can breathe underwater, you'll have to wait for work on the hull until you get the vessel out of water. There are several ways to get your boat out of the water:

Grid: A grid is a system of heavy timbers attached at right angles to pilings that looks like it is underwater when the tide is high. However, when the tide is low, it is exposed. Grids are located with almost all harbor facilities in Alaska. To use a grid, you pull your vessel above it when the tide is high, and secure it to the pilings. Make sure the rudders or propellors aren't located where they will rest directly on one of the beams. Then all you do is wait until the tide is low (and hope you have enough lines on your vessel so that is doesn't tip over!). As soon as the tide is low enough, you can begin working on your hull. You have only the time until the tide comes in again, so be sure you don't tackle more than you have time for, or plan to wait through two tides.

Haul-out: Many harbors or shipwrights have hydraulic haulout lifts that can place your vessel on dry land. There is usually a size limit, so if you have a large vessel, you may not be able to use these. One kind of lift operates at a specific dock position. You position your vessel within heavy nylon straps that have been lowered into the water and the vessel is then lifted out of the water. Wheels and an engine on the lift can move the lift and your vessel to an assigned position on the wharf, where it is blocked up. You have all the time to work on your vessel that you need. When you are done, the lift takes your vessel back to the water.

Another type of haul-out actually performs like an artificial grid. After you position your vessel over an underwater cradle on a platform, the platform itself is raised above the high tide level. You hire the platform for a specific period of time. At the end of the time, your vessel is lowered back into the water, good as new.

Dry-dock: Built especially for large vessels, a dry-dock uses a cradle on a set of tracks that extend down a ramp to below low tide level. After your vessel is positioned over the cradle, the cradle is slowly moved up the tracks, pulling your vessel to the wharf. The vessel is maintained and repaired while on the wharf, and when maintenance is complete, is put back into the water with the same cradle. Extremely large vessels may be left in the cradle for repairs, since it is too difficult to move them.

How do you maintain the fishing, fish processing and preservation equipment?

While your vessel is very important, the fishing gear you use is also as important, and is the difference between profit and loss. If you don't have your gear out, you can't catch fish - its as simple as that. Your gear should be checked periodically for wear and tear. Replace those parts that won't stand up to that next 50-lb king or 300-lb halibut. You wouldn't want to lose that fish! Lines that have been kinked or twisted are especially prone to breaking, so replace those if at all possible.

Generally, net fishermen have the bigger job, and netmending is a specialized technique in fishing that requires a great deal of skill. Netmenders use large needles or meshsticks that correspond to the size of net being mended as well as twine of some kind to repair the tears in the net. Small holes are trimmed, then re-woven by special techniques. Often a sheet bend knot is used. If a hole is large, a panel is removed and replaced.

Fish processing and preservation equipment should be entered on the maintenance list for the vessel. Much of it requires refrigeration units or engines of some type that maintain cool temperatures, and will have manuals discussing the maintenance and repair. If your vessel is small and carries ice only, regular sanitation and cleaning is required in order to have top -quality fish to sell.

This overview has given you some ideas for maintaining a fishing vessel. Maintenance provides for your safety as well as saving you money in the long run. After you have had some practice at maintenance, you'll want to establish your own schedule for maintaining your vessel.

Marine Products

Teacher Page

Competency: Correctly handle, process and market marine products
Maintain fish quality

Tasks: Place legal catch in container and return illegal catch to sea
Explain proper ways to handle fish and shellfish
Explain methods of cleaning seafood
Slit fish, remove viscera, wash cavity and prepare troll-caught fish for storage
Remove, clean, pack and store catch appropriately
Keep seafood cool, clean, moist and moving
Explain the importance of vessel and product sanitation

Introduction

Many of these tasks require actual experience to be completed, and it is suggested that you have students practice them on a fishing vessel. Your should get copies of the quality guides listed below and use them as resources for your students.

Resources

Recommended Salmon Quality Guidelines for Fishing, Tendering and Processing Operations, Alaska Seafood Marketing Institute, Department of Commerce and Economic Development, 526 Main Street, Juneau, Alaska 99801.

Recommended Whitefish Quality Guidelines for Fishing and Processing Operations, Alaska Seafood Marketing Institute, 526 Main Steeet, Juneau, Alaska 99801.

Alaska Sea Week Curriculum Series: VI Fish and Fisheries, Alaska Sea Grant College Program, University of Alaska, Fairbanks, Alaska, 99701. Worksheet 6A, "Taking Care of Your Catch" gives a good overview of the importance of cleanliness and proper handling of fish.

Marine Products

What can you keep, and what must you return to the sea?

You are a commercial hand troller, fishing out of Elfin Cove, in southeast Alaska. It is a good day for catching king salmon, and the price is right. There goes the bell! You have a big strike, although the gurdy is vibrating in a funny way. After doing all that cranking, you come upon a respectable halibut, waving his tail at you from the end of the line. Well, what the heck, you think. I need something to eat while I'm fishing, anyway. Do you keep it? Well, if you have read your ***regulations,*** you would soon realize it is against the law to have a halibut on board your vessel while fishing for salmon.

Your next strike is a king - a nice little one. It looks about 27 inches as it thrashes near the boat. Do you keep it? Nope. This is a ***shaker,*** so-called because it must be shaken from your line, or released. Legal kings must be 28 inches long or longer.

It is important to know the fishing regulations for your particular fishery. The regulations are put in place to protect stocks of fish. For instance, the regulation that only male Dungeness crabs that are 6 1/4 inches across the carapace insures that only mature males are harvested, leaving the females and some males to breed and produce more crabs. You can get regulations for your fishery from the Alaska Department of Fish and Game.

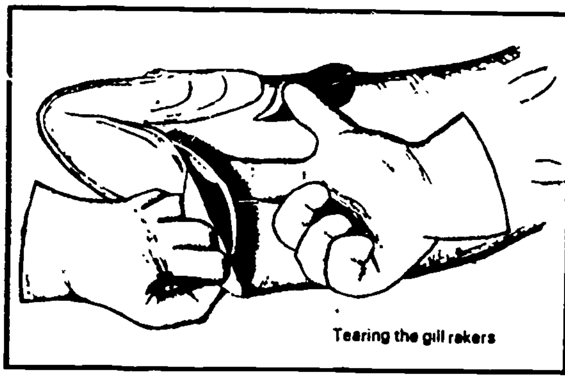
What are the proper ways to handle fish and shellfish?

The most important thing to remember is that ***fish are food!*** They must be handled carefully to preserve the quality. This also helps your pocketbook, because the better the product you have to sell, the more money you make. Fish should be handled carefully at all times. Remove fish gently from the gear, but not by the tail. For trollers and long-liners, live fish should be stunned in the water or as soon as they are brought on board. Don't throw, kick, or step on the fish, and don't let the fish be damaged by something on your vessel. Don't use forks, picks, hooks or pumps that could damage the edible part of the fish.

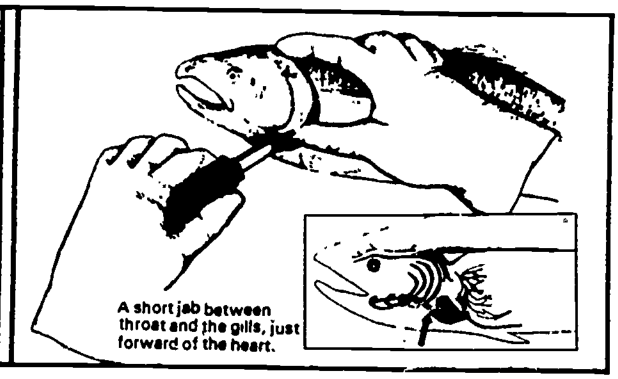
When the fish get on board they should be protected from heat, sunlight, air-drying and bad weather. You shouldn't have any pets on board, because they can contaminate the fish. Be sure the fish do not come in contact with things like bilge water, gas, diesel oil, or other petroleum products. Fish take on the taste of these things very rapidly.

What are some methods of cleaning seafood?

The kinds of fish that are most often cleaned are the salmon caught by trollers, the halibut caught by longliners, and some kinds of whitefish. The first thing to do for all fish is to bleed them. To do this, you cut a slash at the point where the gills are attached. This is closest to the fish's heart, and the blood is soon pumped out of the fish, if the fish has just recently been stunned. To clean salmon, they are gutted and gilled. The line containing blood products that is just under the backbone is scraped completely clean, and the fish is washed. Then it can be packed in ice. Halibut and whitefish are also gilled and gutted.



Tearing the gill rakers



A short jab between throat and the gills, just forward of the heart.

How do you remove, clean, pack and store catch appropriately?

If you catch fish in volume, you'll want to get them below deck and into the hold with a minimum amount of handling. Chutes are often used on board gillnetters, seiners, or trawlers. In the holds, there should be shelves every yard or so to protect the fish from being squashed at the bottom if they are held in bulk. If you have fish tanks, you should have them divided so the fish don't get damaged by the motion of the boat.

All fishermen should use ice or some other method of chilling the fish, and the fish should be chilled as soon as possible. When using ice, the temperature of your fish hold should be from 32° to 35°F. If you use a chilled or refrigerated sea water system, be sure the tanks are prechilled to 30° before loading your fish, then maintain the tanks at 32° to 35°F. To make sure your fish are being held at the proper temperature, check the temperature of the fish hold or the internal temperature of a sample fish every six hours.

Dressed fish should be iced in plastic tubs or holds that have a drain. When packing fish in the tubs, make sure the head is the lowest part of the fish, and pack ice into the body cavity. Then put ice all around the fish, making sure the fish don't touch each other.

Why must you keep seafood cool, clean, moist and moving?

You are in the commercial fishing business for the money, right? (Also, it is and exciting, rewarding career for persons who like the sea, and who like being independent businessmen.) The most money can be made by delivering a superior product to the buyer. To keep your fish in the best condition, remember the four rules:

Cool Clean Moist Moving

To keep fish cool, ice them or place them in refrigerated holds. To keep fish clean, make sure the vessel is cleaned and sanitized regularly. To keep fish moist, don't expose them to sunlight, wind, or weather when they are not in the holds. To keep fish moving, deliver them as quickly as possible to the processor.

What is the importance of vessel and product sanitation?

Ever heard of bacteria? They are tiny one-celled organisms that just want to make a living too. Unfortunately, they make their living by contaminating your fish, and eating their flesh! They grow by dividing, and one bacteria can produce an astonishing amount of progeny in the course of one 24-hour period. Bacteria are normally present in the body cavities and gills of fish, but do no harm while the fish is living. The minute the fish is killed, however, they are able to multiply without being checked. When they are multiplying by using the fish as food, we say the fish is rotting.

To keep bacterial in check, you fish and vessel must be clean at all times. Since fish slime and blood are gourmet meals for bacteria, they should be removed as soon as possible after your fish have been cleaned, or after the fish have been unloaded from your vessel.

To clean and sanitize your vessel, flush all surfaces where fish come in contact with the boat. Use fresh water or chilled sea water. Scrub these surfaces with a brush, using detergent in water, then rinse with cold fresh or sea water. The last thing to do is to sanitize all these surfaces with a solution containing chloring or iodine. Bleach is often used. Rinse off the bleach after 5 or 10 minutes. Now your vessel is squeaky-clean, and ready for the next big catch of fish.