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ABSTRACT

This publication serves as an introduction for high school students to energy related careers. Descriptions of type of work, education and skills needed for engineering, communication, business, and science careers that have the most direct involvement with the nation's energy problems are given. The purpose of this document is to guide interested and capable students into productive careers that will help solve serious national problems related to energy. (MR)

ENERGY Related Careers

Center for Career Development and Occupational Preparation
College of Education, Texas A&M University
College Station, Texas 77843

INTRODUCTION

The OCCUPACS in this booklet are the outgrowth of an interest in assisting capable high school students as they seek challenging career opportunities. Concerned young persons today are interested in the intelligent utilization and conservation of America's energy resources. For these young people, careers that offer an opportunity to be of assistance to our nation in conserving energy resources offer a high opportunity. With this thought in mind, the present effort was undertaken to investigate energy-related careers which seem to offer the most promise for outstanding high school students.

What has resulted from this effort is the group of OCCUPACS which explains career opportunities. In each of these fields, it is possible for an individual to make a significant contribution toward the solution of America's energy problem. No one career, of course, deals directly with all energy-related problems. However, it is possible for one to specialize in quite traditional areas in such fields as engineering, yet still have an opportunity to make a substantial impact on energy-related problems.

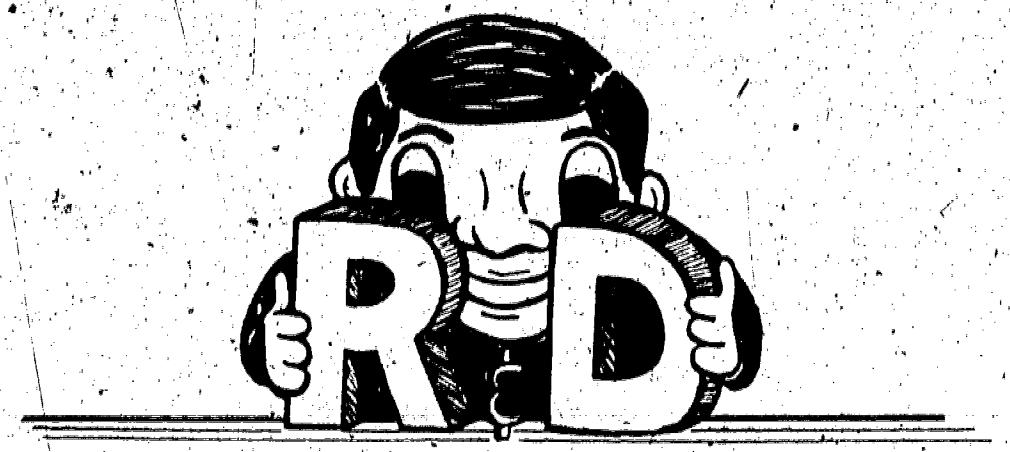
Appreciation is expressed to Dr. Donald L. Clark for his leadership in formulating the approach to the problem, to Dr. Christopher Borman for his support of the activity through the Center for Career Development and Occupational Preparation in the College of Education, and to Dean Frank W. R. Hubert for his continuing interest in energy-related educational activities. This project was supported by the College of Education allocation, Organized Research Fund, Texas A&M University.

A special note of thanks to those persons who worked diligently on the project: to Mary Anna Davis, Misty Gibson, and Dan Langen for preparing the several drafts of the OCCUPACS; to Marty Calvert for her efficient work as project secretary; to Helen Finney for her interesting art work; and to the fine team at the University Printing Center for their production work. Without the close cooperation of all these individuals, it would have been impossible to prepare this material in the time available.

Reactions from a group of teachers participating in the Department of Energy sponsored Faculty Development Workshop during the 1978 summer session provided a number of helpful editorial suggestions. However, the summer schedule did not permit an opportunity for field testing with high school age readers. Consequently, it would be most helpful if those who use, read, or interact with the OCCUPACS would provide a comment concerning their usefulness and suggestions for their revision.

Daniel L. Householder
Project Director

LIST OF OCCUPACS



RESEARCH AND DEVELOPMENT

When you walk into an air-conditioned classroom, drive a car that gets good gas mileage, or call a friend who lives a thousand miles away, you are enjoying the benefits of research and development. Research and development (R&D) is the common denominator of all the fields of engineering. It offers a variety of careers to persons interested in using their talents and abilities to help improve the world.

What is Research and Development?

Basic Research, usually done in a laboratory, is an effort to seek out new scientific principles and gain an understanding of them. Examples might be finding more efficient means of converting coal to gasoline, establishing whether fluorocarbons contribute to the depletion of the ozone layer of the stratosphere, or developing effective alternative energy systems.

Scouting Research is also a laboratory activity, aimed at establishing the technical feasibility of an idea or of a specific objective. Can we develop a useful, economical by-product from waste and garbage? Is it possible to find a non-polluting octane booster for gasoline? Can we develop methods of environmental control which use less energy? A scouting researcher must uncover the questions before the answers can be found.

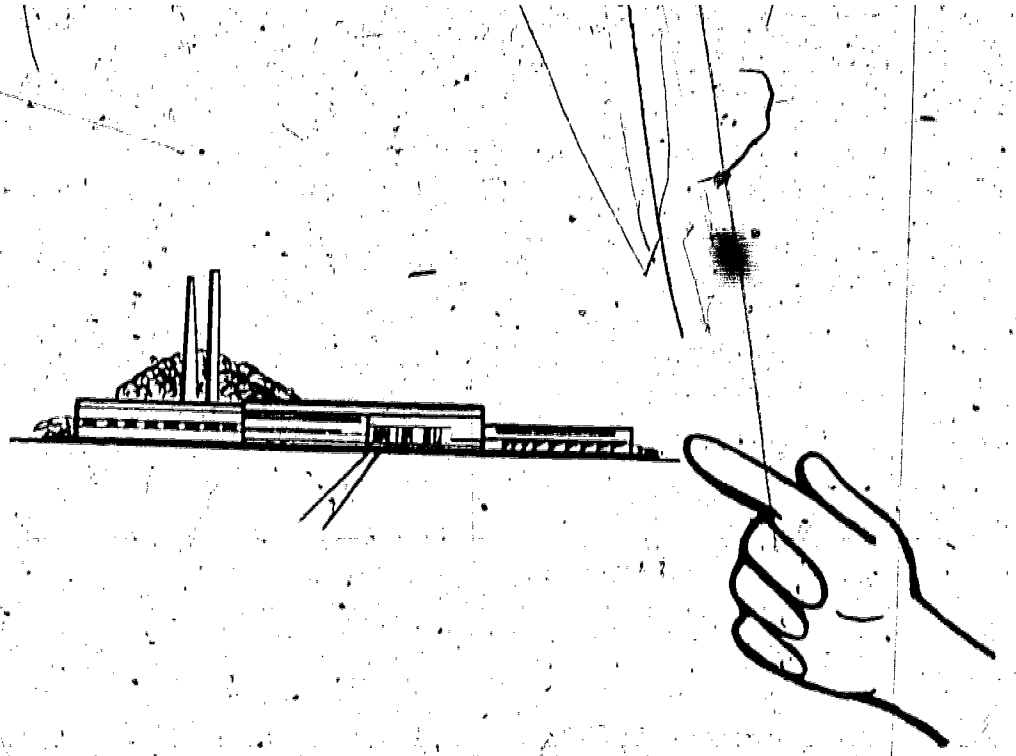
Applications Research starts with an existing product and finds new ways in which it can be used. The researcher must learn to apply the properties of a product, work around its deficiencies, and establish whether it meets the technical and economic needs of the market.

Product Development aims at the creation and evolution of a product after its feasibility has been demonstrated. The product — whether chemical, mechanical, or electronic — is modified and adapted until it performs effectively in its intended use. This work is usually done on a larger scale and with a greater variety of materials than a laboratory situation offers. The potential customer is often an integral part of product development.

Process Development seeks to define an economical and practical method of manufacturing the product. Since the product must be manufactured on a large commercial scale, the laboratory processes must be translated into a small pilot process, where rates, yields, economics, and the effects of the process are evaluated and optimized. A great deal of product and market testing must take place before design and construction of a commercial plant.

Where Does It Happen?

Where research and development occurs depends not only on which field of engineering you choose, but whether you work in education, private enterprise, government, or industry. At the university level, research is performed by individuals and is usually very basic in nature. In government, most research is related to national priorities, such as defense, the space program, or energy independence. It is frequently carried out by teams of researchers either in government laboratories or at a university or industrial laboratory under government sponsorship. Commercial firms or consulting laboratories



do research that is needed and paid for by clients or sponsors who do not have their own facilities.

In industry, research and development has the underlying objective of making money for the company by developing a new product, a new application for an existing product, or a new or improved process. At the same time, the purpose of R&D to improve our way of life should remain foremost. Industrial research is usually done by teams, or by individuals within a team effort.

Who is the Researcher?

Regardless of the nature of the technical activity, or where it is carried out, the most important resource is the individual researcher, whether he or she is a member of a team or an individual investigator. This person may be trained in science or engineering (or both). The level of academic degree required to function effectively in R&D varies, but in many companies it is almost a prerequisite to have a doctorate to be considered for the top management position in research. You can, however, be successful in engineering research and development with a bachelor's or master's degree.

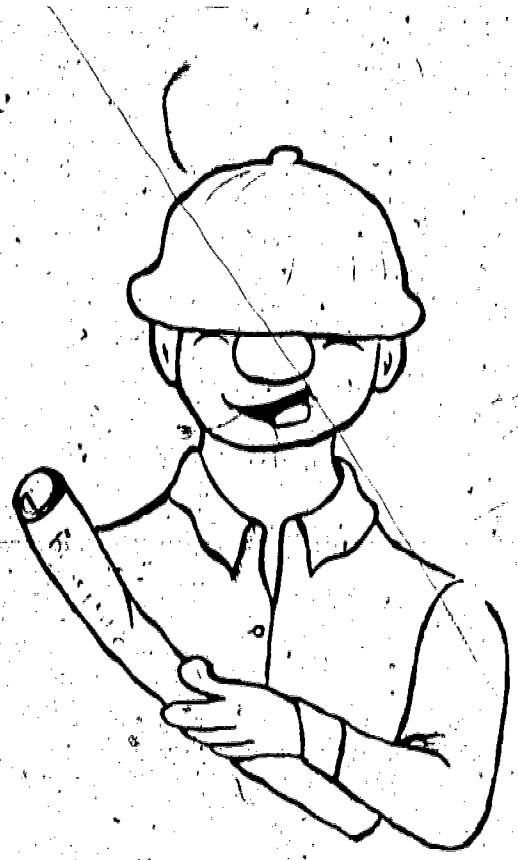
Probably far more important than specific degrees are the personal characteristics of the researcher. An inquisitive nature, originality in thinking, a flair for finding the practical solution, and the ability to plan and carry out a systematic investigation are all highly desirable attributes. Also important are a high level of persistence in the face of adversity, a belief in one's self, and the drive to complete a task successfully.

To succeed in research and development, the individual must constantly be aware of technical and intellectual obsolescence; continuing education is an important part of a researcher's life.

Reward and Opportunities

Research and development is not the route to riches, but the productive researcher is reasonably well paid with a salary comparable to that in other areas of engineering. The work is challenging and satisfying. This in itself is probably the greatest reward.

Opportunities in R&D are growing. It is apparent that many of today's social problems and national objectives — pollution abatement, health maintenance, product safety, new energy sources, and energy-efficient processes — must be accomplished largely through new technology emerging from R&D programs. It is most likely that engineers will continue to find significant, challenging, and attractive employment opportunities in research and development.



PROCESS ENGINEER

What happens when a research and development group comes up with a new process for refining oil, or a decision is made by Exxon to build a new plant, or the market for electrical energy in a specific area increases rapidly? The information is turned over to a team known as process engineers. The preliminary work for the design of a new plant or process is the responsibility of this group. The engineers making up the team may be from almost any specialization — mechanical, electrical, nuclear, petroleum, or chemical engineering. They all must work together to insure the accuracy of the initial design.

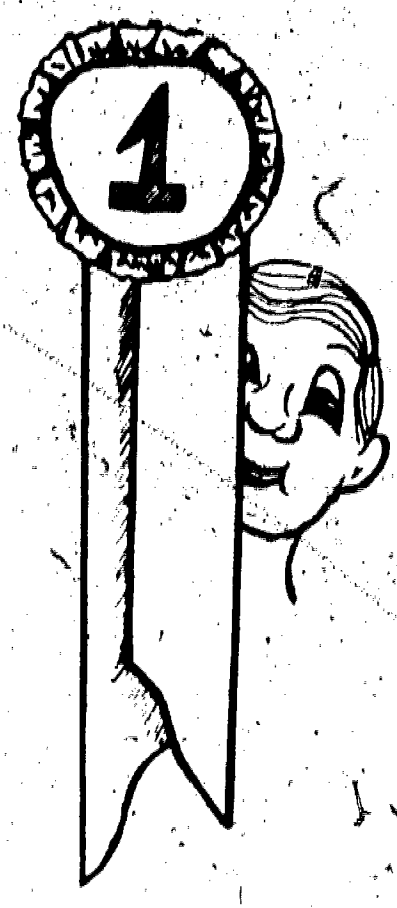
What is Process Engineering?

The first step in process engineering is a quick preliminary design. This enables the team to make an estimate of capital outlay and operating cost, and determine what environmental and other problems can be expected. From this, it can be determined whether the proposed plant is likely to be sufficiently profitable to justify the investment and the risk. Then the more complicated task of the actual design process begins. It is this step that gets the engineer involved in problems such as energy conservation and environmental protection. What source of power will be economically suitable in the world today and in the face of growing energy shortages in the future? Environmental protection laws concerning the location of the plant and the raw materials it uses must also be considered. The design must not become obsolete because of outside forces. Room for expansion and adaptability to change must be included in the design and constant attention must be given to safety.

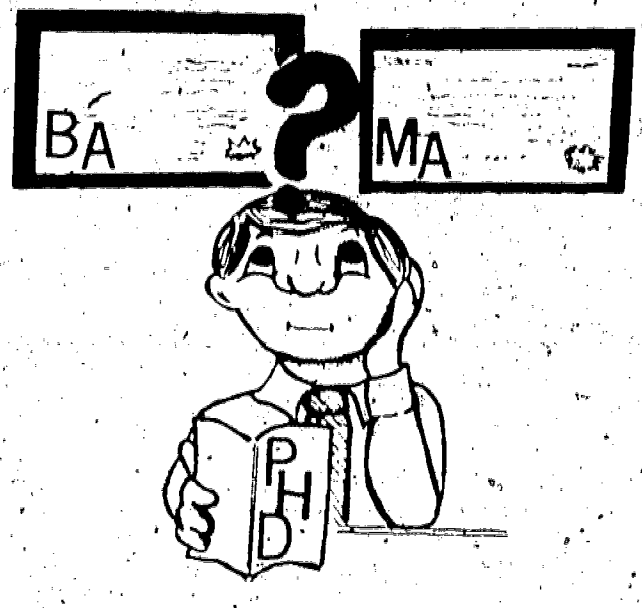
The task of the process engineer is a difficult one, for he must consider all these things in addition to his main responsibility of designing an accurate, efficient system of operations for the new plant.

Who is the Process Engineer?

If a person likes hard work, truly enjoys and is good at the type of creative thinking required in engineering, he may be a prospect for a career in process engineering. However, these are only the beginning requirements necessary for success. As early as high school, the prospective process engineer must demonstrate a firm grasp of the basic tools of mathematics, physics, and chemistry. Because the process engineer works as a member of a team, he must be able to fully communicate his ideas both orally and in writing. The ability to learn quickly is also important, as the process engineer is constantly faced with new information and change.



A bachelor's or master's degree in engineering is required for the process engineer. A doctorate is less important, and excessive specialization may not be as advantageous as a broad knowledge of more than one phase of engineering.



Where Does He Work?

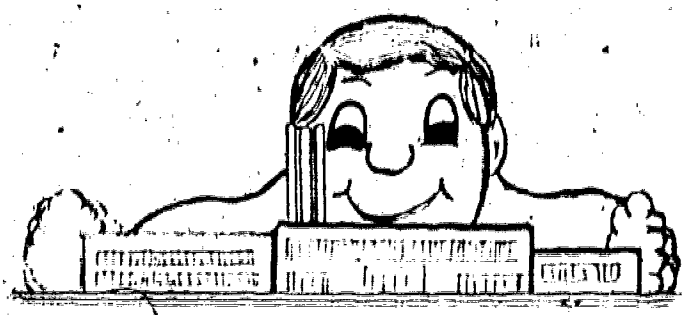
Process engineers usually work for engineering companies, or in engineering departments of large companies such as Exxon, DuPont, or Westinghouse. Some process engineers work directly with operations after the construction of a plant is completed; evaluating, supervising, and redesigning existing processes.

Opportunities and Rewards

The opportunities for process engineers are wide open. Because of the recent emphasis on national energy independence, the energy producing industries are constantly growing, developing new processes, and building new plants to meet the need. The demand for the expert skills of the process engineer is high.

Opportunities for advancement through process engineering are very good. The broad range of skills necessary in the design process make the process engineer an excellent candidate for management as well as other phases of engineering.

Salaries in process engineering are competitive with most other areas of engineering, but few can compete with the non-material rewards of this field. A career in process engineering offers highly interesting and challenging work, a sense of accomplishment, a chance to have a real effect on industry and the world, and a never-ending opportunity for learning.



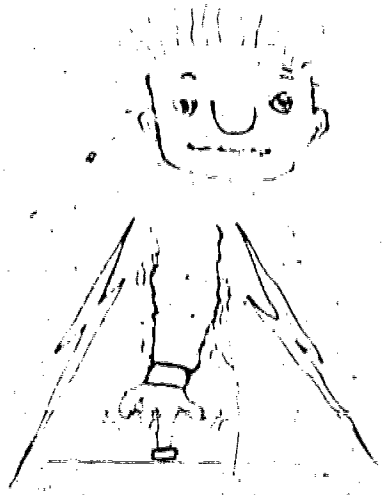
PLANT OPERATIONS ENGINEER

One of the major reasons for our energy shortage is that the American people expect an unlimited supply of energy. When we turn out the lights at night, we don't worry that we might not have electricity when we turn them on again in the morning. If our tank runs dry, we naturally assume there is going to be gas in the pump. But, do you ever wonder whose job it is to see that the power plant is constantly producing electricity, or that the refineries continue to turn petroleum into gasoline? These awesome tasks belong to a group of people known as plant operations engineers.

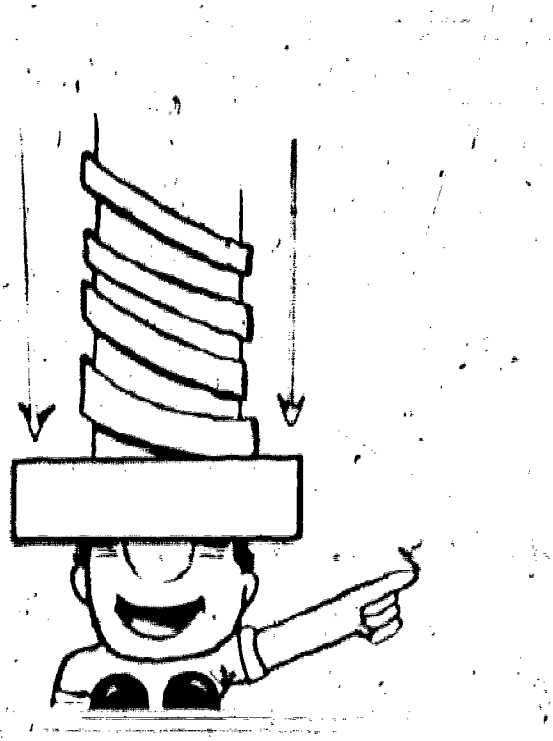
What is Plant Operations Engineering?

Operations is the discipline responsible for making a plant run reliably and efficiently. Most plants are operated continuously for the efficient use of capital and because of the product and energy losses inherent in shutdowns and startups. If any part of the plant is allowed to operate at less than full capacity, production is lost. Operations engineers generally work under the axiom, "Lost production is production lost forever," and for this reason they constantly strive for reliability. They try to anticipate failures and remove their potential causes. When a failure does occur, they carefully analyze the cause, take steps to prevent its recurrence, and extrapolate from the experience to seek out other latent defects that could cause a shutdown. Mechanical failure, operator error, insufficient maintenance labor or parts, severe weather, labor disputes, raw materials shortages, and many other common occurrences combine to challenge the engineer's ingenuity.

Good operations engineers rely on their five senses as well as their knowledge and ability. By scanning the instruments at their disposal, listening to the sound of the equipment, and in general "feeling" the overall operation, they can tell if the plant is optimized. The operations engineer relies heavily on oral communication with the various departments and oral instructions given on the spot to obtain corrections. Occasionally, in emergencies and other



abnormal conditions, the plant engineer may actually perform operations — turning setpoint knobs or valve handwheels, throwing switches, lighting burners, or whatever else may be needed. Other aspects of the job reflect the latest scientific developments. Computers are used extensively in modern plants;



on-line for process control and continuous monitoring, off-line for planning and controlling inventories, maintenance activity, traffic movements, and other complex functions.

The job of plant operations engineer involves many elements: lots of people-to-people relationships, immediate feedback, heavy involvement in maintenance activities, a variety of tasks, and a flexible schedule. In operations, the engineer is involved in the entire workplace, not chained to a desk. There is a minimal amount of paperwork (compared to most engineering fields), but hours can be long and irregular depending on the needs of the plant.

What Makes a Good Operations Engineer?

Engineers usually go into operations early in their careers. It takes time to develop the skills and acquire the experience necessary for the job. The prerequisites for getting into and succeeding in operations include a bachelor's degree in engineering, the ability to deal well with people at all levels, and an aptitude for making the "right" decision promptly. The engineer must be able to take total responsibility for a given situation or facility and use good judgment, especially when under pressure. The ability to think ahead and anticipate problems before they occur is also essential. The operations engineer should possess good oral communication skills and be an acceptable writer. Being flexible, versatile, and a self-starter enables the engineer to handle many tasks simultaneously. The individual seeking a career in this field should possess a strong mechanical aptitude, and even more important, be willing to accept the workplace environment — heat, cold, noise, smell, safety risks, and long and irregular hours.

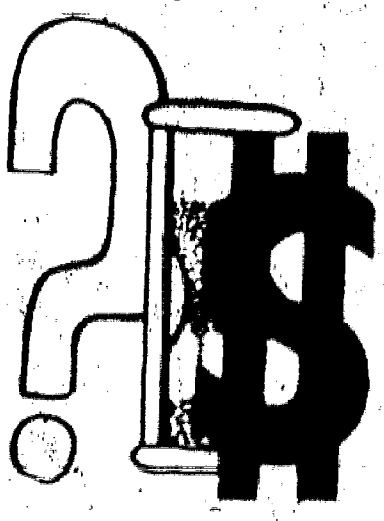
Rewards and Opportunities

Command of the action is probably the greatest reward of plant operations engineering. Decisions lead to action and the right decision usually results in immediate success. Most operations engineers enjoy the informality of the job: comfortable dress, more oral than written communications, the absence of rigid procedures, and the opportunity to select one's activities.

The pay in operations is comparable to that received by engineers in other specialties. Opportunities for promotion are excellent. Frequently, a single outstanding contribution will result in a "battlefield promotion," which will receive widespread attention and can launch a distinguished career.

Prospects for plant engineers have improved considerably over the years. The vast amount of highly sophisticated automated equipment has required that skills in operation be of a much higher caliber than in the past. Recognizing the advancements that the plant engineering discipline has made and will continue to make, more and more engineering colleges are offering an engineering curriculum culminating with a bachelor of science in plant engineering.

The American Institute of Plant Engineers, a professional organization dedicated to the advancement of plant operations engineering and composed of individuals involved in it, recently revealed a survey that indicated a need for more than 15,000 graduate engineers for plant engineering jobs within U.S. industry over the next five years. As our need for energy production increases, so will the need for qualified plant operations engineers.



PROJECT ENGINEER

After the design process for a new refinery, nuclear power plant, or modern chemical process plant is finished, the complex task of erection begins. Research expertise, process design concepts, metallurgical constraints, structural requirements, and process control demands must all be evaluated and satisfied. At the same time, non-technical activities, such as materials procurement, work scheduling, logistical provisions, and progress evaluation must also be carried out. The coordination of all these efforts is the principal function of the project engineer.

What Does That Coordination Involve?

Project engineering combines technical expertise, and managerial skill to transform information and materials into efficiently operating plants. The following are some of the more important activities of the project engineer's task.

Budgeting and Scheduling — The project engineer is frequently asked: How long will it take? or How much will it cost? His greatest value to management is his ability to predict the cost and timing of projects. The man-hours and costs for each separate activity must be accurately identified to arrive at a reliable estimate or schedule.

Overseer — Each discipline involved in the design and construction of a chemical plant has a specific area of responsibility. The project engineer is the only team member who regularly reviews each group's contribution. He is the only one with a current overview of the project. He therefore must be the one to ensure that no essential items are overlooked.

Process Assessment — One of the most difficult tasks facing the project coordinator is to assess the progress made toward the completion of the project. This is not a matter of reporting effort expended, such as man-hours to date versus man-hours budgeted, but rather an identification of milestones that have been attained and an evaluation of how performance compares with original expectations.

Information Management — The smooth execution of a project requires timely and accurate availability of the information required by each discipline. The project engineer must effectively manage the huge volume of paper traffic generated by the design and construction of a plant. Documents must be up-to-date and readily available as each discipline becomes involved in the project.

Mediation — As with any undertaking involving the efforts of many persons, differences of opinion will arise as to the most appropriate, expeditious, or economical method. These often appear as interdisciplinary disputes. Resolution of these conflicts is the responsibility of the project engineer. He does not possess any set authority or as an independent source of information, but as a mediator who ascertains the facts and persuades each party to accept them.

Other Activities — Project coordination is the common denominator for all project engineers. The complete job definition, however, depends on each organization. The project engineer also performs functions such as writing of specifications and requisitions for equipment, assembly of vendor bid tabulations, evaluations and decisions, evaluation of competitive technology alternatives, and start-up supervision or consultative assistance to the plant operations engineer.

Where Does the Project Engineer Work?

The duties of the project engineer may be the same in two different organizations, but his level of responsibility and his approach to the work will be set by the nature of the company in which he works. The project engineer may be employed by a specific industrial company or may work for many different companies as an engineering contractor.

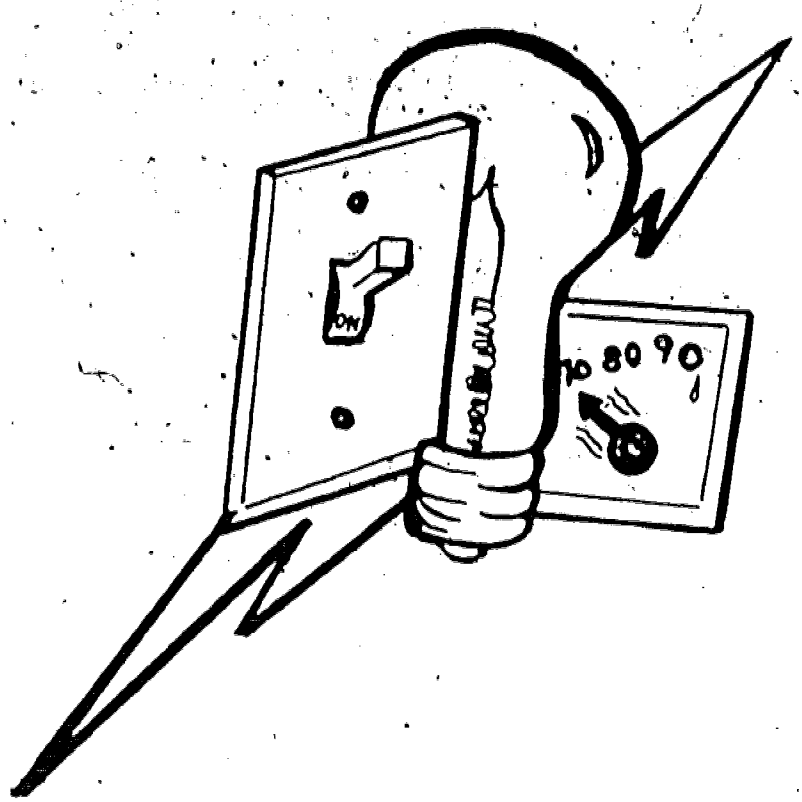
Working as an engineering contractor usually provides exposure to a wide variety of projects. Depending on the interests of the client, a particular assignment may involve petroleum, electrical energy, organic chemicals, metal ores, or nuclear power. The engineering departments of operating companies seldom offer this much diversity. A large percentage, if not a majority, of project engineers find employment as a contractor.

Project engineering in an operating company generally resembles an internal contractor. Relatively few companies maintain full service engineering staffs, and instead rely on the engineering contracting firm for design and construction work. The prime function of the project engineer in an operating company is liaison with the engineering contractors to insure accurate translation of all technical information. If he is to translate technology into a successfully operating plant, he must possess a high order of both technical and managerial competence.

Background and Prospects for the Project Engineer

To be effective, the project engineer must be familiar with the functions of each of the various engineering disciplines. Project engineering, therefore, is seldom an initial assignment for a newly graduated engineer. Prior experience as a design engineer is most desirable and field experience such as construction supervision is also valuable.

The engineer interested in contributing to the energy solutions will find project engineering both mentally and physically demanding and monetarily and emotionally rewarding. When his performance and experience indicate that the project engineer is ready for increased responsibility, the most direct line of advancement is into project management. In the era of the multibillion dollar project, this position can be as demanding and rewarding as a corporate vice presidency. This is not, however, the only opportunity open to the project engineer. His demonstrated managerial skills and ability to work productively with other professionals are broad assets that can find application in many fields.

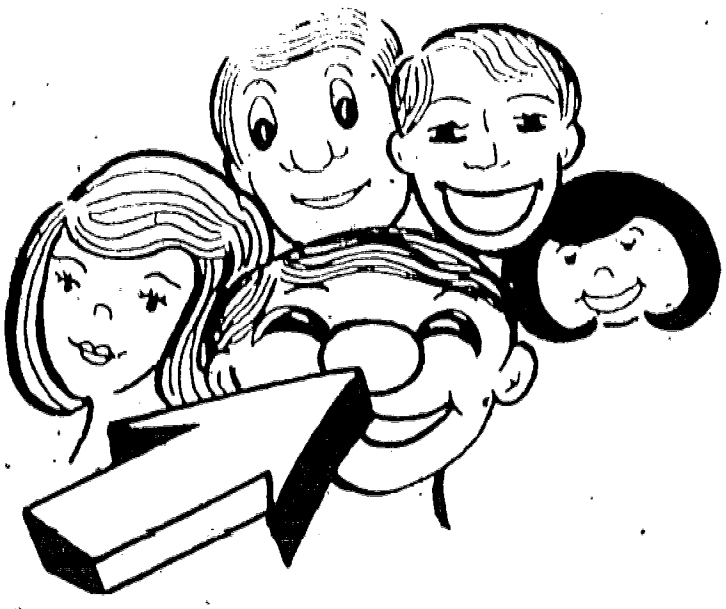


ENVIRONMENTAL CONTROL ENGINEER

In the face of a growing energy crisis, the American population is constantly urged to reduce energy waste by turning off unnecessary lights, insulating their homes, and adjusting thermostats. All these things come under the heading of environmental control. Man's attempt to control his environment is one of the greatest culprits in terms of energy use and waste. Conservation is one way to reduce the voluminous consumption of energy by environmental control, but many people refuse to acknowledge the reality of an energy crisis. Many of our industries become handicapped and inefficient when forced to conserve energy and reduce operating power. Consumer conservation is important, but we cannot rely upon it as the only answer to the energy crisis. We must depend on the advances of environmental control engineering.

What is Environmental Control Engineering?

Environmental control encompasses all of man's efforts to change his existing environment — lighting, heating and air conditioning, insulation, new sources of energy, etc. A career in environmental control engineering could include designing heating, ventilation, and air conditioning (HVAC) systems for nuclear/fossil fuel power plants, performing energy conservation studies on commercial and industrial facilities, or developing more energy efficient lighting systems for residences. The efforts of an HVAC engineer may be directed toward the analysis and design of advanced residential and industrial energy management systems. Many industries now employ an energy systems engineer whose job entails systems analysis, design, and project management relating to energy; load management through thermal storage; and solar energy heating and cooling applications. The role of the chemical engineer in environmental control might be in developing new materials for insulation purposes, or a new coolant for air conditioning systems. Whatever the task, the purpose is the same — to reduce energy consumption while maintaining an efficient, necessary level of environmental control.



Who is the Environmental Control Engineer?

The engineer who works in the area of environmental control may be a specialist in one or more of many fields of engineering -- mechanical, chemical, electrical, lighting systems, or HVAC. A bachelor's or master's degree in engineering and a desire to help solve the energy problem are important prerequisites for a career in environmental control.

Career preparation should begin in high school with a solid background in mathematics, physics, chemistry, and science. A sound proficiency in English, including both reading and writing, is also a necessary tool of the engineer.

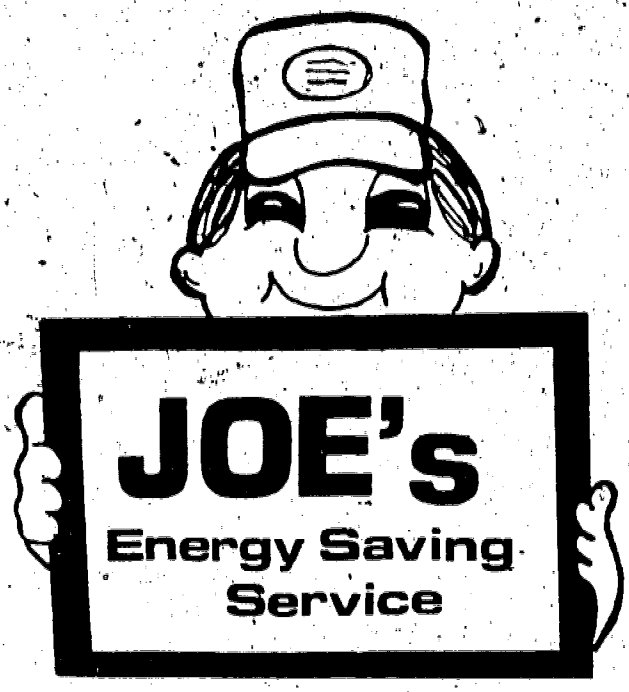
Where Does He Work?

The engineer interested in environmental control has many career options from which to choose. Positions are available in engineering firms, architectural firms, research laboratories, hospitals, private enterprise, government, universities, and even airline companies. Wherever an environmental control engineer works, he will be engaged in research, development, design, testing, production, operation and maintenance, marketing and sales, or administration.

Opportunities and Rewards

With the recent emphasis on energy resources and conservation, opportunities in the area of environmental control are plentiful. A brief glance through the classified advertising of the professional journals will inform the prospect of openings in almost every phase of environmental control. Salaries and benefits are very good and opportunities for advancement are excellent because of the rapid growth of this industry.

A person seeking challenge, responsibility, personal and professional development, and a chance to contribute to the energy solution, should consider a career in environmental control.



STARTING YOUR SMALL BUSINESS IN ENERGY

Are you able to think fast and make important decisions on your own? Are you interested in providing for the future today? Do you want to be your own person and call the shots? Do you think you are being ripped off by the energy crisis? If you answer positively to these questions, perhaps a career in an energy-related business is in your future. Many business opportunities already exist in energy-related fields; new careers are constantly emerging.

Oil and gas prices are increasing, while alternate forms of energy are currently not available in significant quantities. Some new energy saving devices are being developed by independent research laboratories, but many more are needed. Individual inventors are generating ideas which need to be developed and brought into production. Many promising opportunities exist for development, production, and distribution of these devices.

So, where do you fit into this montage of career possibilities? Anywhere and everywhere! As an independent industrialist, you could buy patents on inventions and manufacture them yourself, or you could arrange to distribute and sell products produced by other firms.

A whole new array of professional publications, journals, newsletters, and manuals concerning energy and energy conservation are needed. These offer a viable career option for those whose interests and competencies lie in the area of writing and publishing.

Where do you start? First, analyze yourself. What do you like to do? What sorts of skills do you have? What sorts of jobs have you had that might aid you in your choice of a career?

If producing things is your main interest, you may want to consider the manufacture of materials or devices which are in high demand. These range from energy-saving thermostats, insulation, weatherstripping, and other consumer products to heavy equipment used in the search for alternate sources of energy. This general area is one of the most promising in terms of profit potential and market for a person wanting to establish a new firm.

Are you interested in advertising? You could work up advertising to promote consumer awareness of energy savers, either by working as an independent consultant for different companies to specifically advertise the energy savings of their products, or you could head your own agency that specializes in energy advertising. You might also work for the government designing energy conservation campaigns and helping to sell taxpayers on alternate forms of energy. For example, you could be hired to convince the public to support the use of nuclear reactors to provide an adequate supply of electricity.

Before any product can be produced, it must go through a stage called research and development: the invention and/or refinement of any given product. Opportunities in research and development

range from individual laboratory work to the establishment of major enterprises employing engineers, scientists, and other specialists. This group, working as a team, may work on assignments ranging from the development of energy-saving devices to the establishment of a supply of alternate forms of energy.

If you have a technical specialty and enjoy working with people in a less-structured environment, you might consider a career as a consultant in one of the energy-related fields. Whether you are an engineer, a scientist, or a manager, opportunities exist for independent work with individuals and groups who need your services for a short period of time. This gives the consultant an opportunity to work for a variety of firms concerned with several types of problems.

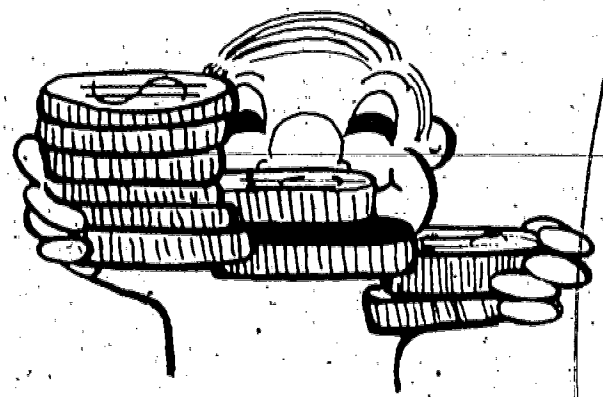
If you would like to run a service enterprise employing people to serve consumers, a variety of opportunities exist. Your firm might, for example, install such items as storm windows, insulation, or

weatherstripping. You might manage an auto service or tune-up center. Recycling firms offer opportunities for profit in discarded materials which can be reused in manufacturing other products or converted into useful by-products.

So, how do you prepare for a career in an energy-related business? Obviously, it is to your advantage to consider attending college. Since you will be setting up your own business, either a major or a second degree in business should be most beneficial unless you have had extensive experience in the business field.

You may proceed by pursuing your career as an individual or as an employee of a larger firm. For example, if you are interested in bio-mass conversion (the conversion of garbage wastes into methanol, which has many current industrial uses and more projected future uses) you should consider majoring in a field such as chemical engineering or chemistry. You might then want to work with firms dealing in this area, since large quantities of capital are required to get started. Once you have acquired some experience (and perhaps some formal business training in addition) you might consider establishing your own firm specializing in the area of most interest to you. Of course, as a manager, you will be able to hire consulting engineers, architects, accountants, and scientists, since it is obvious that no one can be a specialist in all these areas.

If lack of capital is a barrier, you should be aware of the fact that many private investors are willing to sink money into beginning companies. They are especially favorable to highly technical products and newly patented items because of the lack of competition in similar products.



If you are one of the lucky few holders of large amounts of capital, you should consider financially backing a new company. Well managed, they may provide an exceptional return on your investment.

So, if you think you can handle the day-to-day risks and pressures that accompany business ownership and if you really are concerned about our energy problem, then you may be ready for a career in energy-related businesses.

THE ARCHITECT IN ENERGY

"The fate of the architect is the strangest of all. How often he expends his whole soul, his whole heart and passion to produce buildings into which he himself may never enter."

Although less true today than when it was written in the eighteenth century, Goethe captures the essence of an architect in this statement. Architects do indeed put a lot of themselves into their work. They expend tremendous amounts of energy and time planning, designing, and supervising the construction of all types of facilities. They are responsible for designing the type of facilities desired by a client and to build it in the most efficient manner possible without sacrificing quality. They are responsible to the community to build a structure that will comply with existing laws, regulations and restrictions. In addition, they are responsible to themselves to meet each design challenge with brilliant innovative building.

Architects will be necessary to society probably for as long as it exists. They perform the necessary function of designing buildings. Without them, structures would be haphazardly slapped together, which may be alright for a shack, but definitely is not acceptable for a thirty-five story office building.

An architect's first encounter with a project is generally a meeting with the client. He discusses what is needed with regard to size, usage, preferences and financial limitations of the customer.

The next step, which may really be part of the first, is to visit the site. The architect takes into account the climate, soil on which the building is to be constructed, water table and contours of the land.

He then works up a rough design which is shown to the customer for revision or approval. These are developed into the final design and working drawings. The final design shows exact dimensions of every portion of the building including the location of electrical outlets and fixtures, plumbing, heating, and air conditioning facilities, windows, doors, and all other features of the building.

In fabricating the final design and specifications the architect may consult with an engineer to determine types of building materials suitable to the site and design. He may also consult with electrical and mechanical engineers to determine the type and extent of facilities needed.

Included in this list of available consultants are landscape architects. It is their responsibility to design the setting for the building by placing it in its most advantageous spot in regard to prevailing winds, available sun, etc. The landscape architect also designs parking, planning and pedestrian flow.

The architect would then, with the clients approval, select a construction company to erect the structure. This is usually done on the basis of bids — where the lowest bid is generally selected.

Construction of the building is left to the contractor, but the architect needs to make certain that his specifications are faithfully followed.

An architect must possess a wide body of knowledge. He is expected to understand construction methods, be able to apply engineering principles in the use of materials and in construction. He must also must be up-to-date on new issues and methods

such as use of solar panels and buildings designed to maximize the beneficial effects of the climate.

In order to become an architect, a person must study architecture at one of the seventy-nine accredited colleges and universities. The architecture program is generally a five-year program in which the student learns about materials, structural strengths, aesthetic qualities and the development of building plans (among other things). In order to practice architecture in a state, a person must be licensed and registered in that state. Licensing requirements normally include three years of practical experience in a registered architect's office before one is eligible to take the state exam. Upon passing that exam the architect will usually continue in that office working up to jobs requiring more expertise and responsibility. The eventual goal of the greatest number of architects is to establish their own practice.

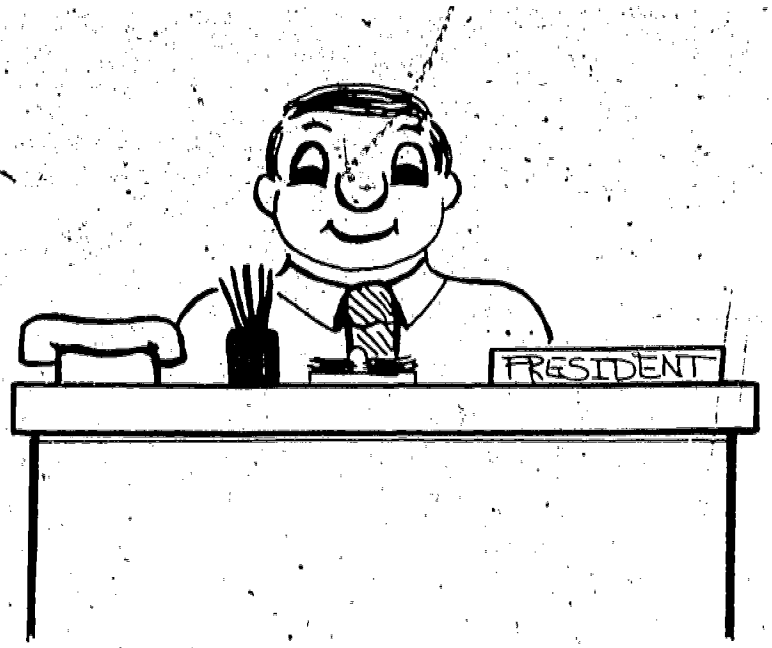
Persons interested in architecture should have a keen intelligence and many of the aptitudes and interests found in the businessman, creative artist and scientist. The aspiring architect needn't be a great artist but needs to have a talent for drawing along with a creative mind and an understanding of good business principles.

Energy saving devices are a rather recent development which the architect must consider in designing structures. The devices, which include such things as improved insulation, solar panels and thermal pane glass have been developed by research engineers and design laboratories. The architect must choose a device which will be the most beneficial to the building in regard to cost and aesthetic qualities.

The architect needs to employ newly developed materials creatively. In a sense, buildings are experiments where the architect and the engineers observe the consequences of using certain new materials, energy conservation devices, or building methods. Certainly, a risk is involved, but it is a highly predictable risk in which many of the problems have been foreseen.

The architect is becoming more and more involved in refurbishing and restoring older buildings. Many of these structures are simply returned to their original state, but many more are redone using some sort of energy saving materials in the process. For example, why not add solar panels to the roof of an old building, especially if they won't be seen? Many older homes were built with almost no insulation. When they were built, the cost of energy to heat and cool them was lower than the cost of the insulation. Therefore, when an older home is "redone," the architect almost always adds insulation of some sort, whether it be fiberglass bats or the blown-in type of insulation.

Architects do play a rather major role in implementing energy conservation. They must know when, where, and how to use which devices and they must at the same time try to save their clients money. Sound challenging? It is. But it is not without personal rewards such as special awards and recognition for the very good.



MANAGEMENT IN ENERGY-RELATED BUSINESSES

When you think of management, what comes to mind? The president of a huge manufacturing company making million dollar decisions from his walnut desk or the chairman of the board of a large bank running the business from the board room? These are indeed kinds of management. But, most students, by the time they become seniors have already become actively engaged in the practice of management. A committee chairperson directing its members in carrying out various tasks is a manager. The editor of a school newspaper giving assignments to reporters, photographers, layout and circulation people is also a manager. Just about everyone who supervises, directs or assigns tasks can be termed a manager.

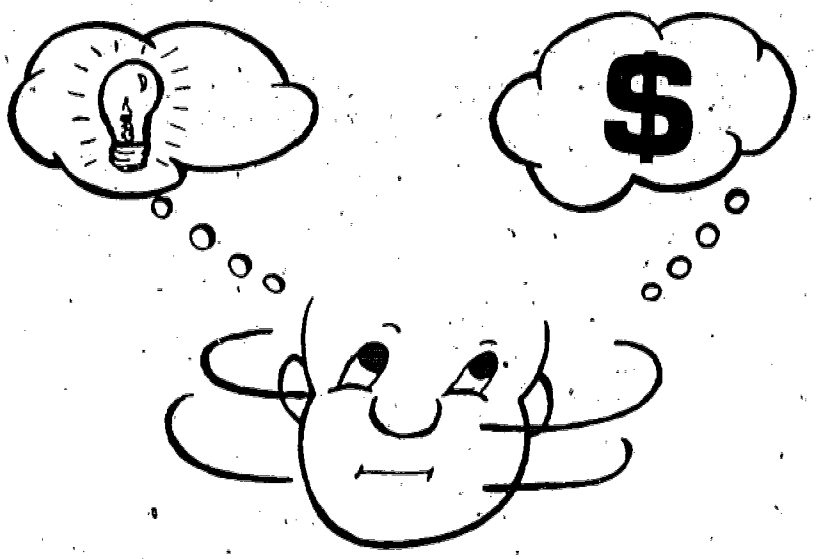
Then, what exactly is management? One of the simplest and most accurate definitions of management is: "Management is the art of getting things done through other people." So that means that anyone who delegates responsibility to other people could be called a manager. A service station owner directing the activities of service personnel and the director of overseas operations in a multi-national petroleum corporation are both managers. Many of their tasks are similar in nature.

There are many words which are synonymous with the meaning of management: words such as administration, supervision, leadership, direction, foremanship and executive function. Although these words imply totally different occupations, the jobs all require implementation of the basic skills of management. These skills include forecasting and planning, organizing, selecting staff and equipment, establishing and maintaining controls, communicating and making decisions.

In FORECASTING & PLANNING the manager must estimate what is going to happen in the future and plan as best he can for those events. ORGANIZING means that work is divided among people or groups of people so that there is no duplication of effort and every individual knows precisely where he fits into the over-all task. SELECTING STAFF & EQUIPMENT is probably one of the most underrated skills necessary but the best project can fail if the people and equipment selected are not satisfactory. In ESTABLISHING & MAINTAINING CONTROLS the manager must have some method of receiving feedback from his staff so he can determine whether or not the project is running smoothly.

Without skill in COMMUNICATION the manager will not be able to make use of any of the other skills outlined so far. Also, inherently included in communications is a great deal of psychology. MAKING DECISIONS is probably one of the most painful and difficult tasks of management. They must often be made from inadequate facts and with very little time available.

A quick glance through the want ads in a newspaper will tell you that the variety of jobs in the field of management is almost limitless. One especially fast growing and lucrative area is in the energy field. Many expanding new companies are seeking managers in every area from vice president of refining which requires cost management skills in a refinery

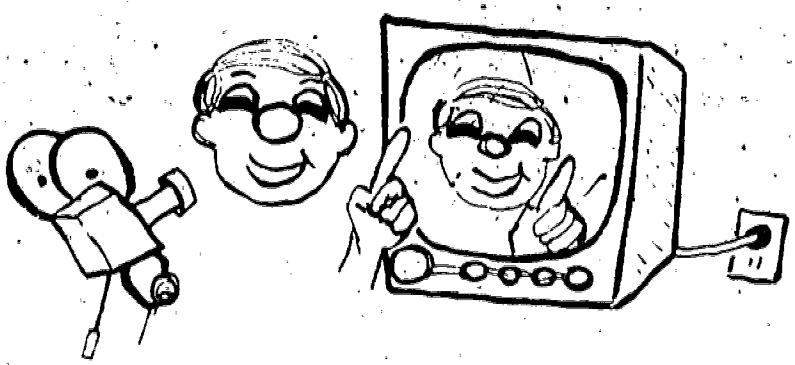


environment to a sales manager for solar panels. The production of energy-related products is a very fast growing new field which demands more and more people with skills and experience in management.

The typical preparation for a career in this area is an undergraduate degree in some technical or scientific field and a master of business administration (MBA). While an MBA is not a necessary prerequisite to being employed as a manager, a person might be inhibited somewhat in his/her climb up the corporate ladder without the proper training. Many companies will hire young college graduates for spots in their executive training programs. These are courses through which a company assures itself of a competent, well-trained staff.

Successful managers share a number of similar personal characteristics with perhaps the most universal being a willingness to work hard. Long hours, travel on the job, and "free-time" concern with business are accepted as a matter of course by most managers. Other traits include charismatic leadership, the ability to get along with other people, win their respect and motivate them to peak performance. One thing that separates a good manager from an average manager is the ability to take a situation or problem and reduce it to its most elementary components in a matter of seconds, make a decision, and then act on that decision.

Energy is an exciting, forward-looking field seeking to provide for our future. As long as our society remains reasonably civilized we will have a need for some source of energy, whether as crude as wood burning fires, or as sophisticated as a nuclear reactor. We need someone to discover and produce that energy supply. Someone will also be needed to plan and forecast for future needs, organize what work is done by whom, select staff and equipment, receive feedback from employees and customers, communicate effectively with others in the organization, and make decisions concerning business. Would you be that someone, the manager?



TECHNICAL COMMUNICATION

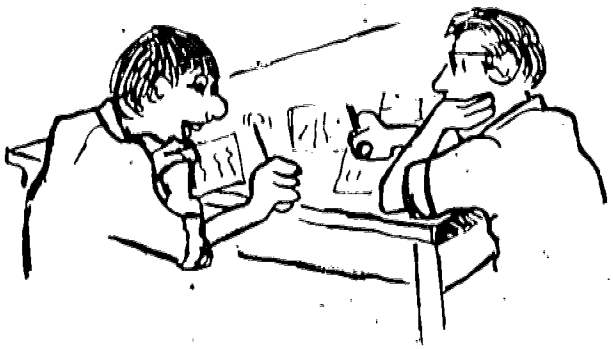
When you think of communication, what image do you create? Television documentaries? Radio news broadcasts? Telephone data transmission? A letter from your grandmother? These are all forms of communication that are used day by day as means of transferring ideas or thoughts from one person or group of persons to another. Without communication, our sophisticated society would experience immediate regress, rather than progress, back hundreds of years. Can you imagine not hearing about the latest rocket to Mars or a cure for cancer? Isn't it nice that a set of directions comes with your new calculator? So, technical communications are, indeed, a vital part of our society.

Many different and widely varied fields are included within the broad area called communications. The two fields covered here are technical writing and technical photography.

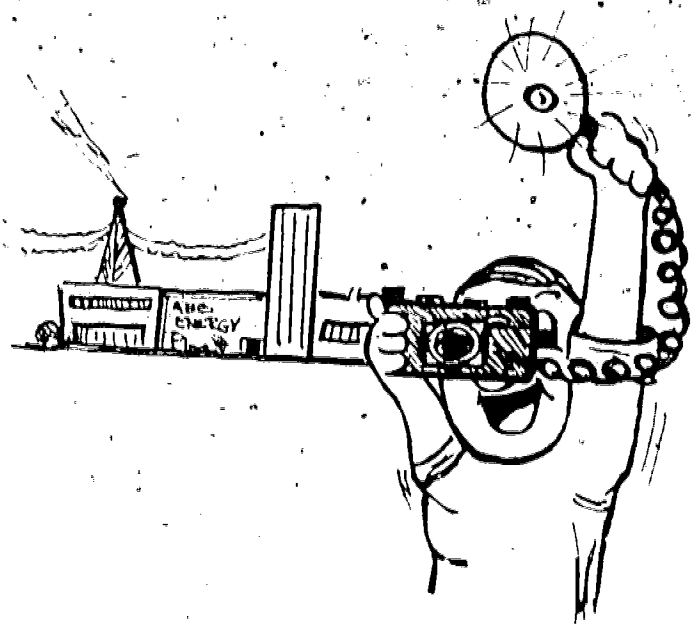
Technical Writing

Technical writers understand the language of the scientist or technician and possess the ability to interpret it clearly and accurately for readers who are not scientists or technicians. These writers act as the liaison between the scientist-researcher and the uninformed reader. They must know a good deal about the technical aspect of the project before they begin to try and explain the project to others.

When a writer begins a project the first step generally is to become familiarized with the project. This is done by talking to technicians, watching the research progress, reading previous articles and taking copious notes. A rough draft is prepared and revised. It is edited by either the researcher or, if the writing department is large enough, it is edited by senior writer or editor. The ability to get along well with others is a definite asset since the writer may work as part of a team assigned to a specific project.



Technical writers are not limited just to writing up research; there are many other writing areas where they may choose to work. The writer may prepare service manuals or handbooks, instruction or repair booklets, sales literature, research proposals and reports, contract specifications and research abstracts. A person may also write publicity releases, catalogs and brochures. Occasionally that person may assist in the preparation of speeches, articles, and other scientific papers and manuscripts. A technical writer usually remains anonymous, with the scientist taking credit for the research as well as the technical article.



Writers must have a firm background in whatever scientific area they choose to specialize in. Quite often, they will major in some scientific field in college, work in the field for a while and then gradually begin to write technical papers. A technical writer needs, in addition to a technical background, a literary background. Since words are the tools and machinery for a technical writer, a good command of the language is a prerequisite to effective communication.

Along with a background in English and science, a writer needs to possess a sharp, inquisitive, imaginative mind. Their articles should be interesting as well as informative.

Writers may also free-lance; to do this usually takes years of diligent work to make a name for one's self in the field. Technical magazines and trade journals hire writers to produce scientific articles; companies who have large research and development departments also hire a great many writers. Appliance manufacturers and the government hire writers to write brochures and instruction manuals.

In 1974, approximately 20,000 men and women were hired as technical writers with the number expected to increase as research efforts increase.

Technical Photography

While writing can be an effective means of communicating ideas to masses, photography can frequently provide an even more effective means. As Confucious said eons ago, "One picture is worth one thousand words."

Technical photographers' jobs are similar in many ways to those performed by technical writers. They form a liaison between the technical, scientific world and the public, drawing both worlds closer together through their media.

Photographs are used by scientists to document the progress and results of particular research projects. A person must possess knowledge of the research being done in order to take pictures of any significant value.

In order to understand the workings of their camera, its limitations and its possibilities, photographers need to have good technical comprehension. They usually work with their own equipment unless a highly specialized instrument is required because they are most familiar with the workings and idiosyncracies of their own cameras and lenses.

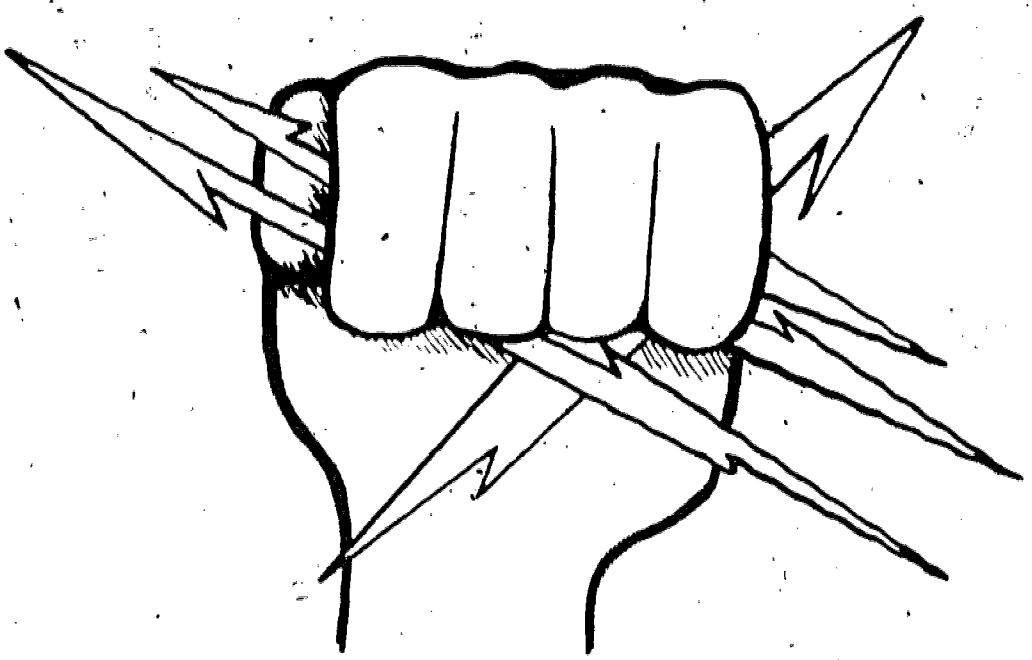
One of the traits of a successful photographer is an inquisitive and innovative nature. They utilize these personal traits to explore every possible angle of a potential shot, making the resulting photograph a bit more interesting and understandable.

Compared to writers, photographers lead a more exciting existence. They must travel to the site to do their work; they may also be called at any hour of the night or day to document some phase of a project. They must be ready to sacrifice a good deal of their personal, private lives to their jobs, but most photographers are more than happy to do this since the field of photography is quite competitive. Generally, the photographers hired are not fresh from college but a bit more seasoned and experienced in this line of work. Many photographers work their way from a position as a technical writer.

When taking photographs for an article, the photographer must work closely with the technical writer in order to take photographs that most accurately describe the written material.

The beginning salary for a technical writer or photographer is generally slightly above the salary of a beginning journalist. Salaries vary from company to company and in different parts of the country.

If you have a creative, technical mind; if you enjoy travel; and if you are good at writing or photography, perhaps a career in communications is just over your career horizon.



CAREERS RELATED TO ELECTRICAL ENERGY PRODUCTION

One-half of the energy consumption in man's history has occurred in the last 100 years; by 1980-1985, electric utilities will be the greatest consumer of U.S. energy. The increasing population and man's desire for a better life has increased the demand for electrical power production. The number and importance of careers associated with electrical energy production are also increasing with this demand.

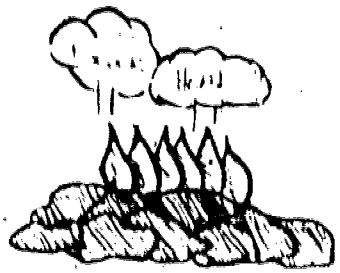
The careers can be categorized according to the fuels utilized to produce electrical energy. Currently, the resources being used for fuel are oil and natural gas, coal, and nuclear materials. The processes for exploration, development, extraction (production) and refining of these resources require skilled and well-trained individuals. For a moment, take a brief look at the present and future status of the various fuel sources.

OIL & NATURAL GAS

The Society of Petroleum Engineers predicts an "unlimited" future for the petroleum industry. The U.S. now consumes 17 million barrels of oil per day and it is estimated that we will consume more than 28 million barrels per day by the year 2000. Because of this increase in demand, career opportunities are greater in the petroleum industry today than ever before.

COAL

Coal, a soft black or brown rock, is probably the most useful substance ever mined. In the United States, it supplies approximately one-fifth of all power and heat. Coal can be burned to produce heat directly, but it is most often used to produce steam for electrical energy production. Conversion of coal into oil and gas is still in the experimental stage, but coal could become a primary supplier of energy if our oil and natural gas supplies continue to decline. Presently, coal supplies about 18% of the U.S. energy demand. The percentage has been declining since the mid 1900's, but with the recent inflation of oil prices, the coal industry and related career opportunities show renewed vitality.

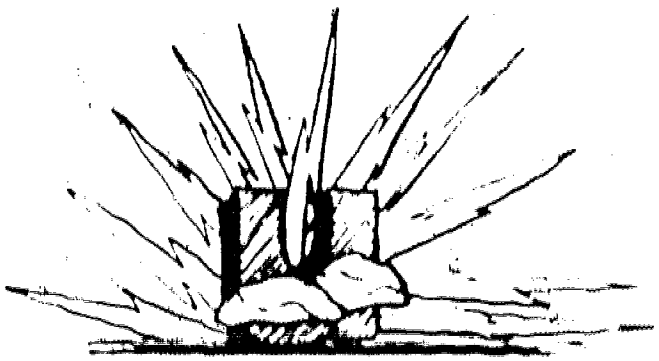


NUCLEAR FUELS

Nuclear power production is the newest and most controversial method of electrical energy production. Complicated procedures are involved in obtaining uranium fuels for nuclear power reactors.

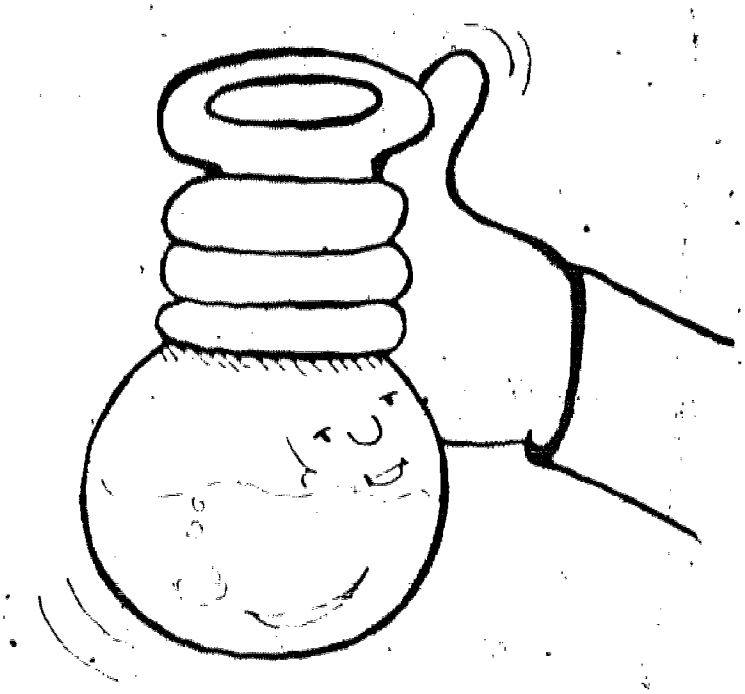
Uranium can be found in vein deposits, tubular or nodular bodies within sandstone layers, or spread throughout sedimentary formations and igneous rocks. Underground and surface mining methods are used in the extraction of uranium. The mines in the Colorado Plateau region have been relatively shallow underground mines. In Texas and Wyoming, certain deposits are mined by stripping, similar to coal strip mining. Once the ore has been extracted, it has to be concentrated before metallic uranium can be extracted from the concentrated uranium oxide by a chemical process. The metallic uranium is then enriched to increase the fissionable isotope $U-235$ from its normal 0.7 percent to about 4 percent for nuclear power reactor fuel elements.

At one time the Atomic Energy Commission acquired all the uranium produced in the United States. Now, all newly mined, domestic uranium is purchased by the commercial nuclear-power industry.



CAREER OPPORTUNITIES

Career opportunities in each of these areas are increasing and will continue to do so as the need for electrical energy production increases. The following career descriptions are some of the possibilities open to students interested in energy related careers. The future of the world depends on the students of today who want to make a genuine contribution to the energy solution.



ORGANIC CHEMIST

Organic chemistry, the study of living things, also includes carbon compounds such as petroleum and coal. An organic chemist in the petroleum or coal mining industries, where research and development play a major role, might be seeking improved petroleum, new uses for chemical by-products or new procedures for preparing organic compounds.

Three-fourths of all chemists are employed by private industry, one-half of these in chemical and manufacturing industries. The rest are employed in food manufacturing, scientific instrument, petroleum, and electrical equipment industries.

Individuals interested in organic chemistry as a career should have at least a bachelor's degree in chemistry. Bachelor's degree graduates usually begin by analyzing test products or assisting senior chemists in research and development. M.S. degree graduates typically begin in applied research.

The 1976 average beginning salaries were: B.S. $11,500; M.S. $13,600; Ph.D. $18,700.

There are 1,100 colleges and universities offering a bachelor's degree in chemistry and 350 that award advanced degrees in chemistry.

CHEMICAL ENGINEER

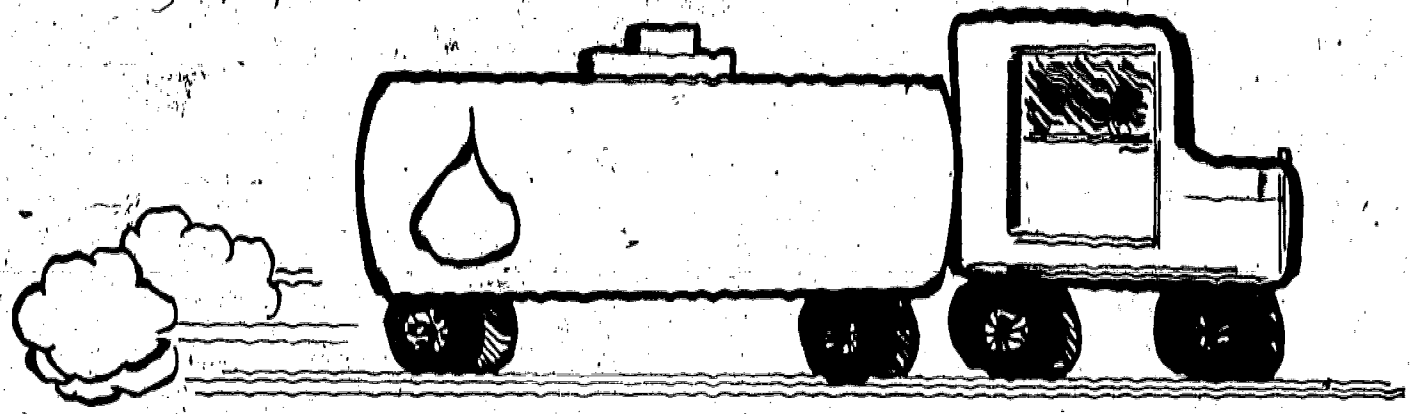
The chemical engineer plays a major role in the refining segment of oil and natural gas production and is concerned with development of chemical plant equipment for manufacturing products and research to develop new and improved chemical manufacturing processes and designs. This specialist oversees workers engaged in construction, control and improvement of equipment for carrying out chemical processes on a commercial scale. The chemical engineer is responsible for determining the most effective operation arrangement such as mixing, crushing, heat transfer, distillation, oxidation, hydrogenation, and polymerization. Supervising personnel working with plant and chemical controlling equipment may be part of the chemical engineer's duties.

Chemical engineering requires highly skilled individuals with an excellent background in chemistry and engineering. The chemical engineering degree, granted by numerous colleges and universities, prepares individuals for careers in the petroleum and manufacturing industries.

Since most chemical engineers are associated with the refining process and the majority of the refineries are located in the southwestern United States, the chemical engineer would expect to be located in this region.

The average starting salaries for a chemical engineer in private industry in 1976 were: B.S.-16,212, M.S.-17,500, Ph.D.-24,000.

The chemical engineering job outlook is favorable, with increasing demand for oil and natural gas, it is expected that the job availability will increase accordingly.



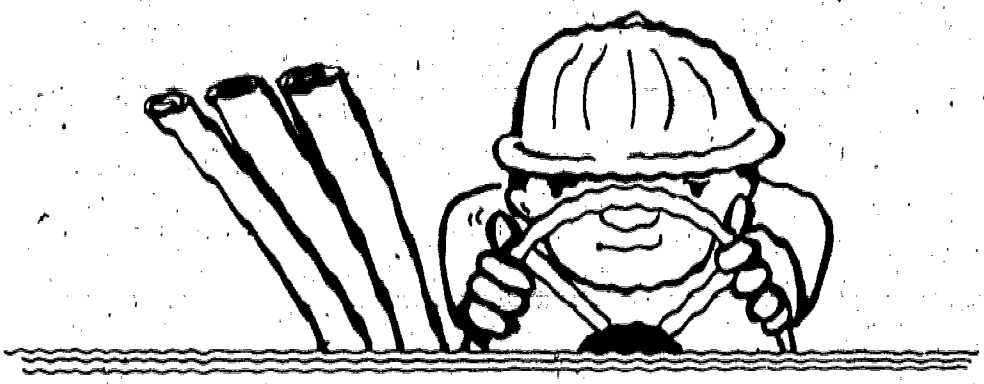
PETROLEUM ENGINEER

The petroleum engineer has many career choices available within his field. The areas to choose from include well drilling and completion, oil production, reservoir engineering, natural gas production, evaluation and finance, research, management and environmental control.

Within these areas, a petroleum engineer might expect to study geological surveys and earth samples, to supervise drilling operations and give technical advice, or to devise methods for bringing wells into production and controlling flow of oil or gas and for reestablishing flow by artificial means after natural flow has ceased. The petroleum engineer may prepare regular engineering reports and conduct special studies on subjects such as salt-water encroachment and equipment operations or may be assigned to conduct geological and geophysical surveys.

There are approximately 30,000 people working as petroleum engineers today. It's a strong, dynamic and well-respected profession. The basic college training necessary to become a professional engineer is a bachelor of science degree followed by successful completion of the professional engineer's exam. The average starting salaries for a petroleum engineer in 1977 were: B.S.-18,300, M.S.-20,250, Ph.D.-21,900.

There are forty universities world-wide that offer petroleum engineering degrees and options. However, virtually thousands more offer other engineering degrees necessary to the petroleum industry.



PETROLEUM GEOLOGIST

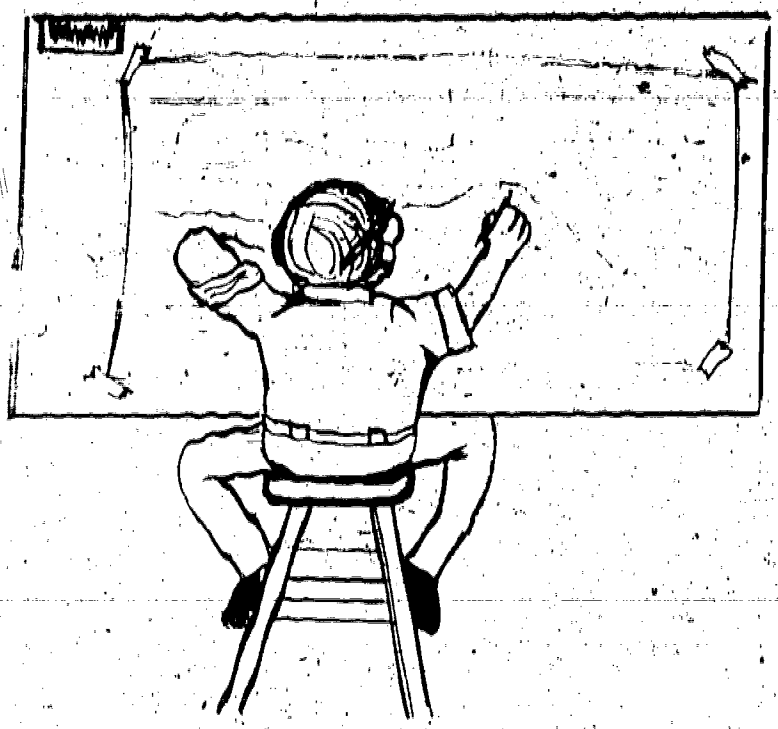
The petroleum industry utilizes many geologists in the exploration and development phase of the petroleum production process. A typical geologist explores and charts the stratigraphic arrangement and earth's composition to locate gas and oil deposits. He may analyze core samples and cuttings from well drillings, examine aerial photographs, or evaluate geophysical prospecting results. Some assignments may require him to prepare surface and subsurface maps and diagrams for location of oil and gas deposits and estimate oil reserves in proven or prospective fields.

The majority are employed by private industry, petroleum and natural gas companies. Others are in mining companies, or in exploration and consulting firms. Some geologists work overseas, but most reside in the southwestern and western United States, including the Gulf Coast.

An exploration geologist often works overseas, travels to remote sites by helicopter and jeep, covers large areas by foot and often works in teams.

Beginning salaries for exploration geophysicists in 1976 were: B.S.-13,300, M.S.-14,900, Ph.D.-18,000.

About fifty colleges and universities offer a B.S. in geology and one hundred sixty colleges and universities offer advanced degrees. Beginning jobs are usually in field exploration or research assistants in laboratories. With experience, the geologist can look toward a promotion to project leader, program manager or office management and research positions.



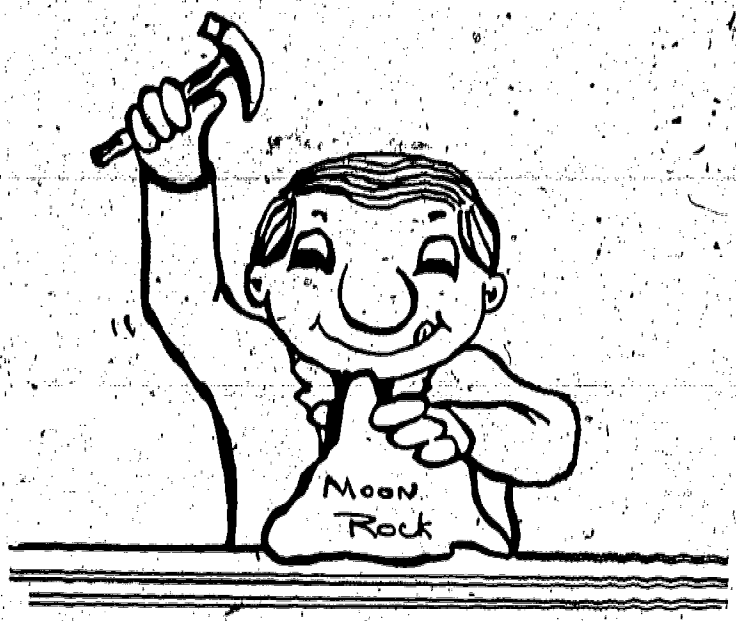
EXPLORATION GEOPHYSICIST

The exploration geophysicist is concerned with the earth's gravity, magnetic and electrical field variations. From these variations, conclusions and inferences are made concerning locations of hydrocarbon concentrations or minerals. To acquire the needed information, special physical and electrical instruments are used, such as seismograph, magnetometer, and electrical-resistivity apparatus. They help the geophysicist to map the subsurface rock formations and locate petroleum and mineral deposits. The exploration geologist computes instrument readings, prepares charts, profiles and subsurface contour maps, determines desirable drilling locations and may be requited to oversee field crews drilling shallow boreholes.

Beginning jobs in geophysics require a bachelor's degree in geophysics or a geophysical speciality. A bachelor's degree in related science or engineering fields may be adequate if course work is taken in geophysics, physics and geology, math, chemistry and engineering.

The 1977 beginning salaries were: B.S.-13,300, M.S.-14,900, Ph.D.-18,000.

Fifty colleges and universities offer the bachelor's degree in geophysics. Sixty universities grant masters and Ph.D.'s in geophysics.



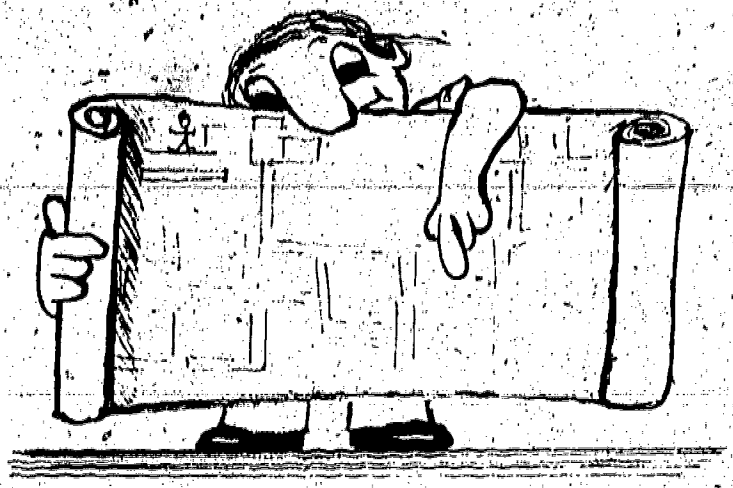
EXPLORATION GEOCHEMIST

The exploration geochemist samples rocks, soils, water and sediment in streams, vegetation and other natural materials. The materials are analyzed for traces of copper, lead, zinc, gold, molybdenum, mercury, and other ore related elements. From these analyses the exploration geochemist recommends locations for more extensive explorations. Due to the small amounts of metal measured in the samples, instrument methods are used to speed the analysis.

Most mineral exploration firms employ geochemists. Others are employed by state or federal geological surveys, or by universities. A bachelor's degree with extensive training in geology and chemistry is necessary. However, most geochemical jobs require a master's or doctor's degree in geochemistry.

The salaries for an exploration geochemist are comparable to those of an organic chemist: B.S.-11,500, M.S.-13,600, Ph.D.-18,700.

The degrees necessary for an individual to become an exploration geochemist are available at numerous colleges and universities.



MINING ENGINEER

The energy dilemma has created a situation demanding more mining engineers than have been graduated by colleges and universities — the result has been a serious shortage and an excellent opportunity for graduates in the field. The demand for coal mining engineers has prompted the highest starting salaries and choice of several good jobs.

Mining engineer jobs deal with extraction of coal from its location in the earth and its transportation to a marketing or preparation point. The job may require the engineer to be responsible for planning new mines — laying out the system and specifying power, ventilation, haulage, drainage, environmental standards and other requirements. This engineer may plan location and development of shafts, tunnels, and chambers, layout and oversee construction and operation of access roads, water power supply, drainage, rail and conveyor systems, and materials separating cleaning, grading, and reduction facilities. State and federal regulatory agencies utilize mining engineers as inspectors and for training purposes. Research institutions also employ mining engineers in attempts to improve mining processes which require the mining engineer's special knowledge. Other jobs are available with consulting firms and on university faculties.

The average starting salaries for mining engineers in 1977 were comparable to starting salaries in other engineering fields: B.S.-12,093, M.S.-14,979, Ph.D.-20,442.

Twenty-two colleges and universities offer degrees in mining engineering. Various scholarships and loans are available for qualified students. Several of the colleges offer work-study programs in mining engineering that can aid the student monetarily and provide valuable experience which generally permits entrance into a higher position upon graduation.

MINING GEOLOGIST

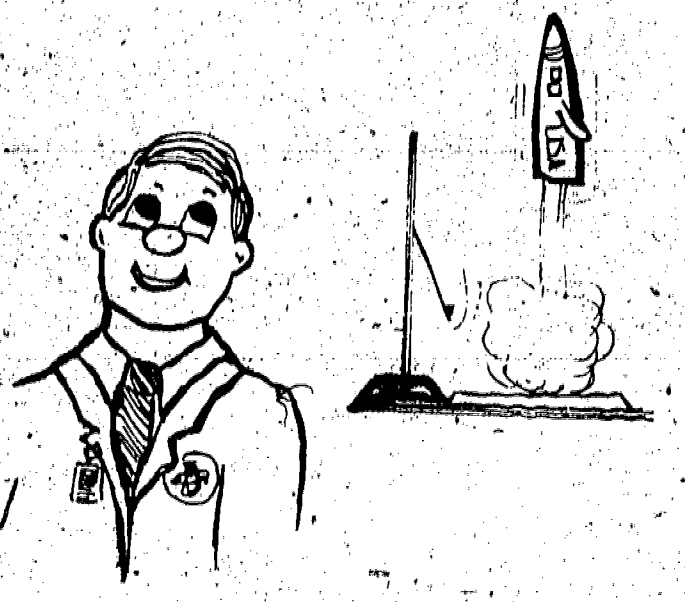
A mining geologist spends a portion of his career at operating mines. The major emphasis of his job is providing significant data concerning rocks, ore, and minerals for mine planning, development, and production. The tasks involved may be updating mine geologic maps, plotting and studying the results of exploration and development drilling, and recommending additional exploration and development.

A bachelor's degree in geology or geologic engineering with emphasis on ore deposits provides the mining geologist with the necessary background to begin professional employment.

Most mining geologists are found in various mineral industries, state and federal bureaus, research laboratories, and universities. Those with more experience frequently prefer self-employment as private consultants.

The salary ranges for a beginning mining geologist are comparable to the exploration geophysicist. B.S.-13,300., M.S.-14,900, Ph.D.-18,000.

About fifty colleges and universities offer a B.S. degree in geology and one hundred offer advanced degrees.



NUCLEAR ENGINEER

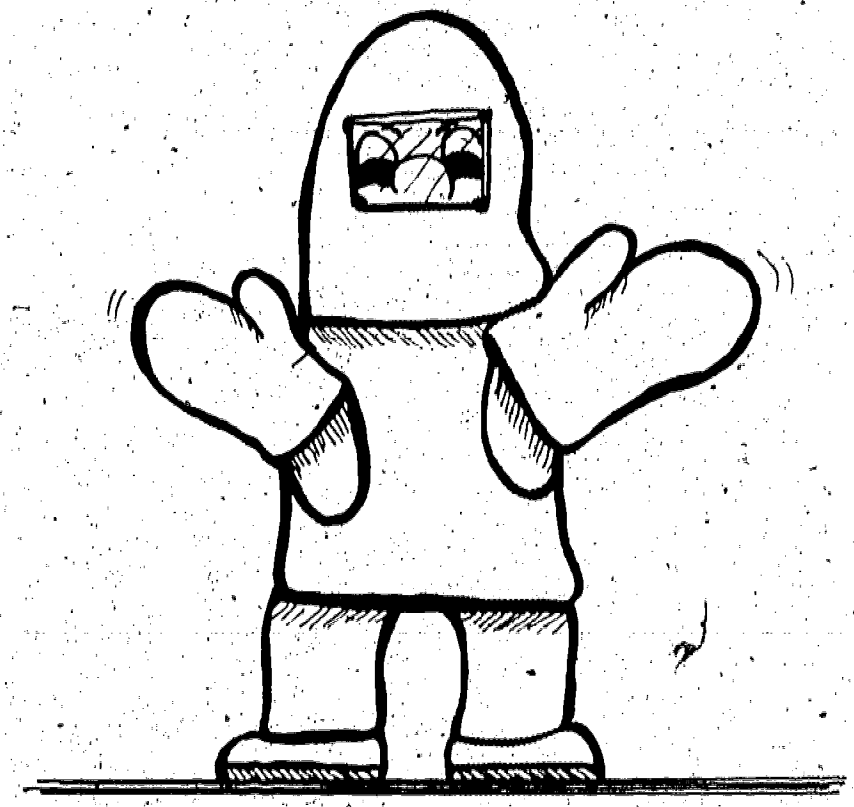
The rapid growth in nuclear powered electrical generating plants, space exploration using nuclear energy as a power source and propulsion, and radioisotope technology has increased the demand for well trained nuclear engineers.

A career in nuclear engineering may entail research on engineering problems concerned with release, control, and utilization of nuclear energy. Challenges in nuclear engineering might be in performing research development and design work or directing operations and maintenance activities in operational nuclear facilities. Examples of problems nuclear engineers are concerned with are thermonuclear analysis and utilization of radiation, analysis and design of reactors and nuclear energy systems. A career in this field may also require the individual to make analysis of radiation effects and shielding design problems, processing of radioactive materials and radioactive waste disposal, and radiological safety controls.

Since nuclear energy is a new and expanding field, it is difficult to pinpoint specific salaries and locations of opportunities. Career opportunities in nuclear power are, however, growing more rapidly than in any other aspect of energy production.

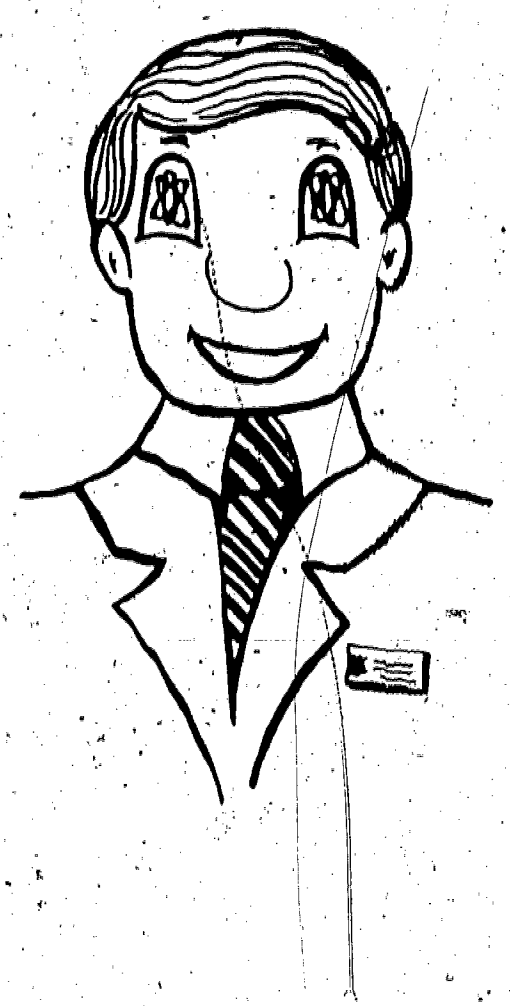
INDUSTRIAL-HEALTH ENGINEER

The industrial-health engineer plans and coordinates private or government industrial health programs requiring application of engineering principles and technology to analyze and control conditions contributing to occupational hazards and diseases. This specialist in health hazards conducts plant or area surveys to determine safe limits of exposure to materials or conditions, such as temperatures, noise, dusts, fumes, vapors, mists, gases, solvent and radiation, which are known or suspected of being real or potential detriments to health, and implements or recommends control measures. Frequently, the industrial-health engineer directs workers engaged in field and laboratory verification of compliance with health regulations. Consultation and technical guidance may be provided to management, labor organizations, government agencies, and civic groups by the industrial-health engineer, especially concerning health-related problems, stream and air pollution, and the correct use of protective clothing or accessories.



RADIATION PROTECTION ENGINEER

Currently, the rapid increase in nuclear power plants planned and under construction is creating a large demand for radiation protection specialists. These specialists must be well trained in all aspects of the nuclear power industry from mining to waste disposal of spent fuels. The nuclear power industry needs personnel with specialized training in radiation protection. Opportunities are available in government, educational institutions and private industry.



NUCLEAR PHYSICIST

The nuclear physicist studies the nature and characteristics of atomic nuclei and observes decay of radioactive nuclei which disintegrate spontaneously, utilizing electronic equipment which measures and records events occuring as rapidly as one billionth of a second apart. Betatrons, cyclotrons, synchotrons, and other accelerators and reactors are utilized to produce high speed electrified particles with which to bombard atomic nuclei. An important function of nuclear physicists is the measurement of structure, energy levels, decay rates, and other properties of emitted particles. Properties and structure of radioactive isotopes are examined to discover practical applications in industry, medicine, and other fields. Improved methods of radiation protection may be developed as a part of the nuclear physicist's work. Specialties in nuclear spectroscopy, radioisotopes, cosmic radiation, elementary particles or nuclear theory are open to the experienced nuclear physicist with advanced academic preparation.