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ABSTRACT

This publication contains the proceedings from a workshop held in Washington, D.C. in December, 1977. The purpose of the conference was to examine project PROCEED (Program for Continuing Engineering Education) as an innovative approach to technology transfer in energy efficiency education and the potential relationships of the project with the Department of Energy. The titles of presentations to the workshop are: (1) The National Energy Problem and the Federal Response; (2) Energy Conservation Education: Major Considerations; (3) False Images In Engineering Education; (4) Effective Methods of Delivering Appropriate Information: A Status Report; (5) Project PROCEED: Developmental History; (6) Project PROCEED: Its Learning Design; and (7) Project PROCEED: How It Works. The actual workshop involved three working groups. The three topics from which the groups developed recommendations and conclusions are: (1) Content and Problems; (2) Delivery Modes; and (3) Management and Viability. A summary of the recommendations and conclusions as well as a list of participants is included in this publication. (MR)

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PROCEEDINGS OF THE FIRST NATIONAL WORKSHOP ON ENERGY EFFICIENCY EDUCATION THROUGH TECHNOLOGY TRANSFER

Sponsored By

U. S. Department of Energy Division of Power Systems

in conjunction with

Massachusetts Institute of Technology's Project PROCEED

edited by Karen C. Cohen, Ph. D.

ACKNOWLEDGEMENTS

I should like to thank all of the participants and well-wishers, the speakers, and most of all, Dr. John Belding, Director, Division of Power Systems, Office of the Program Director for Fossil Energy, United States Department of Energy, who envisioned and encouraged this conference in a delightfully helpful manner.

My further thanks go to Dominic J. Monetta, now Director for Field Coordination, Office of the Program Director for Fossil Energy, United States Department of Energy, for the development of the conceptual framework of this effort.

Courtesy Associates handled the thousands of details that contributed to a well-organized effort, and they deserve special recognition.

Karen C. Cohen
Cambridge, MA

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THE FIRST NATIONAL WORKSHOP ON ENERGY EFFICIENCY EDUCATION THROUGH TECHNOLOGY TRANSFER

INTRODUCTION

The problems of energy conservation involve not just the transfer of technology but also the development of coherent social policies and channels through which information can and will flow. Therefore, the development of a national system, such as PROCEED attempts, to disseminate specific information and around which to build appropriate support to overcome individual and organizational barriers is very much in order.

The mandate is not simply to develop materials per se, but also to develop the communications and referencing system (both human and technological) which are necessary for effective transfer to take place. In other words, the problem is not that solutions aren't known or possible to many energy conservation problems, but rather they are frequently inaccessible to those who need them at many levels.

The purpose of this conference was to examine Project PROCEED as an innovative approach to technology transfer in energy efficiency education and potential relationships the Project and its products can and/or should have to the Department of Energy. To do so, selected representatives from industry, academia, professional societies, and government were invited. The PROCEED system was presented as an example upon which to focus discussion, and recommendations and conclusions about content, delivery, and management were solicited from working groups following presentations. These proceedings attempt to reflect an accurate distillation of the Workshop events and results.

SUMMARY OF RECOMMENDATIONS AND CONCLUSIONS

PROCEED (Program for Continuing Engineering Education), with its ability to be used in traditional modes of continuing engineering education as well as to provide a new approach to updating and problem-solving on the job, is an effort which the U.S. Department of Energy should encourage and evaluate carefully in a variety of ways, especially in areas under its aegis such as energy conservation, alternative energy sources, and associated technologies. A number of specific recommendations were made to the Project as well as to the Department of Energy. They will be examined separately.

Conclusions Concerning PROCEED

Advice to PROCEED focussed on enlarging its mandate and incorporating the widest possible variety of options in its marketing and delivery. More specifically, it was recommended that:

1) Educational institutions use PROCEED in their undergraduate programs to acquaint and accustom future engineers and scientists with this industrially-based problem-solving resource,
2) A broader audience be included, i.e., technicians, managers and others in industry, in addition to engineers and scientists, through broadening its materials and services;
3) Coordination of public and private resources be done by PROCEED through its Consortium,
4) PROCEED publicize those features of its system which make it innovative, e.g., problem-solving cases, explanatory modules, adaptive referencing, and companion human as well as material resources; and
5) A variety of delivery modes be utilized for maximum effect.

Conclusions Concerning the U.S. Department of Energy

The general conclusion was summarized by the third working group:

> "PROCEED appears to be a promising approach to the continuing education of practicing engineers. Its plans for materials and services on industrial energy conservation and its planned delivery system promise to fulfill an important national need. The Department of Energy should thus support PROCEED for a sufficient time to allow an evaluation to be made of its effectiveness in conjunction with the educational mission of the Department of Energy."[1]

[1] First National Workshop on Energy Efficiency Education Through Technology Transfer, Working Group III.

Other recent DoE conferences similarly support the mission of PROCEED and encourage recognition for technician training and appropriate public-private cooperation.[2]

At the Energy Conservation Workshop on "Training Requirements for Technicians," the group concluded that

> "...efforts should be increased to add energy conservation concepts to current engineering-based technician curricula...The engineering technician should learn not only methods, but also the reasons for conserving energy...Developing an inventory of current practices and sponsoring 'new' course development represent tasks which the Department of Energy might finance."[3]

The same group went on to say that

> "More efforts should be directed toward integrating high quality energy-related topics and fundamentals into college courses like physics, chemistry and biology at all levels of education,"[4]

such as PROCEED is developing. Finally, the most critical conclusion relative to PROCEED was

> "Great potential seems to exist for the utilization of teaching modules which the Department of Energy could collect (or have developed) in a broad spectrum of energy-related topics. This seems to represent one of the best techniques for achieving replication and leverage for a modest fund outlay by the Department of Energy."[5]

Recommendations

Given the conclusions and recommendations for PROCEED and DoE, several specific recommendations follow and seem mutually supportive.

1) Materials: Relevant and PROCEED compatible materials should be found or their development funded and utilized with constituencies ranging from the technician, through the scientist and engineer in

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[2]Energy Conservation Workshop for Community College Leaders, ERDA 76-156 (Chicago, November 3-5, 1976).

[3]Energy Conservation Workshop: Training Requirements for Technicians, CONF-7710118, (Atlanta, October 30-November 1, 1977).

[4]Ibid, p. 3.

[5]Ibid.

industry, through management and possibly to the public.

2) Delivery System: Coordination, collaboration of Department of Energy resources and contacts should be utilized to create the widest possible PROCEED-involved constituency and network, combining the help of the private and public sectors.

3) Marketing: Like the delivery system, marketing should be coordinated through federal, state and local agencies in conjunction with private and public institutions of higher education, professional societies, industry, and the support of the Department of Energy.

4) Scope: Expansion of the scope of the system and the types of persons, materials and services addressed could maximize its usefulness and likelihood of impact on the national energy problem. Although PROCEED is an innovative continuing education system for scientists and engineers, the Department of Energy should capitalize on expanding and extending the system to cover a variety of energy-related topics and reach the broadest possible national constituency.

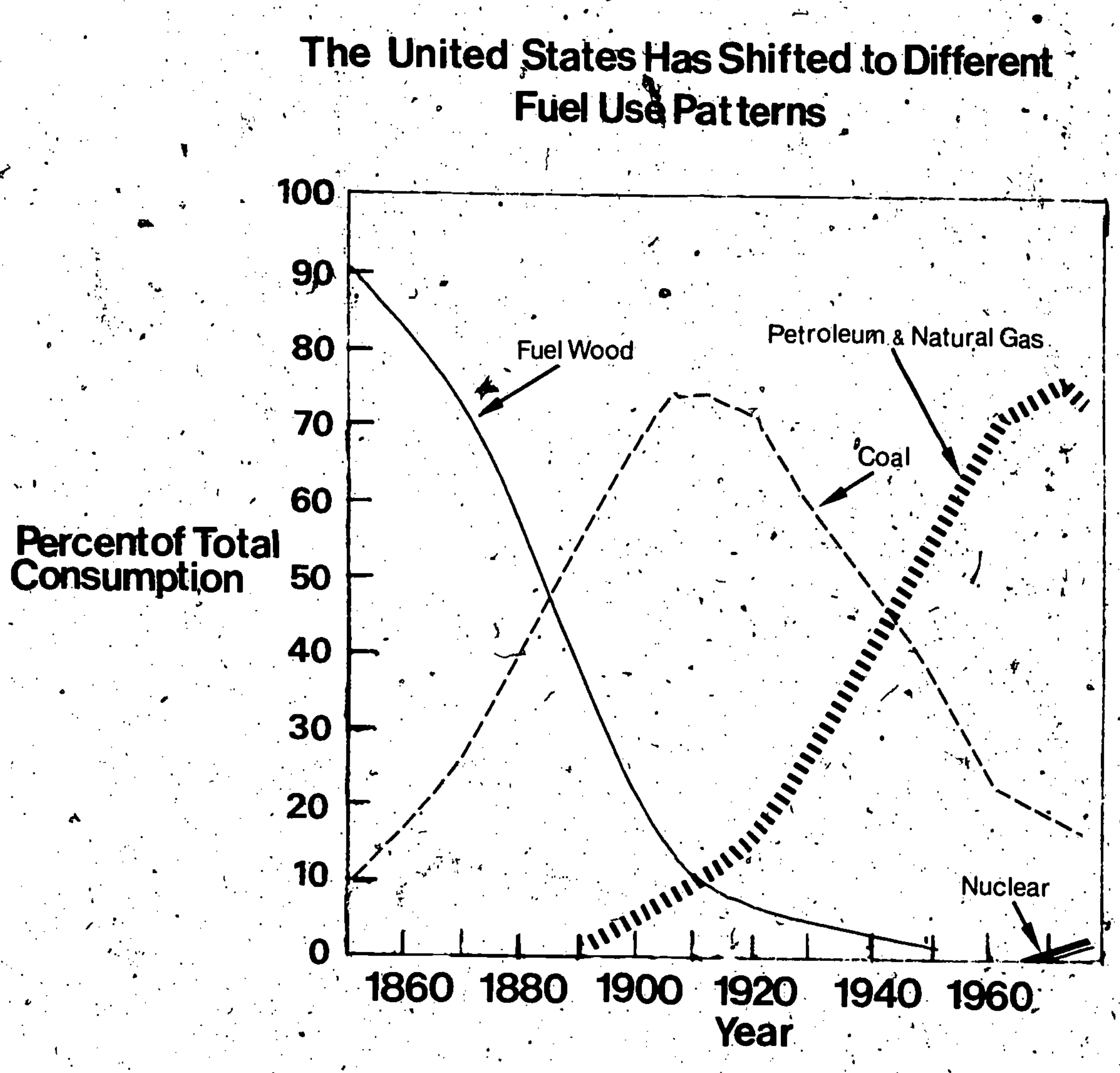
SPEECHES

Dr. John A. Belding

KEYNOTE SPEECH: THE NATIONAL ENERGY PROBLEM AND THE FEDERAL RESPONSE

What I would like to talk about today is why we are interested in this whole idea; what the National Energy problem and plan are all about; and hopefully we can get some understanding of what the urgency is in the education business.

May I have the first slide, please?

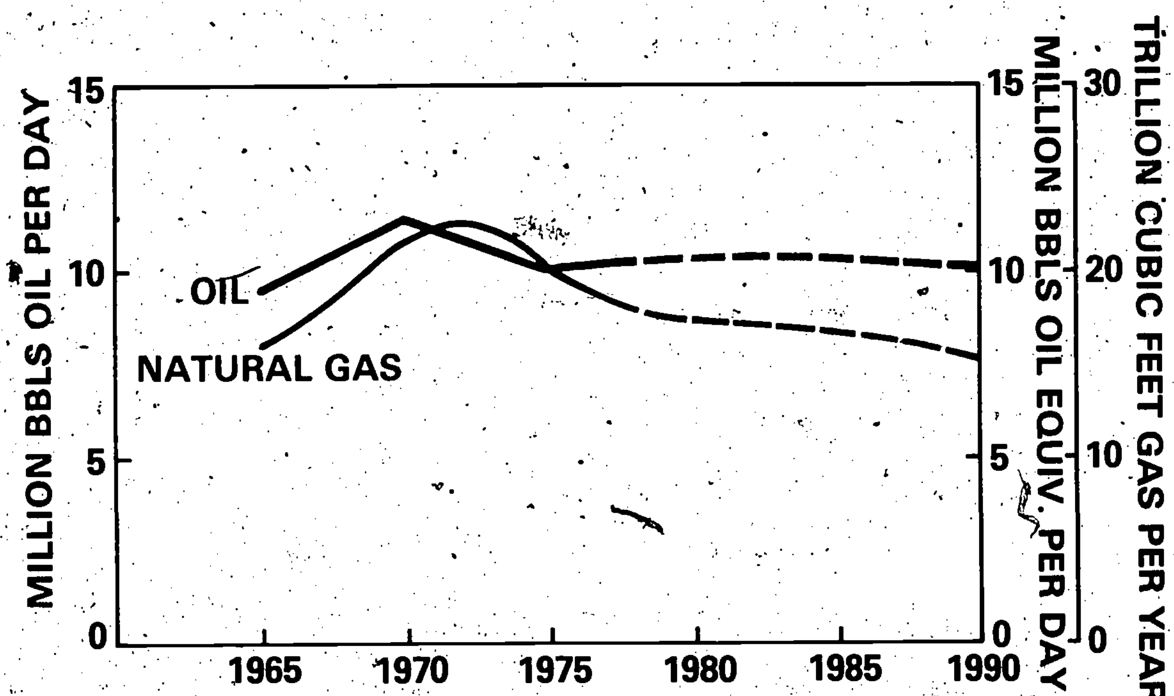


Source: Bureau of the Census "Historical Statistics of the United States" U.S. Bureau of Mines

SLIDE 1

This slide shows the way we have made the transition in the past from wood to coal to oil and you can see that in making each transition it took roughly 60 years. We now have to make another transition. We no longer have the oil available to continue for another 60 years. What we are attempting to do is shorten that transition period to something like ten or 20 years. The problem that we have is that it takes lead-time to do that. We have to develop technology. We have to educate people and make them realize that this is a problem that they can do something about.

U.S. OIL AND NATURAL GAS PRODUCTION



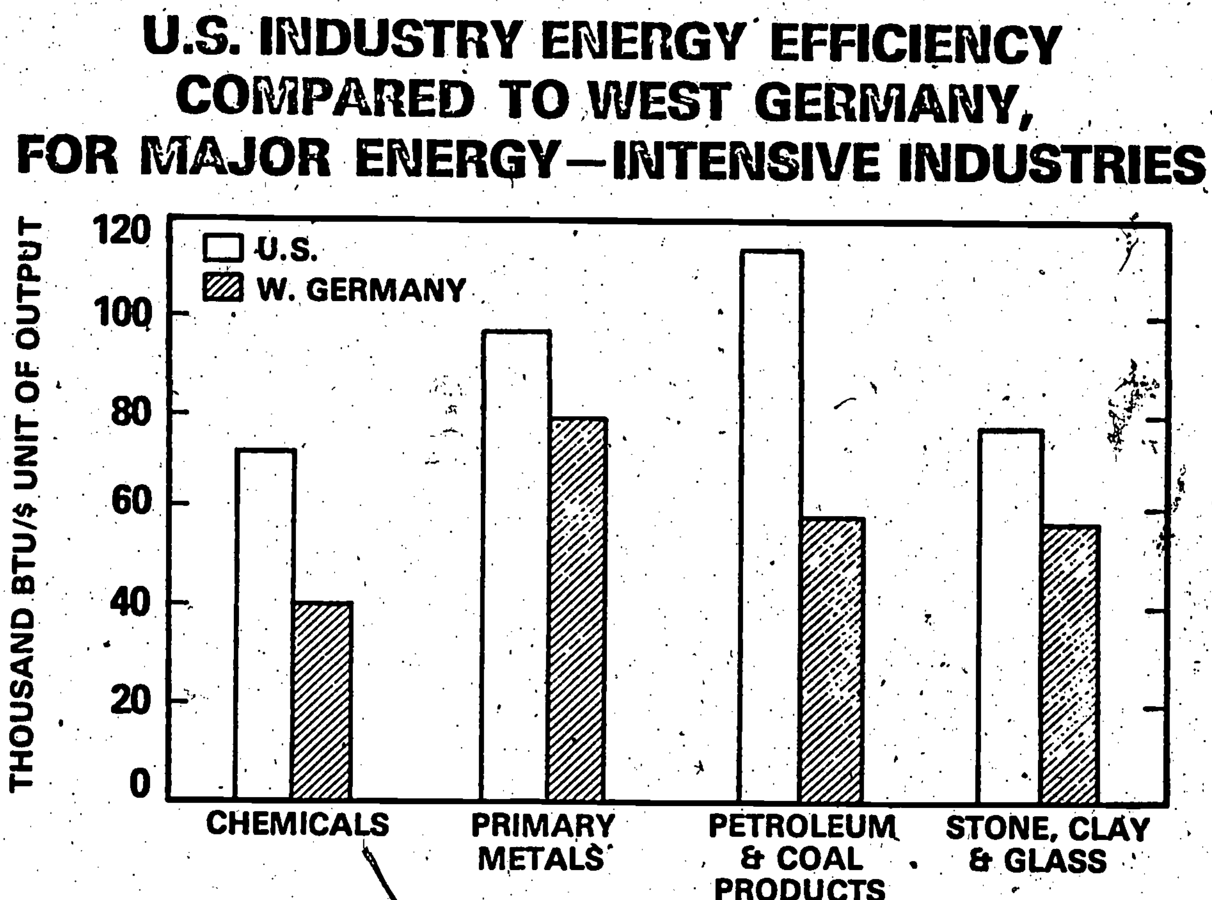
SLIDE 2

This slide shows why we are in the situation that we are in. In 1970 domestic oil production peaked. In 1973 we peaked out in gas production. Some say, "just raise the price, there is lots more out there." In fact, that may be true in natural gas and hence we are attempting to stimulate production, but in oil we think we have pretty much tapped all the reserves or at least know what they are. We anticipate a liquid fuel shortage and we think that we have to be able to aid in making the transition away from liquids if we are going to survive.

The other thing that many of you may be interested in is, of course, the economic picture. The problem with the balance of payments is getting to be more and more severe. Our national export of dollars back in 1973, before the embargo, was about $3 billion for oil. It's now $35 billion and increasing dramatically. So, just from a pure economic standpoint we have a problem.

One of the things that we have taken a look at over the last three years is how to go about making the transition from oil. We have made some projections on how, through the use of energy-efficiency technology, we can make the transition. We have also examined reducing oil consumption by switching to other alternative fuels. By alternative fuels I am talking about coal, principally, and coal-derived liquids and gas. You can see that, if we really take no action, the amount of energy that we use just keeps increasing exponentially. On the other hand, if we can put in more efficient technologies and do some fuel switching we can drop down to that conservation goal, shown by the dashed line. That's what we have got to do and education will play a big part.

To give you an indication of why we are pretty confident that we can do that, this slide



SOURCE: COMPARISON OF ENERGY CONSUMPTION BETWEEN W. GERMANY & THE U.S., STANFORD RESEARCH INST., JUNE 1975

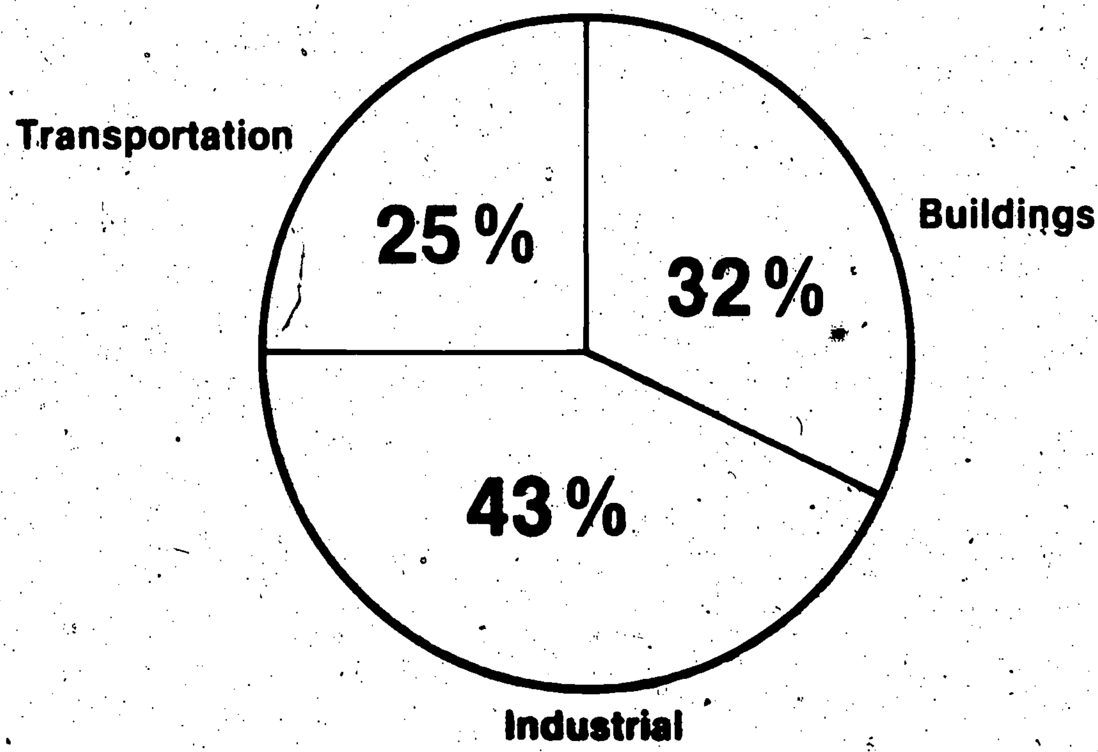
SLIDE 3

shows a picture of what West Germany is presently doing versus what the United States is presently doing. They have been in an era of very high prices and they have been forced into energy efficiency. This is the kind of picture that we would like to see for the United States to be able to make that transition down to using less and less energy.

To give you an indication of how much energy we really use, this slide

Primary Energy Consumption in the United States

Industry Accounts for 43 Percent of Total U.S. Energy Consumption



SLIDE 4

shows the percentages in each of the areas. You can see that automotive is a fairly large portion. The reason that automotive is so important, and I say automotive for transportation because automotive is approximately 90 percent of that transportation slice, is that it's solely dependent on oil.

Remember I said we are going to have a liquid problem. We see it coming. We have predicted it in an M.I.T. study, a C.I.A. study and basically every study now that's coming along is predicting that same kind of liquid shortage. People aren't buying small cars. The industrial concerns are attempting to reduce the amount of oil consumption. But even with this, we are still careening along the same path we were a while back, and people are hoping that they won't have a curtailment. The R.O.I., return on investment, of energy-efficient machinery has got to include plant shut-downs and all that takes education, but it also takes engineers to go to their management and say, "This is what we have to do in order to prevent out plant from being shut down and prevent the lay-offs and prevent the orders from not being filled, et cetera."

THE

NATIONAL

ENERGY PLAN

April 20, 1977

SLIDE 5

I just want to briefly cover the National Energy Plan. As most of you know it's still winding its way through the Congress and has had some semblance of success and some semblance of failure. I want to cover some of the high spots and we will talk about what actually is happening and what we see coming out at the end.

PRINCIPLES AND STRATEGY

FIVE PRINCIPLES PROVIDE FRAMEWORK
FOR PRESENT AND FUTURE POLICIES

- PROBLEM CAN ONLY BE EFFECTIVELY ADDRESSED IF
  - GOVERNMENT ACCEPTS COMPREHENSIVE RESPONSIBILITY
  - PUBLIC UNDERSTANDS SERIOUSNESS AND ACCEPTS SACRIFICES
- NATION MUST REDUCE VULNERABILITY TO DEVASTATING EMBARGOES
- SOLUTION MUST BE EQUITABLE TO ALL REGIONS, SECTORS, AND INCOME GROUPS
- HEALTHY ECONOMIC GROWTH MUST CONTINUE
- ENERGY PLAN MUST BE IN HARMONY WITH ENVIRONMENTAL POLICIES

SLIDE 6

These are the principles that the President laid down in April of this year, and I think if you look at the second bullet under the first point you can see why we are involved with Project PROCEED and continuing education. We not only have to work in concert with the people, but we have to give people the tools so that they can, in fact, work to understand the problem. That's what PROCEED is all about.

You can read the other points, but basically what we are attempting to do is protect the United States from devastating embargoes and put the United States on a little better course without needing the imported oil and natural gas. Since I don't think there are any Sierra Club people here I will only say in passing that we do have to meet the environmental constraints. Normally I spend a great deal of time on that particular point.

The cornerstone of the whole National Energy Plan is Energy Conservation.

PRINCIPLES AND STRATEGY

FIVE ADDITIONAL PRINCIPLES FUNDAMENTAL TO PROPOSED PLAN

- ENERGY DEMAND GROWTH MUST BE RESTRAINED THRU CONSERVATION
- ENERGY PRICES MUST REFLECT TRUE REPLACEMENT COSTS
- PRODUCERS AND CONSUMERS ENTITLED TO CERTAINTY OF GOVERNMENT POLICY
- PLENTIFUL RESOURCES SHOULD BE USED MORE WIDELY, USE OF RESOURCES IN SHORT SUPPLY SHOULD BE MODERATED
- USE OF ALTERNATIVE SOURCES OF ENERGY SHOULD EXPAND

SLIDE 7

And I think the subject that we are going to talk about the next two days, Energy Conservation and Industrial Applications, and how to go about the continuing education of that aspect, is going to be extremely important if we are going to make any headway in the conservation area.

PRINCIPLES AND STRATEGY

OBJECTIVES

- SHORT TERM: REDUCE VULNERABILITY TO EMBARGO
- MID-TERM: WEATHER PEAKING AND DECLINE OF WORLD OIL PRODUCTION
- LONG TERM: DEVELOP RENEWABLE SOURCES FOR SUSTAINED ECONOMIC GROWTH

SLIDE 8

These are sort of simplistic goals of what we have to do and you can see in the short term we have got to slow down on using oil and natural gas. In the long term we would like to be using something like solar or nuclear or coal or all of the above.

PRESIDENT'S ENERGY STRATEGY

- IMPLEMENTATION OF AN EFFECTIVE CONSERVATION PROGRAM FOR ALL SECTORS OF ENERGY USE SO AS TO REDUCE THE RATE OF DEMAND GROWTH TO LESS THAN 2 PERCENT.
- THE CONVERSION OF INDUSTRY AND UTILITIES USING OIL AND NATURAL GAS TO COAL AND OTHER MORE ABUNDANT FUELS TO REDUCE IMPORTS AND MAKE NATURAL GAS MORE WIDELY AVAILABLE FOR HOUSEHOLD USE.
- A VIGOROUS RESEARCH AND DEVELOPMENT PROGRAM TO PROVIDE RENEWABLE AND ESSENTIALLY INEXHAUSTIBLE RESOURCES TO MEET UNITED STATES ENERGY NEEDS IN THE NEXT CENTURY.

SLIDE 9

To give you the three major points that the President brought out in his plan, the first was to reduce the total consumption to about 2 percent. We have been running at about 3 percent oil, gas, all of the energy, so that's about 33 percent reduction. We think we can achieve that.

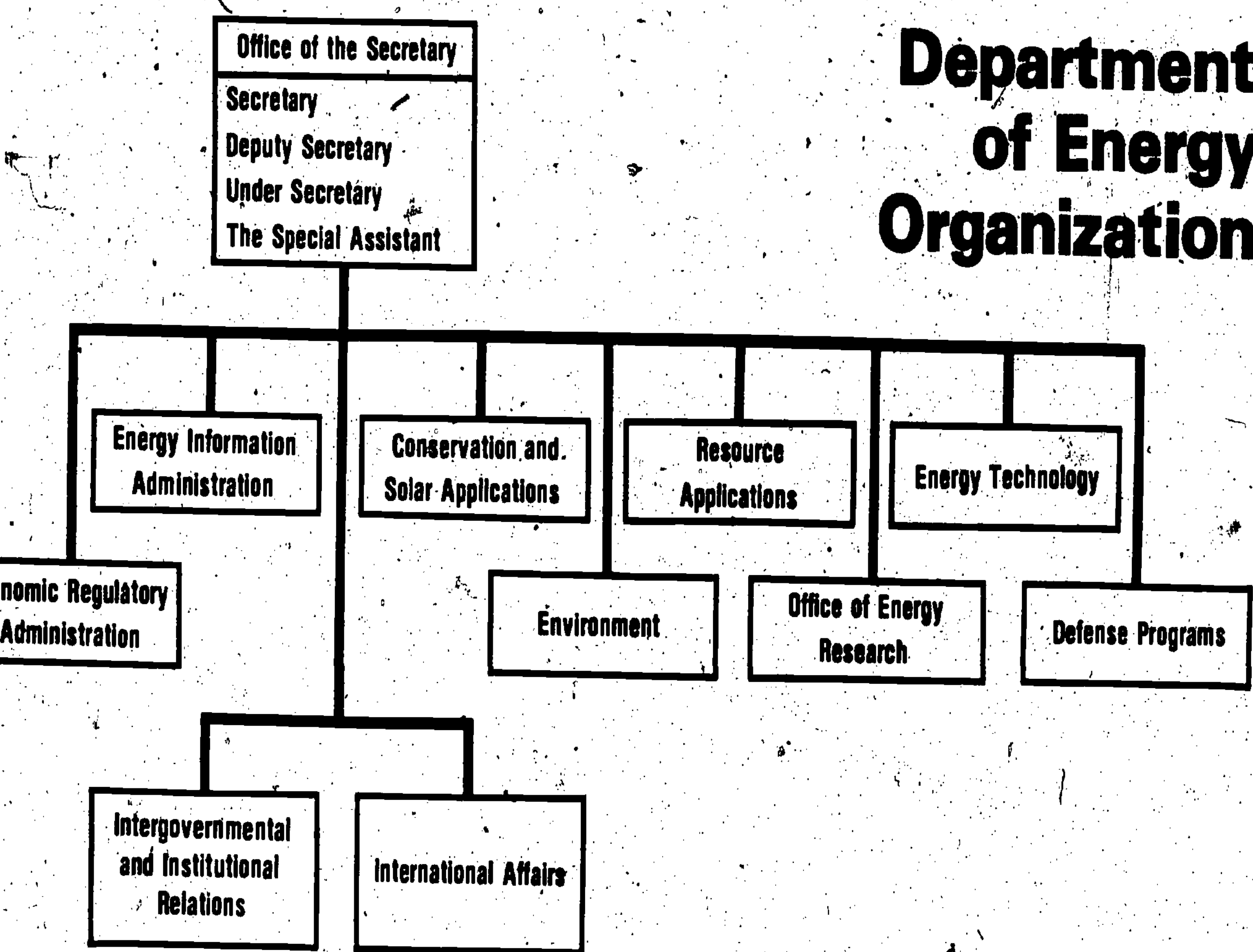
We would also like to convert the industry to coal as quickly as possible and, of course we want to continue the technology development over time.

One of the philosophies that people don't seem to understand about the new Department of Energy is that we really are not in the business of buying equipment. All we can do is catalyze the market and make people who are going to be in the commercial concern go about producing that equipment. This is a very, very different kind of philosophy than we have ever had in NASA or D.O.D. or any of the other Government agencies.

ENERGY PROGRAM STATUS ON CAPITOL HILL

	CARTER PLAN	HOUSE ACTION	SENATE STATUS
SOLINE TAX	STANDBY TAX RISE UP TO 50¢	KILLED	REJECTED BY FINANCE COMMITTEE
TURAL GAS PRICING	RETAINS CONTROLS AT HIGHER PRICE	CARTER PLAN PASSED, WITH MORE GAS ELIGIBLE	KILLED BY SENATE; DEREGULATION APPROVED INSTEAD
UDE OIL TAX	RAISE PRICES TO WORLD LEVELS IN 3 YEARS	PASSED IN BASIC FORM	REJECTED BY FINANCE COMMITTEE
. TAX REBATES	EACH PERSON WOULD GET A SHARE	EACH TAXPAYER WOULD GET A SHARE	REJECTED BY FINANCE COMMITTEE
S GUZZLER TAX	PENALIZES INEFFICIENT CARS	PENALTIES HIGHER, START LATER	REJECTED BY FINANCE COMMITTEE SALES BAN APPROVED BY SENATE
NDATORY MILEAGE	NOT IN PROPOSAL	NOT IN BILL	PASSED
ATING OIL REBATES	RETURNS COST INCREASES IN CONSUMERS	PASSED	REJECTED BY FINANCE COMMITTEE
ME INSULATION	$400 TAX CREDIT	PASSED	APPROVED BY FINANCE COMMITTEE
LAR ENERGY	TAX CREDIT UP TO $2,000	INCREASED TO $2,150 WIND POWER ELIGIBLE	APPROVED BY FINANCE COMMITTEE
AL CONVERSION	TAX PENALTIES TO FORCE INDUSTRY SWITCH	PASSED WITH SOME INDUSTRIES EXEMPTED	PART REJECTED BY FINANCE COMMITTEE; PART APPROVED
PLIANCE STANDARDS	SET EFFICIENCY MINIMUMS	PASSED IN BASIC FORM	PASSED IN BASIC FORM
ECTRIC UTILITIES	REQUIRE CHEAPER RATES IN OFF-PEAK HOURS	PASSED IN BASIC FORM	REJECTED

SLIDE 10


Department of Energy Organization
Office of the Secretary
Secretary
Deputy Secretary
Under Secretary
The Special Assistant
Energy Information Administration
Conservation and Solar Applications
Resource Applications
Energy Technology
nomic Regulatory Administration
Environment
Office of Energy Research
Defense Programs
Intergovernmental and Institutional Relations
International Affairs

SLIDE 11

A lot of people are interested in where we are today. Basically each of the major points that was in the plan is summarized here and you can see that, for instance, the gasoline tax on automobiles was a very unpopular issue. It was killed in the House. The Senate never even put it in the Bill. So that is completely dead. Crude oil tax. It was passed in the House. It was not included in the Senate Bill. Now that is back in conference, so the resolution will be somewhere between not included and what we proposed originally. That's basically the way Civics 101 works in this town, and for those of you who haven't had the rare opportunity to watch it in action you ought to spend some time looking at it because it's not quite the way our old textbook said it would be. It's a very, very intricate process.

(See Slide 11.)

This is the structure of the new Department of Energy and as Dr. Cohen indicated earlier, we are over in that box called Energy Technology. The box called Intergovernmental and Institutional Relations is where the education group is now housed.

People ask, "Well gentlemen, how did you get involved in education? Why are you sponsoring this conference?" It's a very long story, and it really boils down to who had the money at the time. We felt that it was a very important project to pursue and therefore, we went ahead and became involved in the workshop.

We are also helping advise PROCEED on what kinds of topics they should be involved in, and its been a very, very interesting relationship.

RESPONSIBILITIES

FEDERAL GOVERNMENT:

- **CATALYZE DEVELOPMENT OF HIGH RISK TECHNOLOGIES**
- **ENSURE DISSEMINATION OF RESEARCH INFORMATION**

PRIVATE SECTOR:

- **COMMERCIALIZE NEW ENERGY TECHNOLOGY**

SLIDE 12

Well, as I said earlier, our responsibilities as the Department of Energy are not to buy hardware. They are really to catalyze technology development to insure dissemination of the results and to help the private sector commercialize the new machines.

MAJOR REQUIREMENT

Continuing Dialogue Between Government and Industry

SLIDE 13

And I think this is going to be a major point of the new department. I think we are going to see a lot of activity in either what you might call PR or education in order to convince people to conserve, because they are just not doing it now.

PROJECT PROCEED

- DESIGNED TO HELP ENGINEERS SOLVE ENERGY CONSERVATION PROBLEMS IN INDUSTRY
- TIMELY AND CONSISTENT EFFORT WITH THE NATIONAL ENERGY PLAN

SLIDE 14

All I would like to say in conclusion, is welcome to Washington and our beautiful sunny weather that we have today.

Thank you.

DISCUSSION

PROFESSOR COHEN: I think there will be time for a few questions following each speaker, if there are any from the audience. If not, we can continue on.

(______): I have one question on that slide comparing U.S. and West German consumption, energy consumption. I wonder what the basis is. I am not clear on the basis for comparison.

DR. BELDING: They are similar industries.

(______): Not total industries, but similar industries?

DR. BELDING: Right.

(______): How do they achieve this?

DR. BELDING: I think they have had to pay more attention to using waste heat and better processes -- more than we have, because energy in this country has been more abundant and so people have tended to not be as careful with it. A lot of the larger industrial concerns are now jumping and saying, "Hey, we can save that energy" and they are doing it. The problem is that smaller concerns who are paying the higher prices don't have the capital to go back and retro-fit, so they are caught between a rock and a hard spot. If we had said five years ago that we are going to raise the price of oil in five years, then the little guys could have said, "Maybe we had better start retro-fitting and making our process more efficient, because in five years the price is going to be higher" and they would have had the capital higher.

What happened was the prices jumped up, almost doubled, and they said, "My God, we don't have the capital any more."

PROFESSOR TRIBUS: Do you have any information on the variations in industry. In other words, in the United States I know that the best, in terms of energy conservation, is quite different from, say, the bottom 10 percent. Do you know how the variations go in the two countries, in particular when the best in the U.S. comes near to the best in West Germany, and what we are really seeing here is a bad distribution of competencies.

DR. BELDING: Well, I think the best in this country is not necessarily equal to the best in West Germany. See, the return on investment just wasn't there so they didn't have to save energy. What we are really seeing is an economic picture more than a technology picture. We had the technology. We knew how to do it, but we never used it because it never paid off.

Now that we have doubled the price of oil it begins to look pretty attractive, so people are beginning to bring their plants up to the right level, but I think the gradation in the United States is much worse than it is in Europe due partially to some older plants in the U.S.

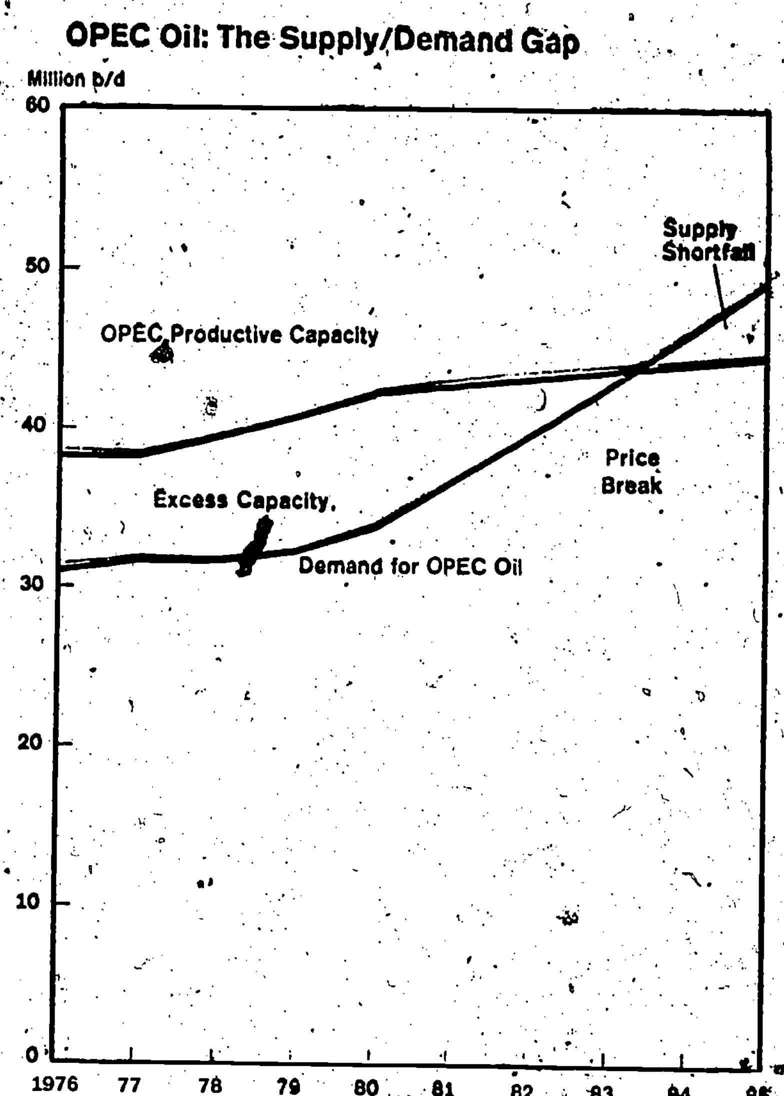
Professor Elias P. Gyftopoulos

ENERGY CONSERVATION EDUCATION: MAJOR CONSIDERATIONS

I would like to make a few remarks about the problems that might be included in a program of education regarding energy conservation.

Let me, before I start, define what I mean by energy conservation, because there are many interpretations. The meaning with which I will be using the words is the achievement of a task with equal or less cost than today, but using less energy. Things that do not satisfy this idea do not belong to the discussion that I will be having.

Now, there is no doubt that the problem of energy is extremely difficult and the discussions that are going on in our Congress reflect the



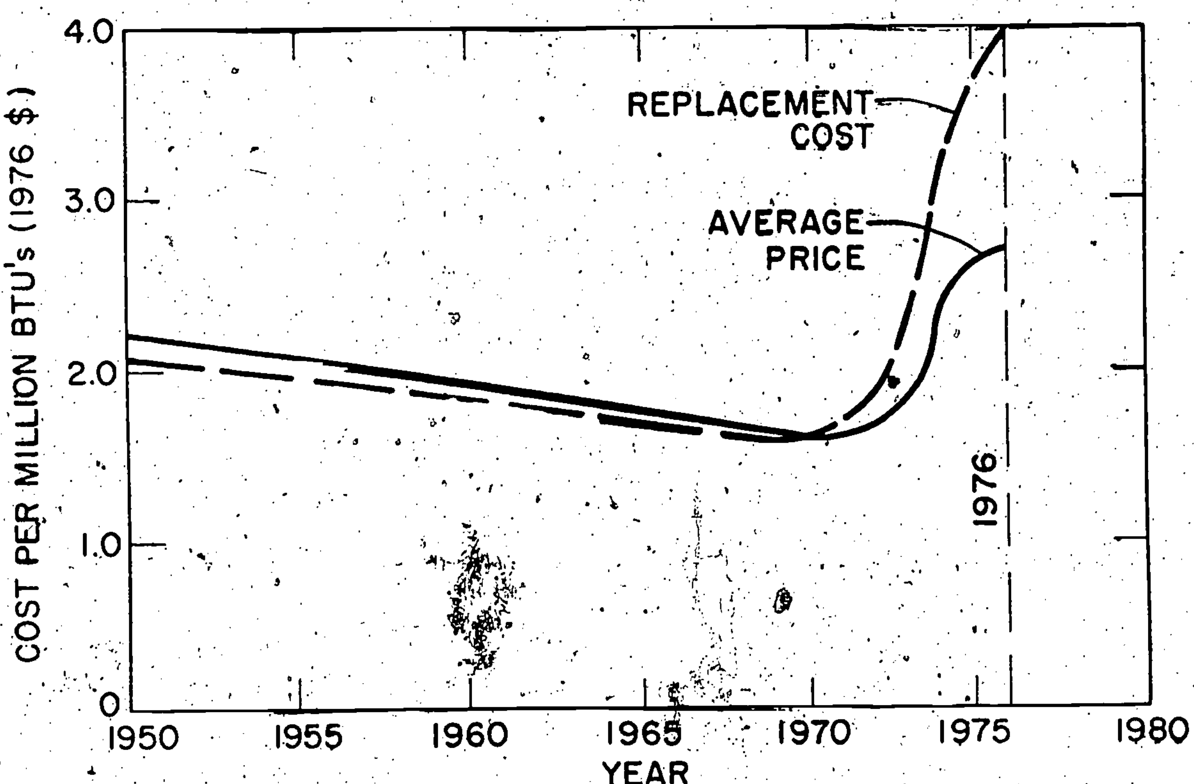
SLIDE 1

fact. It's not simply as Dr. Belding says that Washington works in peculiar ways. It is that the representatives of our people have a very difficult problem. They receive all sorts of conflicting information and they have all sorts of conflicting solutions to offer and, therefore, the need for education at the grass roots is a need indeed.

In a program of education one has to be as inclusive as possible. And you already heard, from Dr. Belding, a synopsis of the problem, especially about the resources. I would like to cast the same problem in a slightly different light than was already referred to.

It's not only so much that we are running out of the resources that we are currently using, especially the liquid and gaseous fuels, but that the rate at which we can provide them in the near future will be less than the demand. This was illustrated in the report that was issued by C.I.A. last April. For example, sometime around 1983 or 1984 oil will be produced at a rate that will be lower than the demand (Slide 1).

Other calculations may differ by one or two years or something like that, but that doesn't change the picture. The Workshop on Alternative Energy Strategies reached the same conclusion. You can use the graph on Slide 1 or a different type of graph, but the message is clear that



Aggregate Cost in Constant Dollars of Industrial Energy from 1950 to 1976; (Weighted According to Usage of Coal, Oil, Gas and Electricity in Industry).

SLIDE 2

there will be a shortage in the production of oil in a very few years from now.

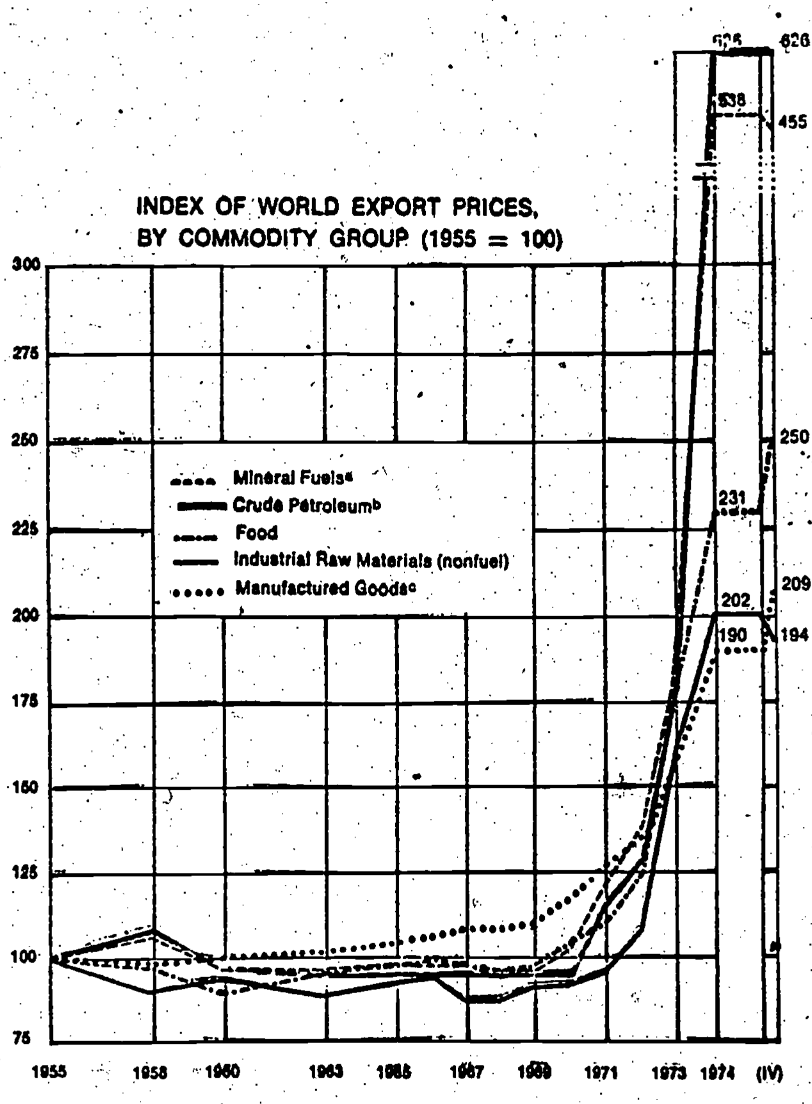
That in itself is not such a bad thing. In the past some energy sources were depleted and had to be replaced and were replaced. But today the situation is different from what we experienced in the past. The problem is that whatever alternatives we have for replacement are much more costly. There is nothing under the sun, including the sun, that will be able to replace the energy that we are currently using at a cost anywhere near or comparable to the cost we have been incurring so far.

This is illustrated by the trend in replacement costs of energy for industry (Slide 2). On this graph the dotted line illustrates the trend in the average replacement cost of energy used for manufacturing in the United States. The averaging is done over the percentages and energy forms used by U.S. manufacturers. We see from this graph, that, in real terms, up to about 1970 the replacement cost of energy used in manufacturing was steadily decreasing. It was decreasing by 1.7 percent per year. In about 1970 this replacement cost started for the first time in our history going up, right now it's almost twice as large as it used to be back in 1950. This is much more important a change than the scarcity or the depletion of the fuel sources that we are currently using because that's what's going to affect and is affecting our economic well being.

Energy Form	Percent of Industrial Use [1976]	($ per Million Btu of Delivered Energy)		Ratio of Replacement Cost to Average Price
		Average Price	Replacement Cost	
Coal	18.0	$0.95	$0.95	1.00
Petroleum	29.1	2.32	3.32	1.43
Natural Gas	39.5	1.73	3.00	1.73
Electricity	13.4	7.62	10.55	1.38
Weighted Average	100.0	$2.55	$3.74	1.46

Average Price and Replacement Cost of Energy Used in Industry

TABLE 1



SLIDE 3

The replacement cost that I have used for each form of energy is shown in Table 1. For petroleum I have taken $3.37 per million BTU, for natural gas $3 per million BTU and for electricity $10.50 per million BTU, which is the same as 3.6 cents per kilowatt-hour.

As far as anybody can tell, in the future replacement costs will continue to rise. That to me is a real threat both to our economic well being and to the competitive position of our industry, because we may not be able to afford the energy we need for our activities and, therefore, we may have to stop using it. But to stop using energy would mean no heating in our homes, no jobs, et cetera. I believe that to a certain extent this will happen. The question that people like you that are involved in energy conservation ask is "Can we reduce as much as possible the negative effects of the higher cost of energy by means of energy conservation?". I believe that great opportunities exist for doing so.

Let us first look at some general economic aspects of these opportunities. Slide 3 is taken from a report of the United Nations. It shows the trend in the prices of various goods including energy. It expresses current prices in comparison with prices in 1955. The most important conclusion from this slide is that whereas the price of oil has increased by a factor of six, everything else (food, capital goods, and labor) has increased by a factor of two to three. We see then that an economic opportunity exists for replacing energy by other factors of production, such as labor or capital equipment.

If this slide were to be drawn for statistics available and pertinent to the United States (Statistical Abstracts, Department of Commerce) we would have found the following. In real terms, the cost of labor and the cost of capital equipment in this country over the past twenty years have remained practically constant within a few percentage points. By remembering the data in Slide 2 we conclude that as far as this country is concerned, the opportunity exists for substituting other factors of production for energy so as to achieve the same task with equal or less cost and less energy, namely by becoming more energy efficient.

So that's the economic opportunity. Let me now turn to the technical opportunity. I would like to ask: "Do we have the technology to become more energy efficient?"

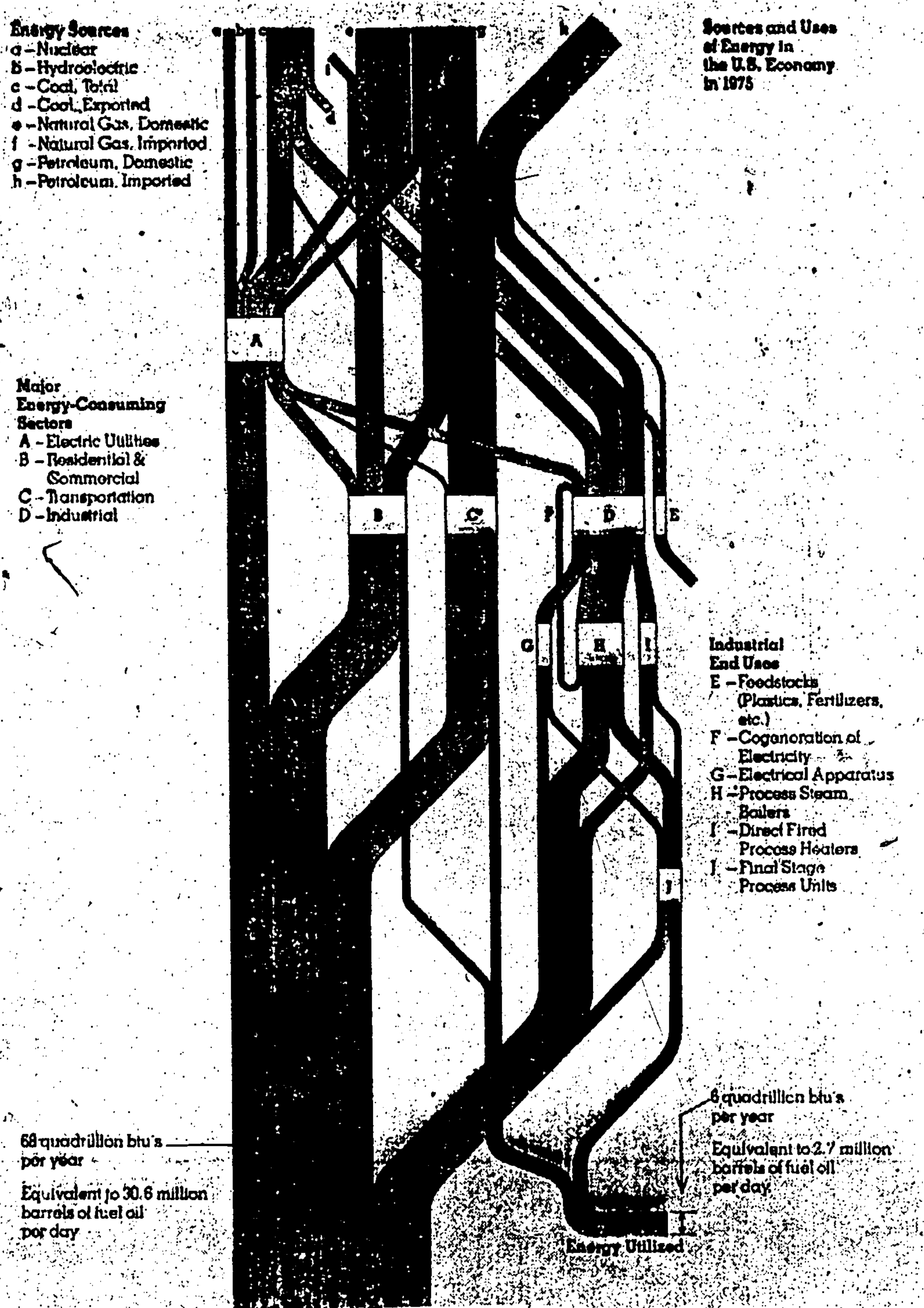
The answer to my question is an unqualified yes.

The lanes in Slide 4 show the flow of thermodynamic availability (not of energy) in the U.S. economy. The figure is different from similar figures that have been presented in many reports and have been published over the last few years. It leads to different conclusions than the conclusions about efficiency in manufacturing which are included in the national energy plan. Let me specifically address this last point. In the national energy plan it is stated that manufacturing in the United States is 75 percent efficient. In Slide 4, if you follow the lane corresponding to manufacturing you will find that, on the basis of availability, efficiency of manufacturing is about 13 percent.

Now, that does not mean necessarily that we are wasteful. As Dr. Belding said earlier, the economics of energy, capital equipment and labor in the past were such that that was the best way of using these factors of production and achieving the goals that we had in our society.

In Germany and Japan, either because of newer equipment or because they had faced higher fuel prices earlier than we did, the corresponding efficiency in manufacturing is about 18 percent instead of 13 percent.

The data in Slide 4 show the various types of fuels that are used in our economy and their availabilities, and the losses of availability in various processes. Here the word availability is used in the sense of thermodynamics. For example, fuels go into the electrical sector to produce electricity. That involves a certain inefficiency. Electricity is generated with an efficiency of about one third. Again, fuels are used for the generation of process steam. That involves certain inefficiencies. The thermodynamic efficiency of process steam raising in manufacturing is about 20 percent. Some of the fuels are used in high and low temperature



SLIDE 4

heating processes, in the chemical industry and other industries. These uses also involve inefficiencies.

Overall for our economy, the amount of availability that we need to carry on all our tasks is about 8 percent of that we consume. In more detail, the thermodynamic (availability) efficiencies of various uses of energy are as follows: residential and commercial space heating 6 percent, water heating 3 percent, air conditioning 5, automobile propulsion 10, steel production 21, oil refining 9, cement making 10, and paper is much less than 1. For the whole economy the efficiency is about 8 percent, and for manufacturing it's about 13 percent.

Now, what are the implications of disseminating this type of analysis of the energy use in our economy?

There are two. First and foremost that we have not reached the limits of efficient use of energy by any stretch of the imagination. There is a very large margin for improvement. To be sure, the realization that there is a large margin does not automatically provide us with the use of that margin. It will take hard work; a lot of money and many years. Nevertheless the margin does imply that working in the direction of improving the efficiency of energy utilization is not like knocking one's head against an immovable wall. I find this implication very challenging and stimulating in addressing problems of energy conservation. The second implication of the correct thermodynamic analysis is that it identifies the uses with the greatest inefficiencies and suggests methods that can yield large improvement.

As an illustration of these points, I will present first some examples of what can be done with existing technology.

Table 2 is a summary of energy savings and costs. Let me comment on the bottom line. This line represents estimates of how much energy we can save with existing technology by the end of the next decade, ten years or so from now. The technology that has been selected has a capital investment cost equal to or less than the capital investment required to produce equivalent amounts of energy from new supplies, energy that would be needed if the saving did not occur.

We estimate that we might save four and a half million barrels of oil per day compared to the demand for energy in manufacturing by 1987. Four point five million barrels of oil per day is about three Alaskan pipelines.

To bring about this energy saving, we must invest a lot of money. Our estimate is that the money that will be required over the next decade is about 125 billion dollars. I don't know if that sounds to you like a lot of money. It sounds like a lot of money to me. But the alternative requires even more money.

On the basis of reported costs for the development of new energy sources of oil, gas, coal and electricity from coal and nuclear power plants, our estimates for capital investment to produce an equivalent amount of energy from new supplies is about 170 billion dollars. So the alternative to energy conservation is much more expensive. We have also made an estimate of the total cost per unit of energy conserved versus that of energy produced from new supplies. We find that with investment in conservation the cost per unit of energy of the mix included in Table 2 would be 2.7 dollars per million BTU, as opposed to about 4.8 dollars per million BTU for new energy supplies. The numbers for both energy saved and energy supplied are high because they include a large fraction of energy in the form of electricity.

ENERGY SAVING TECHNOLOGY	1985 ENERGY SAVINGS IN MILLION BARRELS OF OIL PER DAY	CAPITAL COST		ENERGY TOTAL COST	
		CONSERVATION $ BILLIONS	ENERGY SUPPLY $ BILLIONS	CONSERVATION $10⁶ Btu	ENERGY SUPPLY $/10⁶ Btu
COGENERATION OF ELECTRICITY WITH					
- Process Steam	0.68	54.0	73.2	8.40	10.6
- High Temperature Processes	0.16	3.5	7.1	4.1	10.6
- Low Temperature Processes	0.18	18.6	24.6	8.9	10.6
ENERGY RECYCLING	1.13	9.5	14.2	0.8	2.7
ELECTRIC MOTORS AND OTHER ELECTRICAL PROCESSES	0.46	10.3	19.7	5.0	10.6
PROCESS MODIFICATIONS					
- Electrical	0.23	<10.0	10.2	7.8	10.6
- Nonelectrical	1.69	<20.0	21.4	1.0	2.7
TOTAL	4.53	<125.9	170.4	2.7	4.8

Summary of Energy Savings and Costs

TABLE 2

Now, the types of things that are used to bring about this energy conservation are known to most of you. They involve cogeneration of process steam or process heat and electricity, recycling of waste energy, and changes in manufacturing processes. We hope that the modules of Project PROCEED will bring out specific examples that illustrate both the technology and the economics of energy conservation, and the large energy and cost savings that can be achieved by combining processes (as in cogeneration) rather than by improving the energy efficiency of individual process components.

Another aspect of the correct use of thermodynamics is related to the long-term prospects for high end-use energy efficiency. Beginning ten years or so from now, suppose that we were able to improve the energy efficiency of our economy by one percentage point every two and a half years. Then, we could sustain an uninterrupted growth in real G.N.P. of three percent per year for the next three decades, and still consume no more energy than we do today. Even then, our overall end-use efficiency would be only twenty percent, about equal to that of the steelmaking process today.

The improvements in energy end-use efficiency suggested here are, in fact, not all that remarkable. They are still less than that accomplished over a comparable number of decades in improving the efficiency of electricity generation. This, of course, was the result of enormous and continuing commitments of resources to technological innovation--the same presciption that must be used for research and development of entirely new manufacturing processes.

Despite the economic and technical opportunities, energy conservation faces difficulties arising from politics and realities of everyday life. We hope that some of the modules of Project PROCEED will address these difficulties and discuss ways to overcome them.

Let me comment briefly on a couple of these difficulties. A utility, which is a regulated monopoly, is allowed about ten percent return on its investments (ROI). On the other hand, a manufacturer, who operates in the competitive market, usually requires a return on investment of about fifteen percent. So, when an investment in new electricty supply is contemplated, it is evaluated on the basis of about ten percent ROI. But, when an investment for energy conservation involving electricity is contemplated, it is evaluated at least at an ROI of about fifteen percent, though the conservation investment would accomplish the same result.

Actually, the gap between the two ROIs is even larger. Because of limited capital available to a manufacturer, investments are given priorities. First, the manufacturer must do things required by the Government--such as invest in anti-pollution controls. Second, he must secure his competitive position in the market by investing in expansion or improved production capacity. Then, he considers becoming an energy supplier by investing in energy conservation. Because the third type of investment is a relatively new activity and, therefore, an activity that is perceived as risky, it is given low priority or a high hurdle rate. The payback period required of conservation investments is usually two years or less. Such periods translate into ROIs of thirty percent or more.

Although this performance in our economy is understandable, it seems to me that an educational program in energy conservation should emphasize the need for a harder look at and change of investment priorities. Without a change, the unavoidable transition from the era of abundant and inexpensive energy to the era of limited and expensive energy might be more costly and painful than it need be.

I will stop here and be happy to answer questions. Thank you for your attention.

DISCUSSION

MR. FRIEDMAN: Friedman, Consultant at D.O.E.

I remember reading a newspaper item that indicated that capital was plentiful, that banks had a lot of money but nobody to lend it to, and here we hear about a capital shortage. Is there a way of explaining that?

PROFESSOR GYFTOPOULOS: Yes, there is. It's a little involved but I will try.

The story is quite involved. You see, our industry operates with a certain debt to equity ratio. There is a certain fraction of money that they borrow and another fraction of money that they get from the stock market. This ratio has been established from past practices during which manufacturers were not in the energy supply business. At that time, whenever they wanted some energy they would go and buy it from the energy suppliers.

Now, because it makes sense both for them and for the nation, we are asking manufacturers to make investments beyond the regular ones and, in essensce, we are after a transfer of capital from the energy supply sector to the energy user sector. How will that come about? Suppose a manufacturer were to borrow money for energy conservation. That would increase his debt to equity ratio and, therefore, in the eyes of the banking community, he would appear as being on shaky financial grounds. As a result, bankers would increase the interest rate because a large debt to equity ratio implies a riskier company.

One might suggest that the manufacturer goes to the stock market. Money in the stock market is much more expensive than money from a bank. As you very well know on the average the price to earnings ratio for our industry right now is about seven. This ratio translates into a return on investment before taxes of 30 percent or higher. So that makes it difficult for a manufacturer to raise capital for energy conservation. It is a kind of vicious circle that results in an inconsistency. On one hand, you are absolutely right, that banks say they do have money but they are not asked for it and, on the other hand, manufacturers hesitate to ask for money because of the reasons that I explained.

In addition, there is another reason and perhaps it is an overriding one. It has to do with the great uncertainty that exists in our society about the whole energy problem and you can see that by reading the newspapers every day. Someone says, "Oh, there is no energy problem. So and so in Washington is manufacturing the problem. Wait for a little while, boost up prices, and the problem will disappear, and the economy will grow." Then they say, "No, no, stop what you are doing completely, reduce energy consumption and everything will be fine. Just take the soft path." And you can imagine why people, like you and me, are confused and uncertain. And when there is uncertainty about a new type of activity, the activity doesn't take place.

MR. MASSEY: Bob Massey, with the Department of Energy. Elias, when a company goes into an energy conservation project and compares that with other alternative uses of their capital, do you think they are taking into account the risk factors on energy conservation?

PROFESSOR GYFTOPOULOS: Yes. And that is translated into requiring a hurdle rate higher than that for regular investments.

Let me clarify that a little bit because I know that there is controversy about the statement that I just made, and no agreement. I would like to explain how I reached the conclusion about the higher hurdle rate.

In many conferences that I have attended I have heard representatives of manufacturers state that they would like to make investments in energy conservation, but these investments are costly. They further state that many investments have been made for which the payback is less than two years whereas those that remain require more than two years to pay back and, therefore, are given low priority. That's one source of my information.

Another source of information are the comments made by manufacturers on the voluntary targets proposed by the Department of Commerce and FEA. By reading the Federal Register I noticed that practically all manufacturers had commented that they want the payback period for energy to be less than two years.

Now, in fairness I must say that in other conferences, including the recent one that I attended in Tucson, Arizona, a large number of representatives of manufacturers stated that energy conservation investments are treated no differently than regular investments.

MR. LIBBY: Quint Libby from EPRI. I was just going to make the same sort of comment that Elias just made that the tendency to adjust the hurdle factor for energy conservation investments either up or down is not simple and in some cases the hurdle rate is less and in some cases higher than for other investments. It's based almost entirely on risk. I think Elias just said that it's not whether it's energy conservation or not, but rather how risky it is that determines what the hurdle rate is.

PROFESSOR GYFTOPOULOS: I would like to comment on that because it is relevant to what we are trying to do with Project PROCEED if we are successful. I understand that an investor or a manager should be very careful in his investments and, if the proposition is risky, to ask that it pay off faster so as to reduce, in some sense, the risk. That's perfectly understandable and that's how our economy works. However, if we are successful, and I hope we will be, in our efforts to conserve energy by using it more efficiently, we should recognize that for the next decade we are not talking about things that are far out, never tried before, and are just in the prototype stage. We are talking about technology that has been very well known and has been tried for many decades.

The reason why it may not be practiced in a particular location or in a particular manufacturing process today is because up to now or up to a few years ago it didn't pay to do so. It didn't pay to save natural gas when you could buy it at 20 cents per million BTU.

Why should one spend a dollar or two per million BTU to save 20 cents? It would have been socially and economically ridiculous to do so. But now things have changed. For the same technology, for the same procedure, the economics have changed. It is $3.00, so to speak, per million BTU of natural gas or whatever the price is versus one to one and a half for the equipment that will save it. Therefore, whereas in the past this technology didn't pay to be used, now it does pay to be used.

MR. MAXWELL: Maxwell from Charles County Community College

I understand you to say in summary that the three things you are advocating are, prevailing upon the investment community to change their thinking or habits on debt to equity ratio, for the manufacturers and also the utilities to change their investment in energy conservation over a long period of time, and then clearing up the confusion that exists today, as you pointed out, in the current newspapers.

PROFESSOR GYFTOPOULOS: Not quite. I am sorry. The three things that you mentioned are parts of the difficulty. I prefer that we have a good understanding of the problem. I believe that if we have a good understanding of the problem our society will respond.

For example, I believe that: (1) if manufacturers are really convinced that there will be a scarcity of oil sometime in the next decade, and that whatever alternatives they have for substitution would be much more expensive than what they pay today; and (2) if they fully recognized that there is a technological opportunity for becoming more efficient and that if they do it faster than their competitors they might reduce their costs and capture a larger fraction of the market, then they will respond to the job much faster and much more efficiently than if someone, whether from academia or from Washington, were to impose that type of development through strict rules and changes in the free market system of our society.

So that's why we are talking here about education and dissemination of information and hopefully good information rather than political decisions.

MR. MAXWELL: Thank you.

MR. FRIEDMAN: Friedman, again, Consultant, Department of Energy. Isn't industry accepting some financial help from the Government and aren't they waiting for that?

PROFESSOR GYFTOPOULOS: Yes, they are and some of that is necessary because of several factors that require that kind of help. Time does not permit me to elaborate on these factors. But as I understand it from discussions that I have held over several years, the greatest thing that manufacturers are expecting from Congress is to settle, to come up with a decision that they can believe will stick for a few years so that they know what they have to do. Think of it yourself. For example, right now Congress is debating an additional tax credit for investments in conservation of ten, twenty, or whatever percent. If you were in the process of buying a piece of equipment for energy conservation and you knew that there was some discussion in Congress that would make you save ten or twenty percent would you go ahead and order the equipment before the issue was settled in Congress?

So, my perception of what industry is expecting, in addition to financial help, is some certainty and some decision one way or the other. I believe that, once some energy plan is voted through Congress which has the appearance of being the plan for a number of years, we will see a faster rate of movement in the direction of greater efficiency than we are currently experiencing.

PROFESSOR TRIBUS: Elias has made a point worth expanding. Sometimes I think that the schools of engineering and the schools of business have combined inadvertently to destroy our technical competence and not to enhance it and the culprit, in my mind, is the return on investment calculation. When people get together to make a resource allocation decision, although they don't usually say it this way, they are involved in a three-way trade-off among three human characteristics: greed, impatience and fear.

By greed, I mean that for what they give they want as much as they can get. And by impatience, I mean they want it now rather than later. And by fear, I mean they want it without risk.

Unfortunately, the return on investment calculation only takes into account two of those, greed and impatience, it does not consider fear or risk. It is irrational to require a higher rate of return on investment, that is to be impatient, as a compensation for one's fear, because a higher rate of return requirement discounts future risks equally with future opportunities. It is a technique for painting yourself into the corner in the future.

What Elias Gyftopoulos is telling us is that he says to people, "Look, when you make this ROI calculation don't forget that it leaves out of account the fact you may not have a plant. You may not have fuel. You are not taking into account your risk considerations." And I say that when you try to take risk into account by raising the return on investment requirement, the so-called hurdle, you are being irrational. You are not taking into account risk at all. You may become hung in your risks.

When we teach people what to do about energy conservation, we must recognize that not only must we teach things that are known, but not known to everyone, but also things that are widespread but aren't true. We will have a challenge which goes beyond ordinary education; it is a challenge to make people understand that in doing what they have been taught to do they are behaving irrationally and they must substitute new ideas for old ones that are no longer appropriate.

Professor Myron Tribus

FALSE IMAGES IN ENGINEERING EDUCATION

John Belding has told us what the challenge is and Elias Gyftopoulos has pinpointed this opportunity. The issue for our industries is to learn how to make appropriate capital investments and changes in operating procedure so as to reduce the irreversibilities associated with the use of energy.

The challenge to our government is to take into account that this will be done in a highly decentralized fashion, decisions will be made constantly, and in accordance with the spirit of our country, not under a single plan, not under a single directive, but rather by teaching people what they must do in their own interest.

How we interpret our views of the world depends very much upon the images of the world we already possess. A very simple way of saying it is there is no such thing as an immaculate perception.

As we grow older our lifetime collection of images becomes more complex. We retain the images produced by our earlier experiences and we slowly modify them as we deal with the world. Sometimes we approach a new situation without realizing that it is new and we are unaware that our mental images are inadequate to deal with this new situation.

In this presentation I propose to show how this matter of inappropriate images influences continuing education in two ways: through the planning process for continuing education itself, and by acting as a barrier for adult learners. In Project PROCEED we are involved in adult continuing education. In each case, as we consider these two ways that the false images play a role, we will propose new approaches based on new images. First, I want to consider the problem of false images for educational planners and then I will take up the impact of false images in adult learning.

Many educational planners in industry and academia have their ideas shaped by prior experiences with academic institutions. They tend to develop educational programs by making them as close an approximation to academic systems as they can. And they take it as a given that because of many constraints in the industrial setting they will be somehow or other deficient in reproducing the academic system. They strive towards that which they remember from an earlier experience, that is, a professor standing in front of a classroom with notes, text, a blackboard and students receiving "the word." And in addition, quite often, particularly in industry, the planner will be greatly influenced by the planning process used elsewhere in industry. The planner will present his or her proposals in the form of a "program." These two considerations cause planners to invoke an image corresponding to the first slide.

SLIDE 1

According to this slide, there are needs and resources. A program is to be designed to apply the resources to the needs.

As I said, this view reflects industrial practices where the concept of a program as a management tool is used.

There are, however, some very important deficiencies in the concept of a "program" in an educational situation. A program is a useful managerial concept whenever we are quite sure what it is we want to do, we can develop a meaningful schedule of activities, we can predict the resources required and the times at which they will be required. It is useful to think of a "program" if we can agree on measures of accomplishment and if we can strongly influence motivations.

A program is not a good managerial tool when we are in the process of learning what it is we want to do, when we cannot be sure if we are finished and we have only a weak influence over motivation. I want to argue that learning situations are not effectively managed via programs.

I am aware, of course, that there are many fine educational programs offered by many institutions, including the one with which I am associated. But my experience is that whenever an educational offering becomes too strongly programmatic, it loses its freshness and other qualities that make it a valuable learning experience. What I want us to do is focus less on program and more on process.

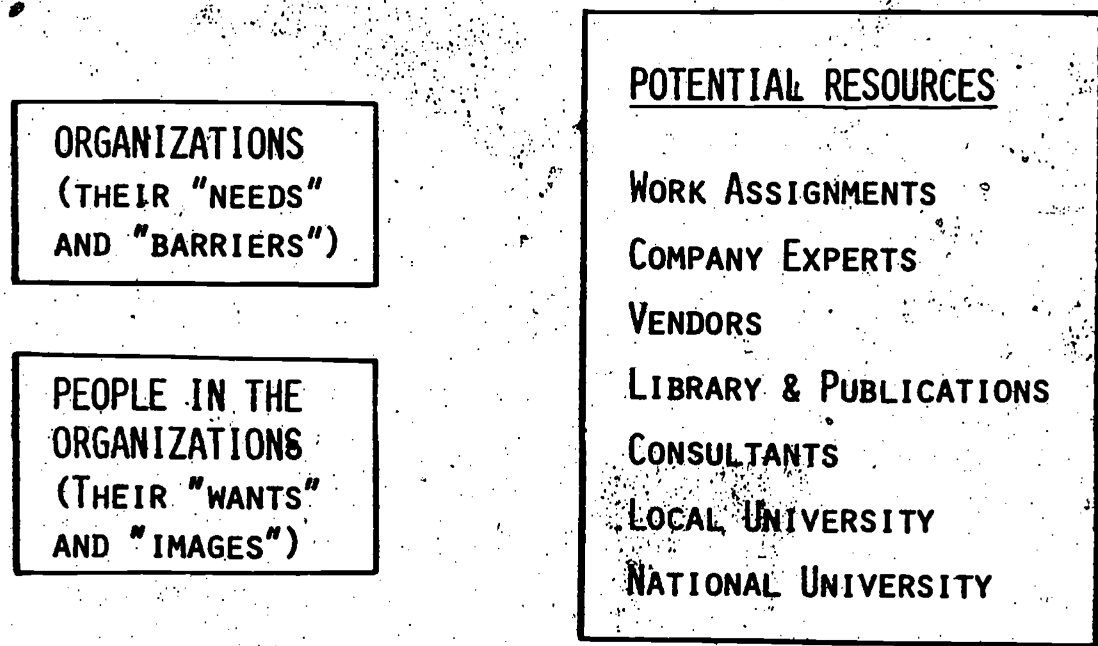
A programmatic approach to education relies upon a well-defined schedule in which it is known in the first lecture what will be covered in the twelfth. Indeed the final examination and the quizzes may all have been written ahead of time. A critic of the programmatic approach once said to me, "The objective should not be to cover the material, but to uncover it."

There are times when a programmatic approach to education is justified. For example, during World War II housewives were turned into welders in three weeks time. A program can be used for that sort of purpose. But if the objective is to prepare people better to deal with their own situation, to comprehend what is going on, then a program is not a good approach.

Developing the comprehension and skills required to act according to the reality that you perceive in your own local situation is a developmental process. What happens at one stage will depend very greatly on what has gone before. There is, therefore, a required trade-off between the control exercisable in a program and the personal development, understanding and creative competencies which will develop when process is emphasized.

I don't want to belittle the importance of programs as managerial tools to accomplish things in industry. I have used them many times myself. When the major task is not directed towards learning but towards doing, as in the erection of a building, the assembly of a product or the establishment of a factory, a programmatic approach is probably the most efficient way to conserve resources and get a job done on time.

Now I want to present a different image.



SLIDE 2

We begin by recognizing that we are dealing with both the organization and the people in the organization; we also deal with many potential resources. The organization has needs as expressed by the management and internal barriers to getting things done. The people in the organization have their own wants, their own desires and they have their own images of the world in which they live. The potential resources for learning are work assignments within the company itself: company experts who know specialized information, vendors who often are sources of information, libraries, publications, consultants, local universities and national universities — I put them in that order for good reasons.

In this last figure we have replaced the simple concept of needs with two concepts, the organizational needs and the wants of the people. It's important to keep in mind that while an organization may have a need, the people in the organization often have different needs. It's a rare organization that can assure that at every moment the aspirations of the people in the company coincide with the needs and aspirations of the management. It is this distinction that creates a bureaucracy. Note too that we have replaced the concept of "resource" with a list of potential resources. This diagram is not yet complete. We have not indicated what replaces a program. In the next diagram we replace "program" by two processes.

A negotiation process is inserted between the managers of the organization and the people in the organization, additionally we insert a process of collective action among the three: organization, people and potential resources.

When we talk with the managers and ask them about the needs of their organizations they are apt to discuss such things as their concern over the speed with which the competition is adopting new designs, the impact of competitors on their industry, the impact of government regulations covering safety, toxicity, energy consumption and so forth. And what they want, or at least what they say they want, is an educational program. They want something with a beginning and an end, an educational program which will take care of these difficulties. A program to instruct the engineers on how to do their jobs better.

If you talk with the engineers they often describe the barriers to applying what they know. They talk about the company procedures that prevent them from doing their jobs, from talking freely to consultants, and of conflicting demands laid on them by their managers. They identify new skills and knowledge of which they have become aware but haven't yet learned. They have a different view of the world. We detect quite a divergence between what the engineers and workers think is important, and what the bosses think is important. Each worker also brings to the factory personal problems, ambitions, and impressions of what ought to be done. Loyal workers who put the interest of the company before their own probably still exist, although I don't think there are very many of them.

In the modern corporation, no one relies on this kind of devotion. People do derive pleasure from this work however, and it's been my experience that if we can show people how to do their work better they will respond. But often they do not really know what constitutes "better" and they need credible clues from the management. They are often acutely aware of the institutional barriers in the company which prevent them from doing their work as well as they could, and many engineers will refer to the politicization of the situation in which they must work.

I am reminded of a story I once heard from R.J. Miller at the time he was President of the Ford Motor Company and I was visiting him on behalf of Dartmouth College. He said, "I was walking through the plant the other day and talking to an engineer who was designing a steering assembly on a Ford truck. I asked him about changing the design to make it safer and he pointed out to me that it would increase the cost of that particular assembly by 35 cents. I told him that that's a small price to pay for the increased safety and protection of the company against damage suits and so forth." Then R.J. Miller said to me, "You know, when I left that fellow I realized that he had been with the company for 30 years and for 30 years people have been telling him, get the cost down. He's seen Presidents come and go and I am pretty sure it's going to take a lot more than my talk with him to get him to do what's good for the company."

In other words, the people in the company think they know what will get them promoted and they need credible information from the management if the rules have changed. So we have inserted a negotiation process between the organization operator, its bosses and the engineers.

This negotiation is not to be confused with the wage negotiations such as might precede a strike. Rather, it's a negotiation to help the top management understand the institutional barriers to the application of knowledge which they themselves may have unknowingly put in place, to understand the motivations which drive the engineers and the other workers. In turn, from the negotiations the engineers will learn of the organizations' needs and how to adjust their demands to those needs.

To the extent that the workers want to become more valuable in the organization and thereby get better paid, have better security, and advance their status and so on, they will probably (and I say "probably" with high probability) adjust their demands for education to conform to what will pay off in the company. But they must be convinced of the company needs and the sincerity of the organization with respect to these needs.

If you ask engineers in industry what they think their needs are, most of them will talk in terms of getting the equivalent of an MBA because in a very large part of American industry the route to success is not in higher technology and technical competence, but on the supervisory ladder.

The engineers need to be convinced of the company needs and the sincerity of the management with respect to these needs. The negotiation process is supposed to bring about an education of both parties. It may be necessary to use a consultant to help to make these negotiations more effective. Because of the hierarchical nature of most organizations, it's difficult if not impossible for the organization itself to initiate the necessary negotiation process. A senior vice-president would find it impossible to convene a group of subordinates and say, "Let's level with one another." There is no way that he could develop a sense of trust that would bridge this gap. They would constantly be saying, "What does he really mean, and if I contradict him will he in some subtle way cut me down later?"

There is just no way that you can create this mutual trust in a typical hierarchical organization without outside help. In all organizations there are continuous struggles for dominance, usually carried out under rules well understood but seldom discussed. The competition for the limited number of positions of real power goes on all the time and within bounds it's probably important to the health and vitality of the organization, but it gets in the way of the negotiation process.

So the introduction of a new negotiation process can be threatening and for this reason two elements seem necessary. One is that there has to be an outside consultant and the other is there must be the support of top management. If there aren't those two, don't bother. Once the organization and its people have come to a better understanding of their needs, barriers and images, one can link up to the potential educational resources. We emphasize the word <u>potential</u>, because too many institutions look instinctively to the universities for help, hoping to take off the shelf courses of instruction that they need.

Rather than discuss the development of collective action in abstract terms, I am going to describe the experience of Bertrand Schwartz in setting up a system in France for teaching statistics.

The client organization was a large corporation with many factories scattered around the country. The head of the corporation was concerned because he knew his people didn't use much statistics. If the approach along the lines of that first slide had been used, that is, to apply resources to needs by means of a program, then a course of lectures would have been set up at a central place, say Paris. The best professors in statistics would have been selected and engineers would have been sent for six weeks or one month or whatever, given a crash course in statistics and sent back to the factory.

Instead, acting on the advice of Bertrand Schwartz, the head of the company searched for and found in the plants seven engineers who already knew statistics. They had studied it in universities, but because of various reasons within the company they were not applying it. These engineers were assigned to meet at a central location about once a month for a couple of days to discuss among themselves what to teach and how to teach it. They began by selecting a book on statistics which, in their view, contained the ideas needed by the organization. They divided the book into sections. Each engineer took a few sections and found examples from the factory where the methods and ideas could be applied. They met regularly, they talked by telephone, they reported their progress, they talked with their consultant. In this way, in about a year they developed a new book built around the problems of their industry aimed at their own problems emphasizing the techniques which they, out of their experience and knowledge, found helpful.

The professor of statistics from the university, acting as consultant, helped them to interpret the theory whenever they found the need or whenever they couldn't handle the particular problem. So at the end of the first year they had compiled their own notes for a textbook.

In the second year each of the seven engineers served as the instructor for about ten engineers at each of the seven plants. The 70 students were given notebooks and asked to search for more examples. In this way they discovered new examples and found places where the book had to be rewritten. At the end of the second year therefore, they had trained 70 engineers plus the original seven.

In the third year the president of the company asked each of the plant managers to report to him what uses he and his workers were making of statistical methods now that they had a skeleton work force. This produced a flood of applications to study statistics and they had no trouble filling up the seven classes with engineers who wanted to know more.

In addition, the managers asked for help themselves. They were now faced with a very difficult problem. They didn't want to sit in the classes with the engineers because they had grown rusty. They didn't want or need that kind of education. They were ashamed to expose how little they knew about these kinds of things. Of course, they knew other kinds of things but they had forgotten many skills. Their new skills resulted from the competitive situations to which they were exposed.

The consultant helped the seven leaders to devise short courses with different objectives especially developed for the managers. The objective was to show where and how statistical methods could be applied, but not to develop skill. For example, reports prepared by the engineers were reviewed and discussed as part of the manager's course.

It then developed that the workers in the assembly line, especially the foremen also wanted training. They were upset by requests to repeat so many measurements. They thought they were being insulted. So a special short course with different objectives was laid out for the workers and especially for the foremen. Naturally the objectives of this course were set through negotiations and discussed with the foremen. So at the end of the third year the company had a work force which contained 150 engineers with a working knowledge of statistics, a staff of about seven who had expert knowledge of statistics and in addition, most of the foremen and managers had been exposed to a statistics appreciation course. After that no special efforts were needed. Many people started going on their own for advanced work at the university.

This example of the introduction of a technology to a hierarchy shows that there are four levels which need to be served differently. There are the managers who need a survey course which will enable them to understand what the engineers are doing, even if they themselves can't do it, and equally important, what kinds of support the engineers need in order to get on with their work so that the managers do not become part of the barrier. Then there are the specialists who need to be in communication with specialists in the university. Only a small specialist staff is required. It can be involved in the company in teaching, in research and in consultation. It is the group for which some "off the shelf" university courses may well be most useful. Then there are the engineers who need to be taught through the work. The theory they learn should be developed in the context of the applications they are expected to make. They will learn best if they are part of the effort to discover the applications and to improve how the methods are implied in contrast to merely learning how it has been done by others. And then there are the workers, especially the foremen who need to be given a qualitative understanding of what is being done so that they can assist the engineers using the new technology.

In developing these four levels, a collective action can thus be initiated in which the specialists, the managers, the engineers, the foremen and the consultants all play a role. There are quite a few negotiations between the management and the engineers to establish the importance as viewed by the management and of the barriers as seen by the engineers. Then negotiations need to be held between the teachers and students to see that the objectives are each consistent with one another. And then between the managers and workers to establish new rules in the event the technology affects them.

Sometimes when a technology is very new, as for example, with microprocessors, it may be necessary to hire an outside instructor. In such a case it's helpful to use two teachers, one from the factory who knows how to make applications and a teacher from the university.

Of course, if the teacher from the university has been acting as a consultant and has a reasonable repetoire of problems taken from factory work, if you can get someone like Elias Gyftopoulos, for example, to teach energy conversion, it may not be necessary to use two teachers. But there are few academic consultants who really understand how things are done in a factory or industry. It's always advisable to pair the academic with the practitioner because the problems of applications, of getting things done in a particular company, tend to be unique.

We dwell on this consideration because one of the central problems of learning is transference, that is, the ability to transfer concepts from one application to another. It's tempting for teachers to teach only concepts. These are most easily organized for teaching purposes and it's relatively easy for a teacher to develop a set of given problems, (That is, "given this, find that.") These problems illustrate how concepts link to one another. However, while this approach is easiest for the teachers, and is probably well suited to teaching fundamentals, it leaves out of account the question of how to apply concepts in real life situations where nothing is "given." Most students are unable to apply their knowledge to the systems they encounter in their work. So often in industry, engineers simply do not and cannot apply most of what they have been taught. After all, life doesn't "give" problems. You have to go and get them. I am reminded of a movie I once saw on energy that showed a coal mine with a coal miner standing in front of it. Somebody asks the miner, "Where does coal come from?" and he says, "It doesn't, you have to go and get it."

Now, let's talk a little bit about the specialized problem of the adult learner. For adults to be interested the instruction should be problem centered and, if possible, centered on problems which come directly from the work they expect to do.

Adults also want to participate in their instruction. They want their educations to be useful, useful on the job, useful in their personal lives.

On the other hand, teachers have their own needs. They like to be able to illustrate the things in a subject that they find interesting. They want to develop in the students the same appreciation for the subject they have themselves. They are very much affected by the history of mathematics. In early Egyptian times, when geometry was just being developed, one of the students asks, "What good is this?" the teacher says to his slave, "give him a coin, he needs always to have some use for what he learns."

This liberal learning tradition which despises the utility of knowledge has had enormous impact on the teaching profession and in many subtle ways you find professors promoting that view of knowledge. But adults don't go for that. Adults and engineers on the job want to know how to make use of what they are taught.

In the classroom the needs and desires of the students and the teachers, therefore, do not always coincide. For example, teachers have limited time and would like to be able to use examples from previous lectures.

But teachers and students can have a common purpose and it is with respect to the best way to achieve that purpose that they should negotiate. Their mutual purpose should be to develop in the student the competence to deal with the problems the students face. And if the learning is to be successful, teacher and student need to agree on what this competence entails. That's why I spoke earlier of the inadequacy of the programmatic approach to education. If you have a program it's not possible to negotiate with the student. A program provides a "take it or leave it" proposition and the record shows 97 percent of the adults leave it. Only about 3 percent of the adult population eligible for continuing education actually participates.

The students and teachers have to agree not only on the competence but how it will be developed. They have to negotiate the level of competence, the degree of autonomy the student should seek to develop, and the style of instruction with which the teacher will attempt to develop these capabilities in the student.

Both the teacher and student have an important role to play because they each have different needs and different constraints. It's through a negotiation process that they come out with the best thing to do for a particular group of students with a particular teacher in a particular setting.

There are several levels of competence on which the teacher and student might agree. For example, they might agree that what the student is to develop is the ability to understand what is going on when an expert in a field renders advice. Another level would be the ability to solve simple problems that have been set, that is, standard simple problems in the particular field of inquiry, or they might agree to develop a higher level, the ability to work routine problems in the field including the ability to extract a problem statement from an unstructured situation, the ability to find their own problems. At an even higher level, they might aim for the ability to work advanced problems in the field including the ability to develop methods specific to the circumstances. And for the highest level they might aspire to the ability to push back the frontiers of knowledge in the field.

Now, these are different kinds of competencies and it's important, particularly with adults, that there be an understanding and a good agreement, obtained via negotiation between the teachers and the students, concerning the level of competency they wish to attain. And in each case, this ability is visualized as being applied with more or less help, that is, more or less autonomously. Each level of capability may be developed in such a way as to require supervision or to be done unaided.

The teachers cannot impose their goals on adult learners. Also, since aspirations change as the students learn more about a subject they cannot just negotiate at the first class meeting and then assume everything is fixed. During every encounter with students, there may be a need for negotiations as student ideas change. Of course, if there are many students in the class and only one instructor, it's evident that the instructor can't cater to very many different objectives all at once. To the extent that the instructor tries to teach each person individually the work load increases enormously. Since well rehearsed lectures given year after year cannot be used, costs will rise. A skillful negotiator can use the negotiations as part of the learning process. These considerations put an upper limit on the student faculty ratio for successful continuing education and automatically sets minimum costs.

Now, let me say a few words about false images in the learning. We have talked about the consequences of inappropriate images on the part of educational planning. We have given what we believe to be a more appropriate image and demonstrated how it leads to an approach which differs very greatly from the usual academic program. I might mention here that at M.I.T. we have developed a series of video tapes on these ideas which some of you may wish to see. I interview Bertrand Schwartz in three tapes. The first tape is called "Seven Barriers to Continuing Education." He gives a list of seven problems adults face when they come into the classroom and what can be done about them. The second tape is called "Why Continuing Education Is So Inefficient, and What To Do About It." The talk that I am giving you today has come from that tape.

The third tape is especially interesting to me because it asks, "When continuing education comes to the university, what must change?" I have mentioned these tapes because it is clear to me now, having been in both academia and industry, that we cannot look to universities as they are now constituted and operate for satisfactory solutions to continuing education problems in these national programs. Some universities appreciate this fact and have created centers for continuing education. Often they are remote from the "real" university campus and function entirely by themselves. In this way they often have a better chance of being responsive to the real needs of adults, but unfortunately, being disconnected from the centers of learning and research, they also run the risk of not being near the frontiers of learning and knowledge.

As I said, adult learners come to the learning experience with a lifetime collection of impressions of how the world around them works. Unfortunately, many of our educational practices are based upon experiences with the young and naive who, in their wide-eyed innocence, seem to accept what the teachers say.

For example, one of the difficulties in teaching the children of the ghetto is that while they may be ignorant, they are no longer wide-eyed innocents. They already know enough to reject anything they cannot use to their advantage. They face real, live problems. They are not so protected against life's problems. When they are in school if what they are being taught doesn't relate to the real world that they know is out there they reject it. Perhaps if the children of the ghetto were very well behaved we would perceive that teaching them isn't that much different from teaching adults. At any rate adults already know a lot and what they are taught must either square with what they know or what they know must be changed. So the first stage of adult learning often needs to be an exploration of the images the students already have.

Adult learners are not blank sheets of paper. They are already filled quite often with false images.

Now, in the technical fields where the students may be expected to have a good acquaintence with fundamentals we should anticipate fewer false images, but even here we must be careful. For example, if you try to teach relativity to someone who has been steeped in Newtonian mechanics for 20 years you will find that it's a very tough job.

Intellectually, people can say the apparent velocity of light is independent of the speed of the observer, but most people trained in Newtonian methods don't believe it. They are stuck with an idea and they have great difficulty changing it.

Or, if you try to teach quantum mechanical principles to someone who studied classical physics for a dozen years it's difficult. They can't get over the notion that you can't observe something without disturbing it or you can't postulate even in your head both position and velocity of a particle.

Or you may try to get a frequentist in probability theory to understand the meaning of Bayes equation. It can't be done. I know, I have been trying it for 15 years.

Or try to teach a group which has previously specialized in analogue controls to design a digital control system.

Unless you have tried to do these things you may take too lightly the significance which prior images have on subsequent learning. And if there are problems with false images in physical sciences, imagine what the barriers must be in the social sciences and humanities where the discourse is not so precise and differences in mental images may persist between two people unnoticed for long periods of time, emerging only when it's necessary to take a particular line of action.

Now, continuing education is concerned with getting things done in the environment in which the adults happen to be and therefore inescapably linked to knowledge in the social sciences and expecially the behavioral sciences. In practice, we have to be concerned with supervisory skills, organizational behavior and the like. And in these areas teachers simply must allow time to exorcise false images.

We have used the word "images". Perhaps it would be better to say "different images" because we are not able to say that one image is false and another image is true. The best we can say is that one image seems to be more general than another, or more limited in its applicability than another.

When teaching children we have many techniques that force the child to develop images similar to those of the teacher: drills, tests, routine assignments, workbooks in which the students fill in the missing words and diagrams. These are all techniques for programming the students with the same images as the teacher. Given the relative physical size of student, teacher, the truant officer and given the force of law, it's easy to understand why this problem of differences in images doesn't trouble the adult teacher with children. But with adults who can decide to stay away it is a very, very tough barrier and can't be swept under the rug. Adults are different. They decide what to reject. They have no need to satisfy the teacher's images. Children learn because they want to please the teacher and because they can't get out of school. They are not problem-oriented in the sense that they want to get specific pieces of knowledge in order to do something they want to do.

Very few children see school as a place to learn how to deal with life's problems. To them school is a place to go to get ready to go to another school which won't accept them unless they have done well in the first school. Bertrand Schwartz gave me a view of the education of children in France which I think applies equally to our own country. He said, "I see two streams of children. The first stream comes to school and doesn't believe what the teacher says, doesn't think school is important, doesn't pay much attention, doesn't learn very much and is passed on to the next grade because the time has come to be passed on to the next grade. In that next grade they don't recall much from the previous grade so what the teacher says doesn't make any more sense. They go on that way passing from grade to grade and at the earliest opportunity they leave school. Then they go to get a job which doesn't require education. That proves to them that they were right. They really didn't need the education in the first place.

"The other group believes what the teacher says, tries to learn and has an advantage in the next year. They relate better to the teacher because they are now the best students and they have reinforced their behavior, they continue willingly and they go as far as they can in education. They they get jobs for which education is required and that proves to them that they were right."

These two streams exist side by side in French and American society. But if something happens in society that requires re-education then there is just no way that you can persuade that first group that going back to school is the way to meet life's problems. And they are the most numerous group.

In our society we have made it easier to stay in school than to go to work. Therefore many people stay in school and get passed along. They really don't believe what the teacher says, but they learn how to survive and get grades. When they get out of school and go to work they often discover that what they were taught in school gave them a nice background, but doesn't obviously solve any of their problems. Such people do not conceive of going back to the classroom to solve real problems. If you send them to a classroom in academia, as things now stand they will probably be confirmed in their suspicion that it's not a place to solve life's problems.

There is an exception. If adults enroll in a degree program they may consider that the degree is very important. They will then jump all of the hurdles you put in front of them in order to get that degree. This is a return to a childhood relation to education, and is not a healthy situation.

Adults will be ready to learn when they feel that what they are offered will help them with their problems, as they understand them. Otherwise they have better things to do with their time. That's an important constraint for anybody who is going to design a continuing education program.

So these two problems of adult learners, motivation and prior images, present the teacher with a new situation which cannot be resolved with recourse to practices that have already been used with children. The adults will stay away. It takes negotiation and discussion as a built-in part of the process.

One more thing. Teaching adults to function more effectively in their places of work requires attention to factors that do not occur in the teaching of young people. To keep their attention the focus must be on the development of competence to do things which they find useful in their daily lives. These cannot be predefined by the teachers. They have to be defined by the students.

The most useful way to determine the competencies required is to start with the problems of the work-place and these problems are both technical and institutional. So we have to have involvement, if not of the bosses, of people who have studied the institution and the organization and the problems of applying knowledge. Consultants can help to develop the processes of negotiation, but in the end the organization has to take on itself the responsibility for defining its own problems.

In successful continuing education we must not only teach knowledge but how to apply knowledge, and in teaching how to apply knowledge we have to take into account the realities of the work-place.

These principles have been used in our approach to the development of Project PROCEED and I hope that in the future discussions of the Project, you will be able to see clearly how these principles have been used in guiding our development.

Thank you.

Dr. Harvey J. Brudner

EFFECTIVE METHODS OF DELIVERING APPROPRIATE INFORMATION: A STATUS REPORT

Last week I had the pleasure to spend some time at an M.I.T. Meeting in New York City called "The Energy Challenge, the Management of Uncertainty." This was an M.I.T. symposium for corporate decision-makers held in conjunction with their Industrial Liaison Program and the Alumni Center of New York. At that meeting there were several papers reviewing the problems of the U.S. energy situation, a problem which we have seen, and as we have seen this morning, which stems from the fact that we as a nation consume too much energy. We consume too much of the energy we consume in the form of oil and gas, and given our production and conversion options, too much oil is and will be imported and in the future too much gas will be imported.

Obviously, the overall solution to the problem has several dimensions. We must reduce some consumption growth rates. We must raise domestic oil production. We must raise domestic gas production. We must convert to alternate sources such as coal and nuclear energy. We must minimize adverse economic impact on the consumer. We must develop other alternate sources such as shale oil, coal, gas and fusion power and we must conform to realistic timetables and orchestrate all of the above factors based on technology lead times and economic factors. The M.I.T. symposium was held December 8th in New York City. The day before, Energy Secretary James R. Schlesinger met in the city with the Conference Board, a meeting with about 400 key businessmen.

The Conference Board is a non-profit organization which seeks to promote broader understanding of business and check matters.

At that meeting the Energy Secretary warned of severe economic trauma of the sort we have not witnessed in this country since the great depression if the energy problem were not quickly considered to be a key factor in the reordering of our total economy.

The Secretary indicated that the 1980s could bring massive unemployment, accelerated inflation and an impossibly large balance of payment deficit that would undermine, perhaps, the entire political system of the United States. As he put it, this is a chronic problem, not a crisis. The fundamental question is no longer what to do; the problem is getting serious about it. In spite of that call for a serious program, Secretary Schlesinger pointed out that for the next few years it was his prediction that there would be little change in the nation's fuel mix, reasonably stable oil prices would continue, there would be somewhat higher natural gas prices and a gradual diminishing of the supply of natural gas available to industry.

The first point I wish to make is that in both of these conferences we find this chronic problem does not allow for any immediate or simplistic solutions. On the other hand, a general conclusion of all of the conferences and analyses seems to be the necessity to change people's and organizations' behavior. If we could change people's behavior toward conservation, if we could change attitudes toward relatively minor investments in energy efficient space heating and transportation systems, if we could change private sector attitudes and promote more adoption of energy efficient manufacturing, if we could generate programs of regional cooperation, we would dramatically change the overall rate of energy consumption in the United States. Indeed we would no longer have the spector of crises of the 1980's awaiting us.

I emphasized the phrase "change in behavior," since this is exactly the psychologists definition of learning. It therefore seems to me that the chronic energy problem has at its core an education problem. A system is needed in which we can quickly and efficiently transfer intelligence related to actions to be taken in this energy area and in other future shock problem areas.

When one mentions this approach, more often than not the reaction is that we can't wait that long. Education and training are long range solutions and this is a serious problem now. I wish to advance the general thesis that effective methods of delivering appropriate information are increasingly practical. New methods are available now. They are increasingly cost effective. They can help generate a U.S. leadership position that not only helps to solve the energy problem but also is a positive contribution to our balance of payments problems, and given appropriate federal leadership it would actually be possible to launch an Energy Education Manhattan Project which could solve the chronic energy problem by 1984.

Over the past several months my own organization has been making a study of alternate technologies which could be used to deliver the content of a national energy education program. Obviously, while print medium remains a highly effective and cost efficient delivery mechanism, multimedia and computers are each year advancing in their effectiveness and capability. The role of the computer in both the classroom and the industrial learning center continues to expand and expand rapidly. From pioneering support by the National Science Foundation in the 1960s the number of computers used for instruction has grown to the point that today almost two million students in the United States now have access to systems and courses at schools and universities and training centers across the nation.

At the same time, new audio-visual media such as laser video disk systems, hold promise for low cost information centers in the 1980s. In order to evaluate the status of these media and evaluate the possibility of computer tracking and diagnosis of achievement and module selection, a survey was made of the state-of-art of various alternate technologies to print.

I will briefly review some of these important technologies and how they may relate to the PROCEED system.

The first slide* we see the numerics 333. This happens to be my business address in Highland Park, New Jersey, but more importantly this

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* Dr. Brudner's slides were in color and could not all be reproduced in this set of proceedings economically.

is the read-out from three of the six digital indicators of a Texas Instrument 1200 pocket calculator. When I explored digital read-outs ten years ago we had to spend about $60 to produce a single Nixi-tube read-out and power supply or about $480 for an eight digit read-out.

The T.I. 1200 can now be purchased for about $7 and of that, only about 48 cents goes into the cost of the read-out.

The point is that in a single decade the cost of reading out 333 is one-tenth of one percent of what it was ten years ago. In other words, within one decade it is very possible for technology to change the cost effectiveness of a system by a factor of 1,000 or equivalently 100,000 percent.

Keep in mind that most financial people, as we have heard this morning, and economists, think a few hundred percent is an excellent return in equivalent time periods.

I believe that there are technologies that are now in late stages of development or early stages of pilot production where equally as significant changes will occur in the next decade.

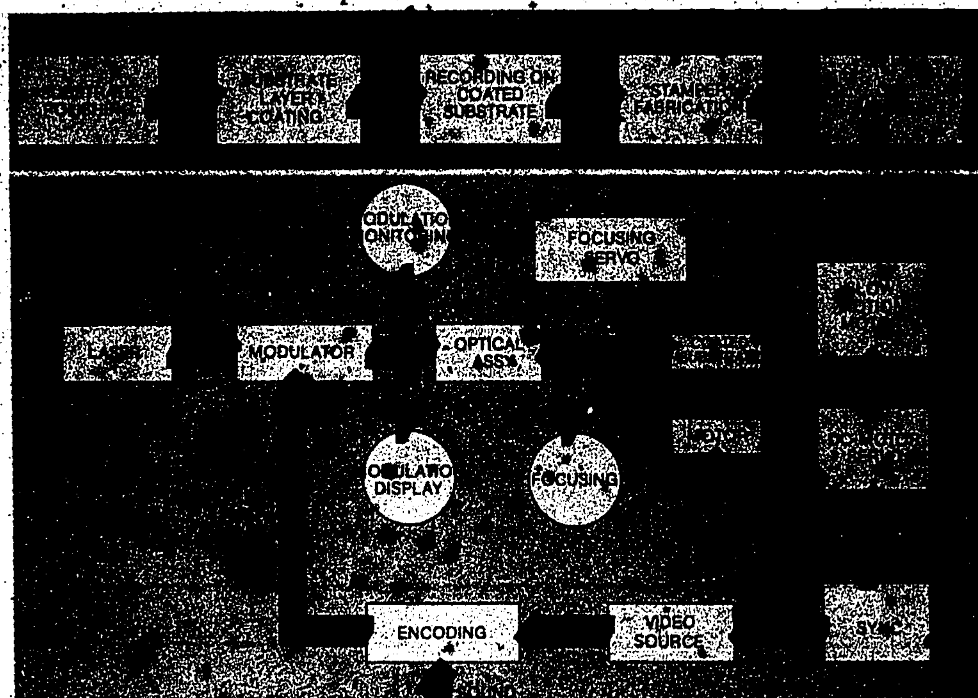
For example, there now exists a process for creating modified vinyl film. The film is embossed with literally billions of bits of etched information, etched intelligence, and is produced at the Thompson C.S.F. Corporation in France as part of its video disk system, the TTV 3600. This is a system for optical recording and read-out of video signals on a laser video disk. Most of you have heard about the Philips MCA System. However, for instructional and educational use it may be the Thompson CSF System that is more appropriate. This is because they have stressed the education and training markets in developing their system's concepts. Work began in 1968, as you see, and like the Philips MCA System they have a solution to the problem of high density, video and data storage. The disk achieves fast random access and inexpensive duplication.

For the reporting we produce a software medium which is exposed to virtually no mechanical contact and therefore just about zero wear. For the optical video disk, additional advantages are slow frame or stop frame without time restriction.

Slow motion, fast motion and long information storage live on the disk and literally unlimited storage life of the information on the stampers that are used to make the disks.

There is now direct recording of frequency modulated video signals on the engraved tracks that make up this disk. The disk revolves at 1,500 RPM in Europe, based on their 50 cycle per second AC current, at about 1,800 RPM in the United States with 60 cycle AC current. The engineering preproduction prototypes shown of the Tompson CSF player has many controls, but only to allow for all of the instructional adjustments or complex modes described earlier in some of the papers, such as Myron Tribus' review.

The production model, however, will have only three controls. I



SLIDE 1

SLIDE 2

witnessed the test of this unit in the United States two weeks ago, and pointed out that a continuous spiral track, spiraling inward on side A, the top surface of the disk, and starting from the inside and spiraling outward on side B, would allow for a continuous recording of our information on the Thompson CSF disk. This is possible since the laser beam can be focussed at either of the two surfaces in spite of the transmissional nature of the system. The length and spacing of the micro-pits, as they are called, that are engraved on the plastic, varies in accordance with the FM Modulation of the video signal. If you think of an area the size of a pinhead there are about one million micro-pits in this area.

Each revolution of the disk corresponds to one television frame. I have information relating to the disk production technique, but I will not cover that here. Suffice it to say that the process very much resembles conventional vinyl audio recordmaking, and the materials cost of producing a video disk in large quantities, say over 1,000 copies, run about 60 cents.

These are some systems diagrams of the process.

(See slides 1 and 2.)

This is video intelligence detection and for balance I do also want to describe the Philips MCA laser video disk system which is quickly approaching production stages at a former Magnavox plant in the United States. This system is quite similar to the Thompson CSF one. It is the better known system. It works on a reflection principle instead of a transmission principle through the disk.

The quality of video presentation in both these systems enables reaching the theoretical maximum quality of our NTSC television transmission system. In other words, one generates a literally perfect television picture with either of these systems.

I would now like to move on to the computer side of our review. If we begin looking at a Sperry Rand UNIVAC Computer System, we can get some idea of where we are and where we are heading in the area of computer systems. If you add up all of the computers in the United States the number is quickly approaching 100,000. The total dollar value of these systems is about $37 billion. This infers that the average electronic data processing system and its pheripherals costs about $370,000. I believe there is every reason to believe that the newly emerging integrated circuit technology shown in montage in the next series of slides will produce an equivalent computer system utilizing ship technology and bubble or disk memories or combinations of both for about $1,000 or less within the next decade. We have gone from boxes to cards to chips. From small scale integrated circuits, as the trade refers to the technology, to medium size integrated circuits, to large scale integrated circuits in the past decade.

The computer system of the future that I am referring to, could and probably will be owned by just about every graduate engineer who is interested in continuing his education.

If we look at where computers are impacting on management and dissemination systems at present, we first see the newly developed computer controlled typewriters. Keep in mind the IBM Slectric unit was developed with computer control in mind. IBM has successfully modeled the office of the future around the so-called technique of word processing as it applies to the generation of printed text.

Project PROCEED will probably utilize this approach in 1978, next year, for it's initial module developing production.

With instructional computers we possess the capabilities of multimedia delivery systems and computer managed instruction. The professor is backed up by a large amount of instructional content on audio tapes, slides, film strips, single concept films, TV tapes, workbooks, etc. And even communication systems are adjunct to the overall learning composite. These systems are called computer managed instructional systems, since the computer system concerns itself largely with the administration of learning.

The Westinghouse PLAN* System (Program for Learning in Accordance with Needs) was the first national CMI System with data processing for thousands of students spread out at dozens of locations in the United States, all taking place overnight at the Measurement Research Center in Iowa City.

The computer tutor or CAI System is more familiar; for example, the Plato system. Computer networks are growing very rapidly as sophisticated terminals are being developed. A key development is the fact that more and more students in the United States are becoming computer literate. Indeed, reasonable, (I stress the R) reasonable computer literacy will quickly become the fourth R in education in the 1980s! Consider the Philadelphia School System in this presentation prepared by the Bell System for its corporate account executives. Bell and AT&T represents a company which has developed a short presentation you are about to see with enlightened self-interest in mind.

[The audio transcription of the presentation follows.]

There is an American city where computers enhance the learning effectiveness of thousands of elementary and secondary school pupils every semester. A city where children learn at their own best speeds, basic skills in reading, mathematics, science, business and social sciences. A city where children are computer literate. The city is Philadelphia, typical of large urban school systems across the country. Cost-conscious, budget-tight, actively and continuously searching for ways to do more for the pupils at less cost per pupil. Teachers and students express overwhelming support for the added effectiveness computers provide.

"Computer-Based Learning Systems refer to the various means by which the computer is used to enhance the instructional process. They enable students to work at their own rate of speed, assuring each student the education best suited to his or her needs. They do free the teacher from routine clerical tasks allowing them more time to work with the individual student."

Dramatic pioneering strides have been made through the competence and vision of educators such as Dr. Sylvia Charp, Director of Instructional Systems for the School District of Philadelphia.

"The demands of computer programming reinforce desirable mathematical methods such as organizing information, analyzing procedures, systematically checking answers, and finding the errors. It allows the students to explore mathematical concepts. The students use the computer as a tool to help achieve the various objectives of mathematics and science. Simulations are of special interest to both mathematics and science teachers especially as they illustrate concepts which cannot be done in the classroom."

The School District of Philadelphia became involved with the computer in 1966. It is now endorsed by the National Council of Teachers of Mathematics, and the curriculum has been revised to include computer usage. Mathematics is now only one of its many applications.

"Test results do show that the use of the computer does enhance learning. We wish to make students Computer Literate. In our school system students in the 8th and 9th grades in all of our schools do have the opportunity to become a computer literate to understand the computer's role in their daily lives."

Today's educators are looking upon the computer as a highly effective teaching tool ... a way to extend their teaching skills. The Bell System recognizes the power of this medium ... and we are ready now with systems to help you make use of Computer-Based Learning in the most cost-effective way.

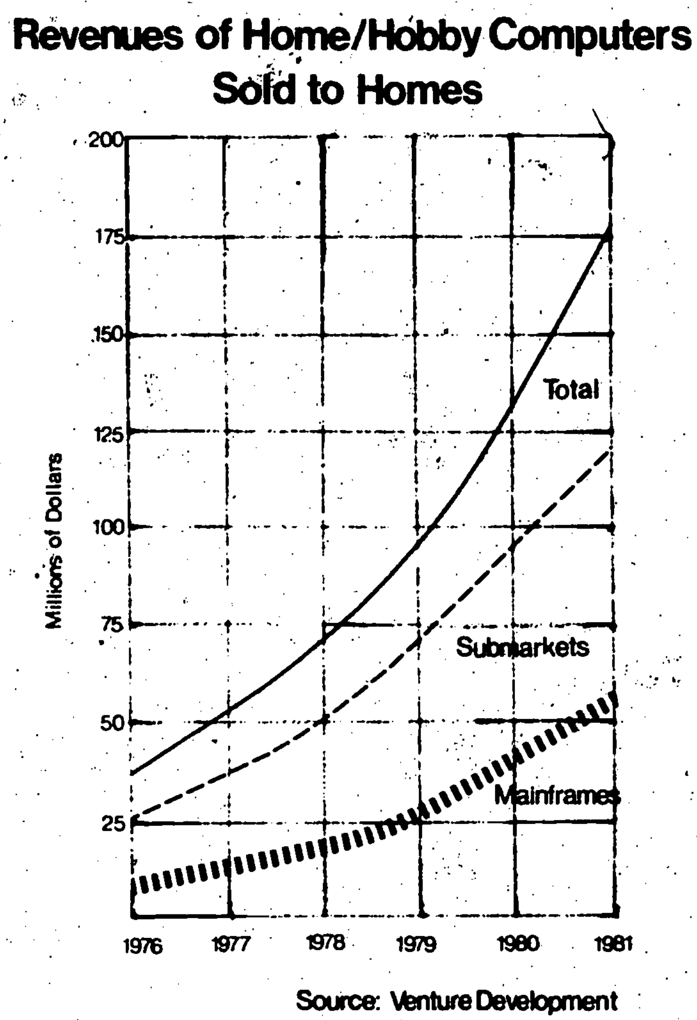
In conjunction with this program, Bell System has now prepared an overview for high school students on the subject of computer literacy and literally millions of our high school seniors over the next year will be exposed to basic or reasonable computer literacy concepts.

The next three illustrations show the network possibilities which I would rather not go into detail about here. We may use them at the workshops.

As an aside there have also been dramatic developments in the areas of computer animated graphics, and in computer control devices that are also touched upon.

I would like to conclude with three sets of curves. The first curve shows the market over the next three years, 1978, 1979, and 1980 for what is coming to be called home computer units.

(See slide 3.)

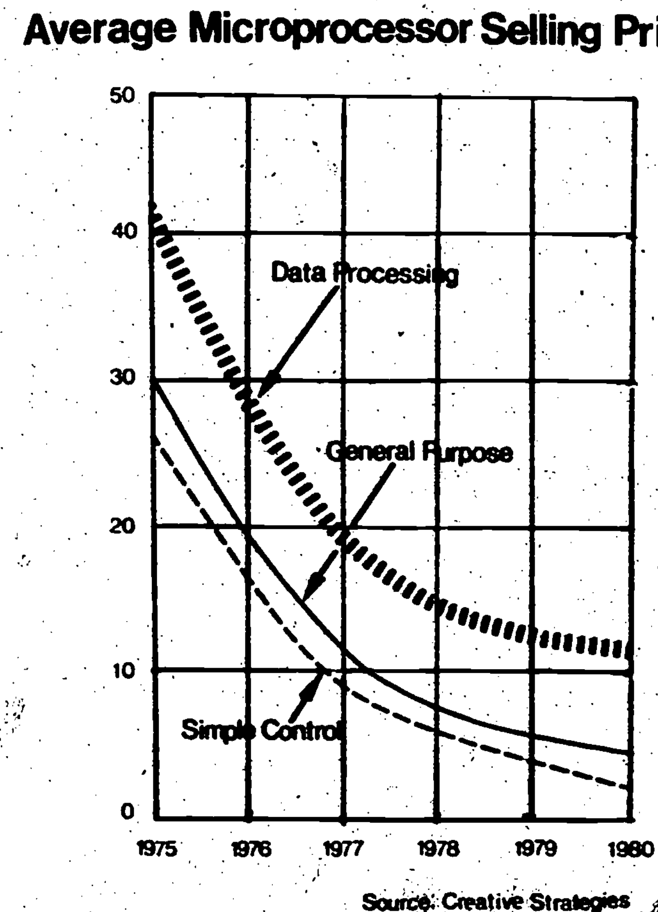


SLIDE 3

This market has already reached a level of about $78 million a year. It will grow just in the next three years to approximately $175 million a year, roughly 150 percent growth.

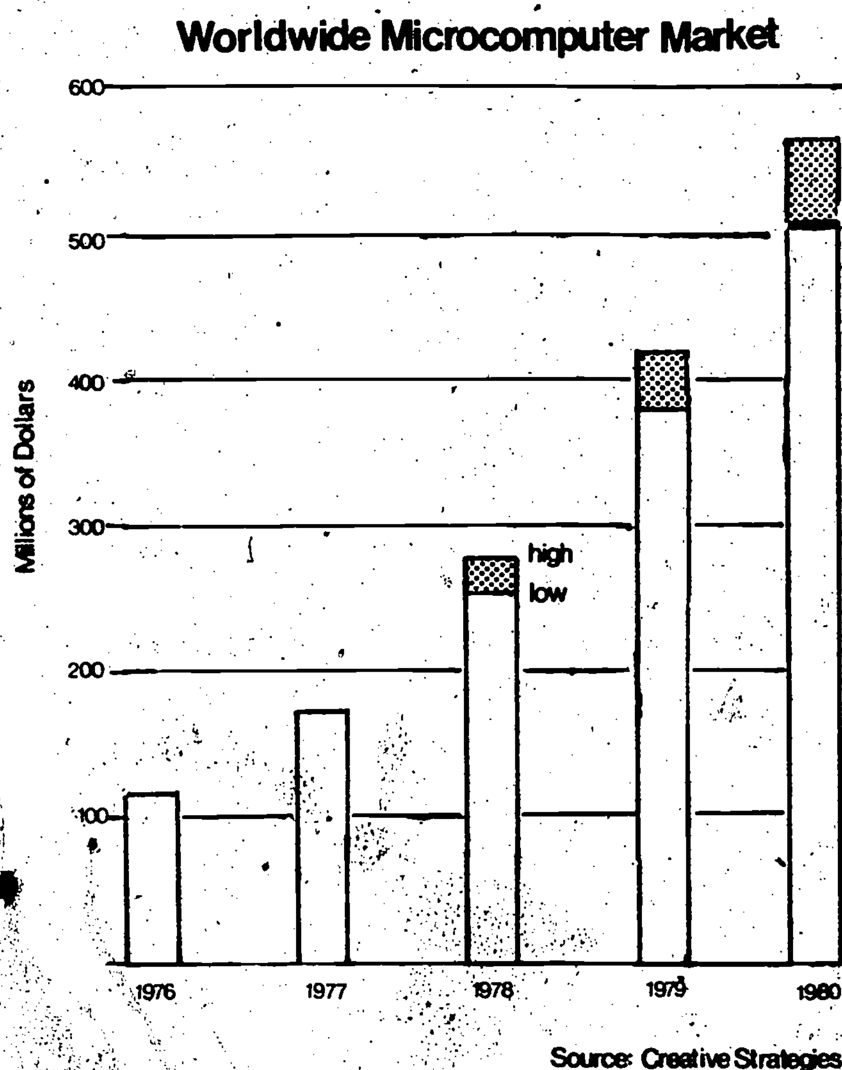
Yesterday's New York Times financial section reference this spectacular growing market.

(See slide 4.)



SLIDE 4

The next series of curves indicates the drop in price that is taking place as these technologies are increasingly being applied. A $30,000 system in 1975 is going to cost just a few thousand dollars by 1980 and by 1987, as I indicated earlier, the system will be well under $1,000.



SLIDE 5

Finally, a slide showing the overall growth of the micro-computer market as it's expected to develop over the next several years. This brief review has not covered recent developments in satellite and laser communication systems, in growing U.S. cable TV networks, in video cartridges, slow-scan television and several other very significant areas.

I do return to my major thesis that these technologies can have great significance with respect to the national chronic energy problem.

For example, just last year, because of our leadership in microprocessor large scale integrated circuit technology, the United States was able to generate a positive balance of payment contributing over $1 billion after exporting some $3-1/2 billion worth of equipment in this area. Thus, not only do we have the opportunity to build up a delivery system for energy conservation information and alternate energy systems, but at the same time we would offset some of the dull-drain from the crude oil imports.

Keep in mind that in 1949 there were 12 computers in the United States. By 1960 there were 6,000 computer systems and now there are about 100,000. The rates of production and user are increasing dramatically.

Learning stations in industry or at some library center of the future may well be an economic and factual reality within the next decade. As Lester Brown has put it, "We may be on the verge of one of the great discontinuities in human history. Those who think that the final quarter of this century will be merely an extrapolation of the third will be seriously disillusioned."

Thank you.

Professor Lawrence B. Evans

PROJECT PROCEED: DEVELOPMENTAL HISTORY

The name of the Project, PROCEED, stands for Program for Continuing Engineering Education. It was funded by the National Science Foundation in 1975 at $772,000. This was for the first stage of a rather ambitious program to develop a new approach to continuing education.

We anticipate that this first phase of activity will probably extend for about three and a half years, or in other words, will carry us until about the middle of 1979.

The Project is centered at M.I.T. and is administered there, but it is not, as you can see from the presentations this morning, an M.I.T. effort. Largely the work is a national effort. The work is going on all over the country and an important stage of our whole Project involves the formation of a not-for-profit Consortium of industry, professional societies, universities and industry to help in developing and disseminating the materials. The Project has a lot of everything. It has a lot of directors. It has three of us.

In addition to myself, there are Myron Tribus and Karen Cohen as Co-Directors of the Project.

The next slide lists some of the things that motivated us at M.I.T. and the National Science Foundation to turn our interest in continuing education into Project PROCEED. There are three important needs for continuing education:

1. The nation needs means for engineers to move from one area of specialization into another as national priorities change. This is particularly evident in the early 1970s, as we saw the space program decline we saw the pollution become important, energy problems become important;

2. Employees and employers need to acquire technical expertise in new areas. That's a frequent need; and

3. Individual engineers need to keep up-to-date, maintain the currency of their knowledge and skills. They need to enhance their education. They need to obtain advance degrees in some cases, and they may wish to diversify their skills to modify career paths and in particular, again, some of the work that was going on at M.I.T. in the early 1970s indicated that engineers in particular had problems in remaining in technical works as they approached their mid-career situation.

It was quite evident that the existing system of continuing education was not adequate to meet all of these needs. Professor Tribus explained, I think, many of the reasons this morning in his talk. If we look at the dynamic efficiency of the continuing education process it would be at least an order of magnitude lower than anything that Elias Gyftopoulos presented.

MOTIVATION

NATION NEEDS MEANS FOR ENGINEERS TO MOVE FROM ONE AREA OF SPECIALIZATION TO ANOTHER AS NATIONAL PRIORITIES CHANGE

EMPLOYERS NEED TO ACQUIRE TECHNICAL EXPERTISE IN NEW AREAS

ENGINEERS NEED TO:

- **MAINTAIN CURRENCY OF KNOWLEDGE AND SKILLS**
- **ENHANCE EDUCATION**
- **OBTAIN ADVANCED DEGREES**
- **DIVERSIFY SKILLS TO MODIFY CAREER PATHS**

SLIDE 1

So, out of all these needs we and the National Science Foundation decided it was worth trying an ambitious new approach to see if we couldn't come up with a system that had some more desirable characteristics.

Basically our goal is to develop and test a new system of continuing education, but it also has a number of characteristics of the existing approaches, e.g., university short courses, company short courses, professional society short courses, going back to universities to get a degree, learning it on your own from a groom that makes the traditional approaches ineffective. The PROCEED system is to have at least these important characteristics.

First and most important it's to be modular. That means that the materials to be learned are to be broken up into small bits or small packages so that they can be put together in different forms so they can be easily modified and adapted.

Second, a system is to be individualized. That means it will permit individual learners with individual needs to go to the system and learn what they need to know efficiently and effectively.

It's got to be readily accessible. The problem with many courses are that they are never given at the time the person really needs the information to solve a problem on the job. We are looking for the PROCEED system to be accessible all over the country at the time and place that is convenient to the user.

It's to be problem centered and this again was another key feature mentioned this morning. Characteristic of adult learners is the need that what they learn be relevant to problems that they face.

Addressing national needs is another characteristic required because of the fact that we are developing the program under National Science Foundation support and in order for the Foundation to support it it needs to be directed toward problems of national importance.

Further, it must provide the potential for credit or certification because we find that users will not use a system of education unless they can get some tangible credit in addition to the credit gained from simply learning the material, or at least there will be a number of users for which the issue of credit is important. So these are at least some of the major characteristics that the PROCEED system should have. These are, in effect, what you might say the requirements of the system are.

The goal of Project PROCEED is to try and develop a system of this type and then to assess when such a system could be cost-effective and self-sustaining. In other words, it might be possible to develop a very effective system but it might be so expensive that no one could afford it. And so the issue of economics is very important in our work.

GOAL OF PROJECT PROCEED

TO DEVELOP AND TEST AN INNOVATIVE NEW SYSTEM OF CONTINUING EDUCATION WITH THE FOLLOWING CHARACTERISTICS:

- **MODULAR**
- **INDIVIDUALIZED**
- **READILY ACCESSIBLE**
- **PROBLEM-CENTERED**
- **ADDRESSING NATIONAL NEEDS**
- **POTENTIAL FOR CREDIT OR CERTIFICATION**

AND TO ASSESS WHETHER SUCH A SYSTEM COULD BE COST-EFFECTIVE AND SELF-SUSTAINING

SLIDE 2

Let's look at the next slide which describes some of the concepts of the PROCEED system as it has emerged.

CONCEPTS OF THE PROCEED SYSTEM

- **ADAPTIVE REFERENCING**
- **INDIVIDUALIZED WAYS OF USING SYSTEM**
- **PROBLEM-SOLVING HELP BASED ON REAL INDUSTRIAL CASES**
- **FOUNDATION OF THEORETICAL SUPPORT WHICH USER MAY EMPLOY AT HIS DISCRETION**

SLIDE 3

Others will be going into a bit more detail on how the system will actually be used and what some of the major components are, but here are what I consider to be the unique features of the PROCEED system.

The first unique feature is that it's to contain what we call adaptive referencing. This means that when someone comes to the system to learn something, to get a piece of information, it gives exactly as much information as was required. In other words, it's adaptive to meet the needs of a user.

Second, there are to be individualized ways of using the system. Not everyone will come to the system in exactly the same way. There need to be many paths through the system so that study programs can be tailored to meet individual needs.

Third, the system is going to help engineers in industry solve problems on the job. This means that the material that's taught, in other words, the problem-solving assistance that it gives, will have to be passed on real industrial cases, not textbook examples.

And fourth, there are the foundations of theoretical support which the users may employ at his discretion. In other words, the theory that's required will be there. It can be referred to as needed, but it will be at the discretion of the user.

Now everybody agrees that modularity is an excellent feature in an education system, particularly one that people are going to use by themselves on their own. The thing that no one is certain of now is, how do you put together a modular system or get the pieces linked together, and where an individual can find his way through the system to meet an objective, and that's the part that we have been working on in Project PROCEED. I think that's the part where we are making a start and we are going to make a contribution.

The question is how do you go about designing and implementing a system that has these concepts. These are, in effect, what you might say the functional specifications of the system or part of the functional specifications: how do you go about actually designing the system.

On the next slide I listed the activities that we have gone through, almost in chronological form.

ACTIVITIES

DEVELOPMENT AND TESTING FIVE EXPERIMENTAL MODULES ON INDUSTRIAL ENERGY CONSERVATION

DESIGN OF THE FRAMEWORK OF THE PROCEED SYSTEM -- AN ADAPTIVE REFERENCE SYSTEM

DEVELOPMENT OF FULL PROTOTYPE PROGRAM OF MODULES ON INDUSTRIAL ENERGY CONSERVATION

SLIDE 4

When we got started on the Project we were interested in developing modules for use in continuing education. Most of the people we talked to had never seen a module and before they would even discuss the possibility of using modules they wanted to see an example. So our first approach was to put together five experimental modules on industrial energy conservation, and we have some examples here at the meeting. A module looks very much like a small monograph. It's designed for self-study. It has exercises broken up into sections so you can proceed sort of at your own pace. This one happens to be on the subject of control systems that save energy.

We have another one here, energy conservation opportunities in a small industrial plant. We have another one on improving the efficiency of boilers. There is one on synthesis of heat exchange networks. There is one on the principles of thermodynamic availability.

Our goal here was to produce modules very much in traditional monograph format to get them in the hands of engineers in industry and see if they actually would be useful as the primary needs of learning.

Simultaneously with the development and testing of these modules, and I will tell you the results of our testing with them in a minute, simultaneous with the results of developing the modules we began the design of the framework of the PROCEED system. That is an adaptive reference system. This has taken place over the past year at M.I.T. We convened an interdisciplinary team of experts from around the world in the fields of continuing education and learning design, psychology, educational testing, engineering education, career paths, to help us design and firm up on the exact characteristics of the system.

Once we had done that, then the members of our Project staff, lead to a large extent by Dr. Paul Johnson from the University of Minnesota, began designing the components of the system. In other words, they said we designed what would the modules look like, how would they be developed.

A key aspect of the PROCEED system is that it's to be developed, based on real industrial problems. And as I say, there is the chicken and the egg situation. You can't really design a framework without any materials, and yet, you can't produce any materials unless you have the framework design.

So with our first cut at the materials we designed the framework and now we are in the third phase of developing the full prototype program of modules on industrial energy conservation and these modules then are going to be used to let us fully develop and test the framework. I will describe the steps we have gone through in this operation.

We spent most of last summer making visits to industry. We established teams of people at M.I.T., University of Minnesota, University of California and the University of Texas. In fact, Professor David Himmelblau led the team there. These teams consisted of a faculty member and one or more graduate students who visited local industry where they have recently solved an important energy conservation program, and in effect documented the case history of that solution.

The approach they took, the information that they sought, the questions that were raised, the compilations that were done, decisions that were made, they documented that process for about 80 problems from visits to around 35 companies. And this basic problem pool gives us then a cross-section of the kinds of problems that people have been solving. This then tells us what skills are needed by engineers in industry who are working in the field of energy conservation. It gives us a base set of skills and these skills then become the topic of the full set of modules on industrial energy conservation. A set of about 30 modules which are now in the process of being commissioned.

We have been recruiting authors for the last couple of months and expect within the next two months to have all the modules commissioned, and under development.

That summarizes, then, the work we have done on developing the PROCEED system. Let me give you just briefly the results. The five experimental modules that we developed were sent to industry; they were well accepted and our first conclusion here is based upon preliminary field trials and is that the modules do, indeed, work and engineers will use them.

We concluded that the basic idea of the PROCEED system is workable, based upon pencil and paper prototypes. We will know better when the full system is developed, and we have enough knowledge right now to be confident the system is going to work.

The initial versions are going to be in the printed medium; subsequent generations then will be adapted to use computer managed instruction, computer assisted instruction and many of the alternate technologies that Dr. Brudner mentioned in his talk will surely be used in the PROCEED system of 1988; and the question is how much sooner, and that is something we will have to decide.

We are also working on other topics. Industrial energy conservation was our first one. The second topic deals with the protection of workers and users from toxic substances, and we hope to develop other topics including alternate energy sources, waste treatment and disposal, to mention a few.

Karen Cohen is next going to outline for you briefly the learning system and its components in more detail. Michael Mohr is going to give an example of how the system would be used.

Thank you.

Professor Karen C. Cohen

PROJECT PROCEED: ITS LEARNING DESIGN

Today's speakers have discussed at considerable length the challenges and opportunities that this project must deal with in terms of content, delivery modes and management. I would like to try to explain why many of the decisions we have made in developing this system make educational and psychological sense. To do so I have to discuss briefly certain assumptions about engineering practices, training and continuing education upon which we are operating. Given our assumptions and knowledge of the learning process I would then like to outline for you briefly the functioning components of what we call the PROCEED system from the point of view of the <u>user</u>, the engineer on the job, not the company that might pay for it, not the professional society or university that might give credit for it, but from the point of view of the engineer with the real energy conservation problem to solve.

As we all know, continuing education is considered critical in most professions. In engineering the need is even more visible than in many other areas such as medicine and law. Attempting to build an educational program that is more than token for the practicing engineer is a major undertaking. In so doing, we try to take a realistic look at the nature of the educational needs of the engineering industry. The most important problem, the most important assumption and guiding force for our efforts, was that engineers work on solving real problems under specific constraints. So problem solving became the heart of our approach.

Further, when engineers need help or information to solve their problems they rely on colleagues, vendors, trade literature and in-house or external consultants, probably in that order.

The entire PROCEED system, therefore, is modeled to fit this pattern. It can be a source of information and a consultant as well as a teacher or guide. Others will explain these features in more detail.

Suffice it for me to say that the entire system is seen by its developers as a support to the engineer and his habitual ways of working. The fact that it can be other things as well and can even potentially lead to degree credit at the post graduate level is really a bonus. The system is unique, therefore, in the array of continuing education options such as short courses, in-service courses and graduate courses. For such courses PROCEED is an innovative restructuring of the various kinds of information and processes necessary to solve problems which each engineer can use and adapt in his own way. These kinds can range from a desire for a simple piece of information or technical calculation through fundamental learning or relearning of basic principles and practices in the field as they apply to energy conservation.

In addition to these content and quality concerns in our materials, we also attempted to build in the most successful features which psychological and educational literature as well as innovative educational programs have illuminated. Thus, we have many additional subcomponents to PROCEED.

We have things like self-diagnosis, varying levels of access, frequent feedback to each user about his understanding and progress, clear structuring of learning objectives, summaries and guides for browsing or skipping through known materials, tests and answers, total self-pacing, modularity, options for certification, to mention but a few of the components of the learning design of the system. Perhaps a diagram can explain it more clearly.

(See slide 1.)

This diagram shows how, starting with the core notion of problems to be solved or cases, as we are now calling them, you can understand the inter-relationship of all of the other material components of the system. For example, given the problems you can define the competencies necessary to solve it. Given the definition of competencies, we have guidelines for authors and hopefully with an incentive like money, a set of modules written to teach people such competencies.

Again, given a set of problems it's possible to develop self-diagnostic procedures, tests, and exercises, the examinations and the kinds of activities people have to go through to prove they have learned what we are trying to teach them from the same set of problems.

And finally, with the problem-solving orientation we can specify further aids involving levels of access, path diagram, and referencing options which are integral features of the system. In addition to its own materials, PROCEED references to other guides, aids, and sources of information.

This diagram, then, illustrates how the system hangs together conceptually around the notion of problem-solving.

The next figure is much less complex. It indicates the components which at first blush are important to the <u>user</u>.

(See slide 2.)

The adaptive reference system, the cases and the modules themselves for the energy conservation topic.

Since Dr. Mohr intends to demonstrate the adaptive referencing feature to you quite specifically in a minute or so, I will move on briefly to mention additional aides within the system.

However, no matter how self-contained the system we develop is or the program might be, some people will always require extra assistance, and we see this as coming in several forms.

(See slide 3.)

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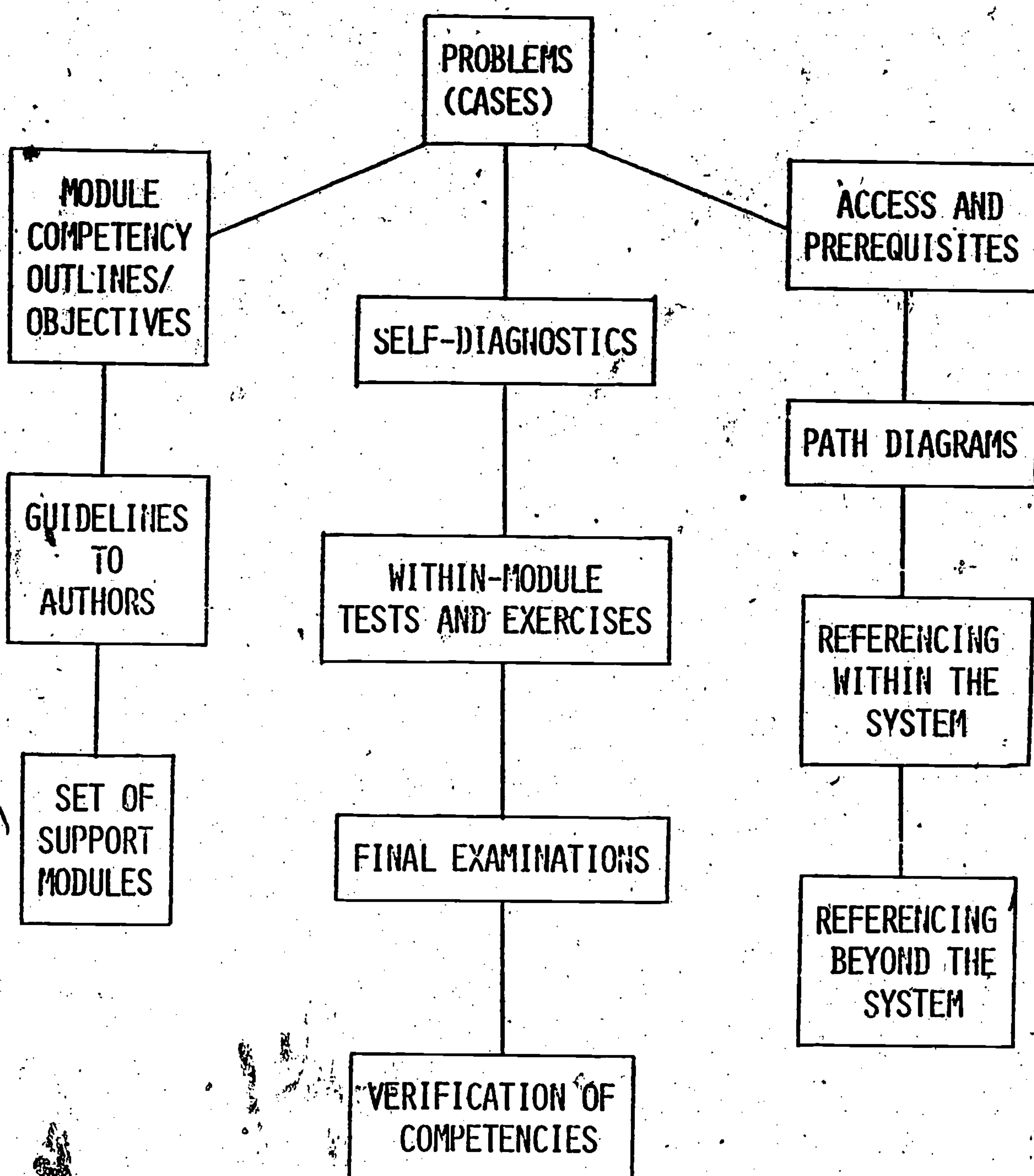
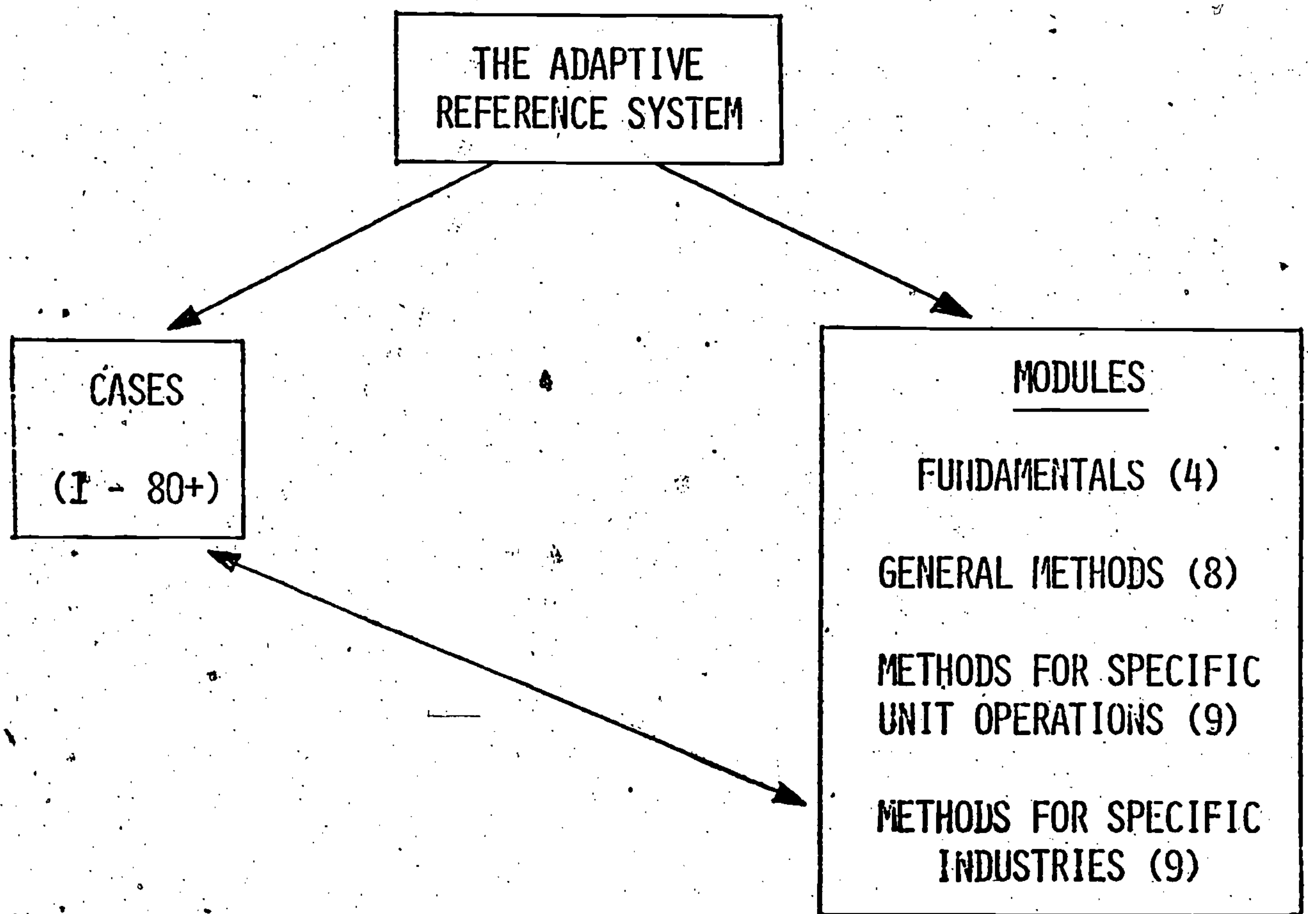
I. CONCEPTUAL FRAMEWORK FOR THE PROCEED SYSTEM



SLIDE 1

II. THE PROCEED SYSTEM TO THE USER

MATERIALS (FIRST GENERATION: PRINT FORM)



SLIDE 2

USER AIDS BEYOND THE MATERIALS

1. "HOTLINE" CONSULTANTS
2. CONSORTIUM CONSULTANTS
3. INSTRUCTORS IN:
   - A. GRADUATE COURSES
   - B. IN-SERVICE PROGRAMS
   - C. PROFESSIONAL SOCIETY OFFERINGS
4. SUPPORT (PEER) WORKSHOPS, GROUPS
5. VERIFICATION OF COMPETENCIES
   - A. STANDARD EXAMINATIONS/MODULE OR AREA
   - B. REVIEW OF SOLUTIONS BY:
     - EXPERT PANEL
     - PEERS

SLIDE 3

At the very beginning we see Project consultants operating through a hot line which the Project staff might run for people who have questions and don't understand certain things in the material. This is a very short term measure. We hope that very quickly the Consortium concerned with and involved [illegible]PROCEED may develop a national roster of consultants willing and able [illegible] help individuals with the program, with the module, if there are any questions about it so that people can make use of others in their area.

Further, as our materials become used in graduate courses, in in-service programs and in professional society offerings as they already have, the instructors of those courses should be able to provide support and help.

We plan to set up and would like to see replicated, peer groups studying the same module in a particular industrial site, so that people can become colleagues and help each other, people who are working on the same problem, using the same module. We see this as an ultimately potent method for providing support and help.

Finally, verification of competency is a feature beyond the materials available if the user wants to get some credit in some fashion and take some kind of test under standard conditions to prove that he's studied the material. Given our final examinations and all of the other kinds of tests and answers with each module it is possible for external verification of learning. It would have to happen, obviously, in conjunction with a degree-granting institution, professional societies such as the AIChE or ACS, or an industrial program.

We have the knowledge bank of expertise that's needed to solve these problems. That includes the case studies, case study materials, the modules, the extra references which the students can use if they need them, and also the adaptive reference system with which the system user interfaces with this bank of knowledge which have been mentioned.

Module Topics on Industrial Energy Conservation

Fundamentals

Basic Energy Overview
Economics
Systems Engineering Methodology
Thermodynamics

General Methods

Co-generation
Cooling Systems
Fuel Substitution
Insulation
Lighting
Space Conditioning
Steam Balancing
Waste Heat Management

Methods for Specific Unit Operations

Crushing and Grinding
Distillation
Drying
Evaporation
Fluid Beds
Furnaces
Other Separation Processes
Prime Movers
Refrigeration

Methods for Specific Industries

Cement
Chemicals
Food Processing
Fuels
Glass and Clay
Oil Refining
Primary Metals
Pulp and Paper
Textiles

Suggestions for additional topics are welcome.

SLIDE 1

This is a list of the modules which we envision on the energy conversion, part of the PROCEED system. They are broken into four parts: fundamentals, general methods, methods for specific unit operations and methods for specific industries. What we are trying to do here is cover the ground in terms of these materials in the fundamental sense, sort of general things that apply across many industries and then bring it together in important industries.

The adaptive reference system of Project PROCEED is basically designed to respond to questions and I have listed some possible questions here that a user might come to the system with in increasing degree of generality.

For example, he might come with a very specific energy conservation problem. "Can you help me with a fuel tank installation?" That's quite specific. He knows what the problem is and wants help in solving it. Or he might say, "Where in my cement plant should I look for energy conservation opportunities?" This might be someone who has just been given responsibility for energy conservation in a plant.

Or alternatively he might want to look at where energy conservation fits into the grand stream of things, "What should I know about energy conservation in order to do sensible things in the plant in which I work?"

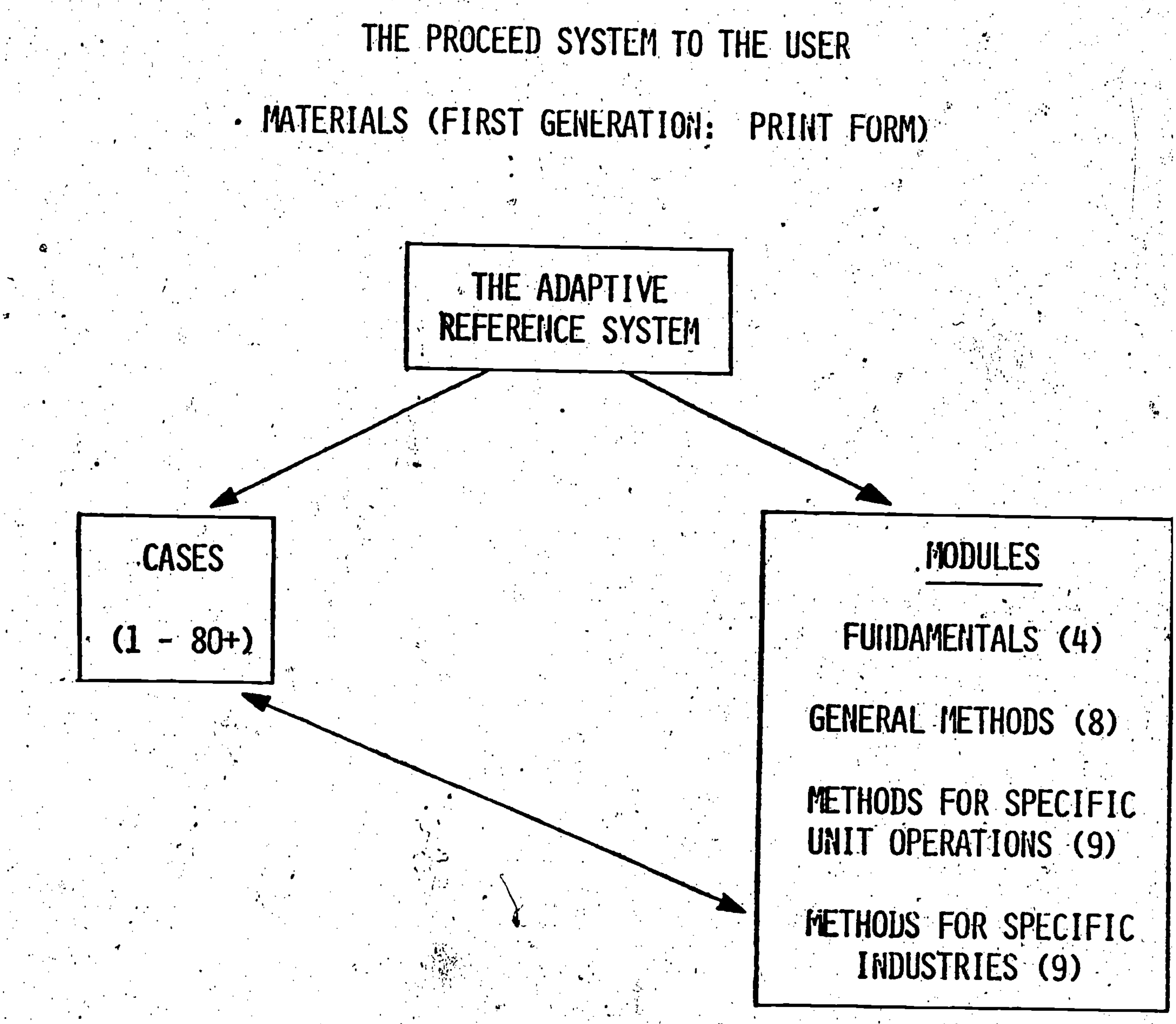
Or finally, he might say, "Can you help me improve my basic engineering skills?"

At this point we are not prepared to deal with that one, but we hope one day to be.

(See slide 2.)

The adaptive reference system is the top part of this diagram. The user comes into the system with a question and it might be a question like one of those mentioned earlier, very specific or somewhat more general, and we feel that it's up to us through the adaptive reference system to respond to his question. The adaptive reference system processes his question through our query index and tries to lay out for him the materials which would be relevant to his question.

We want, wherever possible, to give him the minimum amount of information that he needs in order to solve his problem. We don't want to overweigh him with things that he doesn't need, but at the same time we want to interact with him as Myron was talking about this morning and give him some choice of what happens to him. So we want to not simply say, "All right, that's your question, you do so and so," but we would like, through this query index system, to show him things which we think would be relevant to his question. We might show him the abstract of a case study. We might refer him to a module on distillation. We might refer him to a module on thermodynamics and the query index system could present abstracts of these so that he can look at it and say, "Well, I don't really want that. That kind of strikes me as being pretty good. Maybe I will get to that later. Let me try this one."



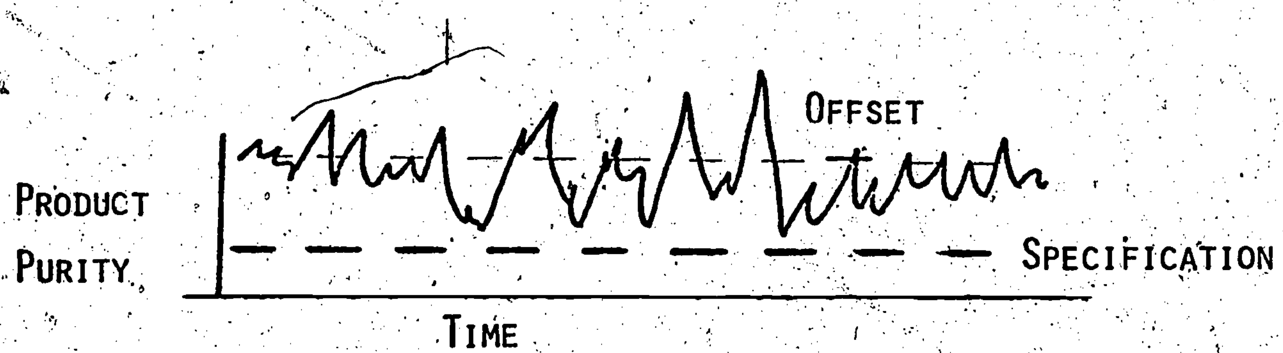
SLIDE 2

Now, the adaptive reference system also includes a cross-referencing among the materials so that if he starts into a case study, at some point along the way there will be something that has to do with distillation, he will be referred to the distillation module. Now, he may choose to go there or not. He may say, "I know that already and I won't go," or he might go. Looking at these abstracted referrals, the user then says, "Give me module number 1," and so from our file of materials we pluck module 1 and he has it.

EXAMPLE

QUERY: HOW CAN I REDUCE ENERGY CONSUMPTION IN THE DISTILLATION OF NATURAL GAS LIQUIDS TO PRODUCE LIGHT HYDROCARBONS?

ASIDE - THIS IS REALLY HIS PROBLEM.



SLIDE 3

Example query, "How can I reduce energy consumption from distillation of natural gas liquids to produce hydrocarbons?" Now as an aside to you, he has certain purity problems on the product. Because of varying feed conditions the actual product composition varies as shown. Therefore, in order to be sure of meeting specifications he has to continually make a purer product than the specification calls for and this difference in product purity can mean a lot of energy loss.

So, the query index, hearing his question, responds to him by giving him first the abstract of the distillation module. The details of this are not important, but it's simply the outline of the material that is contained within our module on distillation. It also gives him a case study abstract which says, "We have a case on energy conservation in a natural gas fractionation plant." Again the details are not important but this would be an abstract of the case study which has been developed out of the kinds of problems that we picked up this summer.

The engineer, because we happen to have his problem on the nose, chooses the case study and he says, "All right, let me start with this. This sounds like my problem. Let me see what someone else did with it." So he proceeds to use it.

QUERY INDEX RESPONDS WITH

1. ABSTRACT OF DISTILLATION MODULE
   - A) THERMODYNAMICS OF DISTILLATION
   - B) STAGES VERSUS ENERGY
   - C) COLUMN INTERVALS
   - D) COUPLING OF COLUMNS
   - E) USE OF LESS VALUABLE ENERGY
   - F) GUIDELINES FOR SELECTING OTHER PROCESSES
   - G) CONTROL SYSTEMS
   - H) HOW TO FIND ATTRACTIVE COLUMNS FOR ENERGY CONSERVATION

SLIDE 4

AND WITH

2. CASE STUDY ABSTRACT

"ENERGY CONSERVATION IN A NATURAL GAS LIQUIDS FRACTIONATION PLANT"

This case concerns the introduction of stabilizing (computer) process control in a natural gas liquids processing plant to reduce the energy required to separate the feed into the various light hydrocarbon products. Rising fuel prices have forced a closer look at ways to reduce energy requirements in the chemical, petro-chemical, and refining industries. Particularly close attention must be made to an energy intensive operation such as distillation since in that unit operation energy is the agent supplied to separate a mixture into its components.

Fluctuations in feed rate and other disturbances to the gas plant result in variations in product composition when there is not adequate control on these compositions. Because of high penalties associated with failure to meet product specifications, the columns are typically operated at larger reflux ratios than are actually required, and products that are purer than required result. Stabilized control of product purities can allow the distillation columns to be operated much closer to the minimum product purity specifications with considerable savings in energy. The use of control to save energy is particularly attractive because the capital costs of adding more controls are usually low and there are no extensive modifications to the process.

The management of a natural gas liquids plant recognized the need for improved control and commissioned an in-plant feasibility study by a process control consulting firm. This study indicated that energy savings of about 30% could be realized by implementation of a stabilizing computer process control system on the four plant distillation columns. A feed forward, material-balance control strategy which utilized five process gas chromatographs was recommended.

SLIDE 5

Other interactions with PROCEED may follow, as he uses this case study module, based on his recognition as he goes along. He might think, in order to really appreciate this case study I really should understand availability a little better. Maybe I ought to get that thermodynamics module and at least read part of it. Or, I am fuzzy on distillation, maybe I ought to get this information from the distillation module and do part of it. So he keeps interacting with the system, getting what information he needs when he realizes that he needs it. This process may, of course, lead him to ask other questions which brings him around in the circle again, and puts him back into the query mode. He asks another question and the system is off and running again.

That's basically how the system operates and in the workshops this afternoon we will be discussing three different aspects of it.

DISCUSSION

JOHN DOGGETTE: (Oak Ridge Association Universities) I am not really sure what my question is exactly, but in your concept of a system, until it becomes fully operating, what are you going to do with the holes in your system? Are you going to be able to refer people to other systems that are similar or other modules developed at some other place or are you going to say call me back in three years when we get around to developing that module, or are you going to advertise? I mean sometimes systems such as yours can fail only because you can't do everything at once, and thus people get turned off by your system because it isn't in place when they want it to be in place.

DR. MOHR: Well, for one thing we expect to drop, fully blown, into the world with about 35 modules and anywhere from 1 to 80 case studies involving energy conservation which we think will fairly well cover that area. We are sure that experience will show us that we have some holes and we will fill these in however we can, either by referencing to textbook material which we plan to do anyway or to other modules. There is no reason to re-invent the wheel if a suitable text is available.

PROFESSOR TRIBUS: I think it would be useful to know the three things we did in deciding the content.

First, over a period of about eight months graduate students under the supervision of Larry Evans and myself worked out strategies for solving industrial energy problems and this led to flow-diagrams with pictures of things you would do under different circumstances. These flow charts ran, I suppose, 15 or 20 pages and maybe a couple of hundred steps. That represented combined experience and modules.

Then, we got a bunch of people together who had experience in this field and they talked about how you solve energy problems. There was a very satisfying overlap between what they had to say and what we had out of our logic and experience.

Then we sent teams into industry who were working on industrial energy problems and in those interviews they asked, "What did you do, what did your boss have you do, what happened then, what calculations did you make?" We were very satisfied with how that matched the recommendations of our consultants and our earlier logical analysis.

So we are fairly confident that when we have this thing operable that we will hit most of the questions.

Now, we have one ace in the hole and that is that somewhere along the line we will have the provisions early in the game to call on a human consultant either by phone or some other way a[illegible]t will be related to the initial delivery system. Given all of th[illegible]hink we will not be caught in the trap that you describe.

LEROY MARLOW: (Penn State) Maybe I am getting ahead of where you want to be at this time and should wait but will these modules be available to other states, and if so how and at what cost?

PROFESSOR COHEN: Of course they will be available -- and soon. A major decision facing us involves the best delivery system; one of the working groups is going to help address that and get your advice as to what you think would be the most feasible modes.

WORKING GROUPS

I CONTENT AND PROBLEMS

II DELIVERY MODES

III MANAGEMENT AND VIABILITY

WORKING GROUP I

"CONTENT AND PROBLEMS" QUESTIONS

Group Leaders: Elias P. Gyftopoulos
Martin Horowitz

1. What are the primary problems requiring education in the area of energy conservation for the individual engineer, for industry and for the country? (Technical and non-technical)

2. Can the subject matter (energy conservation in industry) be adequately covered by the system described in the first Plenary Session? What <u>should</u> be added? What <u>could</u> be added?

3. How can relevance to the users be assessed? What further research may be necessary?

4. Have the needs of engineers been addressed adequately?

5. What format is most flexible and will most easily allow expansion of the system to cover any number of subjects and to serve differing professions and differing levels of education?

6. What steps are now recommended to Project PROCEED and the Department of Energy in the area of energy efficiency education?

WORKING GROUP I

RECOMMENDATIONS AND CONCLUSIONS

Working Group I dealt with the topic of "Content." Professor Lawrence B. Evans presented the summary.

PROFESSOR EVANS: We took the questions that were given to us as stimulants to discussion rather than as specific questions for which we were to get the answers. Seven major observations arose during the course of our discussions.

1. The first observation was that the idea of the PROCEED system was basically good but that it could not be fully evaluated in its present form. A number of people in our group mentioned that its communications system is the key to the PROCEED system. Once that is established we will be in a position to demonstrate the viability of the concept.

2. Our second observation was that in addition to graduate engineers (toward whom the PROCEED system now seems to be largely targeted) there are at least three other categories of people who might need to be covered by such a system. The first would be managers, including top management. The second group were technicians, people who do not have a college degree but who play a key role in implementing energy conservation programs, particularly at the point of proper adjustment of a boiler or furnace, which was mentioned as an example. The third category of people were people with college degrees but not in the process field. For example, these might include chemists who are involved in process development or electrical engineers who may be concerned with plantwide energy conservation and need some background in process thermodynamics and the technology involved in energy efficiency.

   The problem of sensitizing operating plant personnel to the magnitude of various kinds of energy losses and to give them just a feeling or a sensitivity was important. And it was pointed out that frequently it is the operator on the midnight shift that defeats many of the good ideas for energy conservation.

3. Observation number three was that the PROCEED system would be of primary use to smaller companies and to consultants who lack extensive technical resources.

4. Observation number four was a corollary to that; namely, that large companies already have the basic engineering competency needed to apply energy efficiency. For the large companies, however, the most useful component of the PROCEED system would be the case study, particularly if they dealt with new plant or process design. It was also felt that large companies

might use some of the PROCEED materials in their smaller subsidiaries where their technical resources are harder to reach. They might also use them if we covered areas other than basic engineering. If we covered technicians, for example, the large companies could use materials in this area.

5. Observation number five was that a great deal of material already exists relating to energy conservation, much of it developed by the Department of Energy with their funds with the bulk of it developed by private industry. It would be helpful if these existing materials could be integrated or incorporated into the PROCEED system.

6. Observation number six stressed the importance of keeping the system up-to-date. And this may be a particular problem as changing legislation alters the way energy efficiency is defined and/or mandated.

7. The final observation was in the form of a recommendation to the Department of Energy: that they should encourage the development and the use of the PROCEED system, though such use obviously should not be made mandatory.

MR. MASSEY: I was wondering if any other people here in the room might have had some thoughts about content, which was part of our mission. In looking over the list of subjects, are there other subjects that people think could be used?

PROFESSOR KATZ: As I listen to you and listen to the comments I often identify another audience in addition to those that you have suggested, and that happens to be the recent graduate, the very recent graduate. I find that there is a big gap between their preparation and the preparation of the recent graduate -- what you really need to know to make a creative contribution in industry.

I find that, increasingly, with the fast moving targets we have, particularly in the energy field, there is so much that these young people don't know. There is a tremendous area for education there, bringing them up to speed, so to speak, before you even get into energy conservation. And I would like to differentiate that group from that of the practicing engineer. I think it is important that we do keep those two separate.

MR. FRIEDMAN: I second that remark, and I wonder if the emphasis should be to broaden the knowledge of the new graduate or to intensify it; broadening the knowledge to introduce them to more aspects of the industry of the world rather than giving them another course in differential equations.

PROFESSOR TRIBUS: We find it useful to distinguish between teaching engineer<u>ics</u> and engine<u>ering</u>. The engineer<u>ics</u> topics that are taught by the academics pertain to logic and the development of scientific and analytic capability. Engineering is concerned with doing, designing, creating, producing and the like. And when a person graduates from scientific training and enters industry, one of the things required is to understand how to put all that knowledge to work. And that includes what are the criteria whereby something is judged? How are we now doing it? What are our problems? Where do we think we are going?

I believe that Project PROCEED will contain a lot of material that is directed in that line. I think we will have to wait until we have some experience.

MR. CHO: I would like to elaborate on the concept that Professor Katz was talking about. Perhaps the materials of PROCEED could be introduced at the senior level or graduate level in conjunction with conservation courses, so that when these people graduate from the university they will have had some experience with real world problems, particularly the case histories (perhaps in lieu of textbook types of problems). And perhaps they would be better equipped to handle real world problems.

PROFESSOR TRIBUS: I agree that it is desirable to use these materials if we can with some undergraduate students. But I would like to caution against the philosophy of engineering education that looks upon it as though the student were to become equipped for life before he leaves the university. It's as though he were starting for a journey into a desert where there are no gas stations and, therefore, before the student leaves the school everything required to survive over the next 30 years has to be loaded onto him.

The whole idea of Project PROCEED is to take into account that at school people don't learn all the things they need to know and that continuing education is essential. What we are trying to get at in this program is a form of continuing education that is much more responsive to what people need than heretofore. While we have no objections to the material finding its way into the undergraduate curriculum, the number of people we can reach that we know will work on the problem that we are teaching is just too small. The probability that the person who takes a course in energy conservation is assigned a task in energy conservation is just too low for us to count on it as being an effective way to meet the national need.

So while we would like to see that go, I would like to emphasize that this is an educational system for people who have been assigned a new task and aren't prepared for it; that is where the need is going to have to be met.

PROFESSOR EVANS: The point is made that this may serve as a useful source of examples (not necessarily to train people in a specific task), and the point is well taken. I take those two comments to complement each other.

MR. KLINE: An engineer coming into our industry in particular has a number of selections and decisions to make. He has got to learn that there is a time to sawmill-rig and there is a time to engineer. And what decision he makes is going to determine which field of engineering he goes into.

If the man is going to engineer everything, he is going to end up as a specialist. And we have many of those people available to us to call on. If he is going to make a combination of sawmilling and engineering, he is going to end up as a generalist in engineering, which is the man we need for energy conservation, because you have to look at the whole process. And if he is a man who is going to sawmill-rig all the time, he is going to end up in process management of some sort.

MR. MAXWELL: With Professor Katz's comment and going one step lower, for example, he spoke to the graduate engineer and he spoke to the undergraduate engineer. We do not want to neglect the high level technical training institute, two or three year terminal education program, do we? We should target some of the material for those people that are operating as boiler engineers, for example. Some of this system could well become part of the advance technology training that these people undergo.

PROFESSOR EVANS: That is a point that will probably come out loud and clear from all of the discussions. And whether it should be included in the PROCEED system is another question. But it certainly is a need that has been identified.

DEAN LANDIS: Since Project PROCEED is not particularly well-equipped to address itself to the role of the technician or the operator, in your discussion are there any points that might be of value to DoE or any specific recommendations that should be followed?

PROFESSOR COHEN: If you mean Project PROCEED is not well-equipped because it is not well funded to deal with every level of all of the hierarchies of people that must be educated, I will agree with you. But I feel in fact the concept of Project PROCEED is one that is very compatible with training at all levels, and that it is mandatory that we or others develop compatible kinds of materials so that the entire system becomes a very useful resource to industry in general.

DEAN LANDIS: One of the problems with continuing education is that we have been trying to start the engineer with it years after he has been out of school, instead of starting him off during his undergraduate or graduate education, so it would then be a lifelong process. So I disagree with Myron. Let's use it in the graduate curriculum. If you can use it in the graduate education, you are ahead of the game.

PROFESSOR TRIBUS: I did not say students should not use it, I just said don't rely on the use there to meet these national needs.

WORKING GROUP II

"DELIVERY MODES" QUESTIONS

Group Leaders: Harvey J. Brudner
Paul Johnson
C. Michael Mohr

1. What are the potentially most useful technologies available for disseminating appropriate information?

2. What are the advantages and disadvantages of various delivery modes for different types of users?

3. Should users successfully completing modules receive some form of certification? What are the options?

4. What quality control mechanisms are necessary? At what level?

5. In what ways should the user be able to access the system? To what extent should computers be used as access points?

6. How can the system be continuously evaluated? How can the system be modified to reflect the evaluation? What up-dating procedures should be instituted?

7. What delivery modes are recommended to Project PROCEED and the Department of Energy?

WORKING GROUP II

RECOMMENDATIONS AND CONCLUSIONS *

Working Group II dealt with effective delivery of modes, Professor Paul Johnson of the University of Minnesota presented the recommendations of that group.

PROFESSOR JOHNSON: I think it is safe to say that our group ranged far and wide and while there was no consensus on many issues there were many options proposed, many suggestions made. I will try to summarize the kinds of things I think emerged, and I am sure that members of the group will help me after I have finished.

I would like to present four predominant issues that we dealt with, and then propose a strategy for making recommendations to Project PROCEED that I think most people in the group would support.

1. First, there is an issue concerning the cases. It is important as Project PROCEED moves into its next phase of development that we make certain the cases that are at the heart of the system are representative ones. That is to say, the cases we choose should be representative of the class of tasks or problems to be solved by engineering practitioners; and also that they be representative as best as we can determine of problems that are on the horizon.

   It is also important that the cases be timely; timely not only in the sense of problems that people are currently working on but also timely in the sense that the user is going to recognize that the problem solution is one that he would be willing (and likely) to use.

   The example that was proposed by our group is quite on the mark -- if the kind of cases represented in PROCEED concerns a problem where the turn-around time on the investment that has to be made is too long, then the user is going to reject it as something that is too technical for him to deal with. The cases that we put into the system need to be prioritized with this kind of thing in mind.

   We have to make certain that we have cases in the system the user feels are important. He should recognize them as important for practical as well as industrial reasons.

   It is also important that the cases have a degree of quality control. Quality control should not only be addressed when the decision is made to put a case into the system -- that is, when the data are collected on the cases -- but also as the case is being developed (in, for example, the form of expert commentary on cases so that the user has a clear indication of the status of what he is looking at).

2. A second area in which issues were raised that are relevant to the delivery concerns of Project PROCEED is making certain that the system we create (both modules and cases) <u>reference the outside world</u>, that is to say, it must recognize that there are other information retrieval systems and case study libraries that engineers are accustomed to learning from.

   Just as we reference the world, we have to make sure it can also find us; PROCEED should be indexed in such a way that other national networks can find it, and people who are on other national networks can locate PROCEED materials as a means of solving problems they have.

3. A third issue that came up [illegible] brokerage. One way to imagine PROCEED is as a large Consortium that offers its wares nationally through a large computer network or other form of information network.

   An alternative structure that I think the group felt strongly about is represented by the idea of local control. What this means is that if you contemplate something like continuing education you must argue that what PROCEED has to offer should be distributed through the local university setting for continuing education or through the local corporate or industrial setting or through the professional society where continuing education also goes on. Many members of the group felt that a measure of local control is not only desirable but indeed necessary in order to achieve the effective delivery of the PROCEED system.

4. The final issue is more complex, and what I propose to do is to define it strategically in a way that the group identified it. Following that I will present our recommendations.

It seemed as we talked that a distinction needed to be made between two related but somewhat different ways of looking at the PROCEED system. One way of looking at it that is reflected in my remarks thus far is that it is a system of continuing education. PROCEED has a knowledge base of case studies, a set of modules which support these studies, that can be delivered to people who want to improve their problem-solving skills as well as their knowledge of the field, and perhaps also make changes in their career orientation.

The PROCEED system is also a problem-solving aid to the industrial consumer. The knowledge base of case material offers the possibility of enhancing or improving the solutions to problems that industry faces.

We believe that issues of delivery mode and marketing strategy may need to be considered separately under each alternative.

With that distinction in mind, let me then deal with the last issue. The issue of delivery of what PROCEED has to offer involves things like choosing a medium, choosing a print orientation, audiovisual orientation or computer-based orientation. There was very strong feeling among a segment of the group that high technology is here, and it really isn't a question of whether a computer-based format is feasible but rather how soon we are going to make our system compatible with that form of delivery.

And so the real question concerning the computer delivery of Project PROCEED is more one of the user than of the technology itself. It is a question of the cost. It is a question of the feasiblity at different points in time, and for two somewhat different audiences, the continuing education audience and the problem-solving audience.

It seems clear from the kind of discussion that we had in the group that the best way to solve these issues was through the development of prototypes and the testing of those prototypes in the marketplace with a variety of potential users and client groups.

The idea that the user needs to be thought about carefully as we contemplate delivery is very important. Things that came up in this regard were matters involving not only a hot line to a source of experts like at M.I.T. but also the possibility that users can talk to one another.

There is also the whole idea of delivery in terms of user groups, that is whether people are perceived to use PROCEED alone or in settings involving more than one individual in one place, or in some sort of a communication network with individuals at different locations all working on the same problem. These are important possibilities that need to be addressed.

Our recommendations for delivery modes of the PROCEED system take the following form. One might think of stages -- four stages, let's say -- and that really the delivery question involves progressing through these four stages. We are currently compatible with delivery in a print mode. The exemplary modules that we discussed yesterday are completed. In fact, we have passed them around at different points in the session. As you can see, they are only in print form, but basically they don't reference anything. They don't even reference each other; nor do they reference the outside world. That was stage one of our development.

Stage two, which is where we are now, was an attempt to let the generation of the module materials derive from a needs assessment or user analysis to be carried out through the development of cases. The 35 modules that we have discussed here are an attempt to meet that need. The kind of referencing that can go on among these cases and modules as well as the outside world is a second stage of development.

But it is very important that we consider soon, the development of prototypes that begin to incorporate other kinds of technology. For example, one of the major means through which users may discover us is the adaptive reference system.

The adaptive reference system is best presented on a computer terminal, and so it is important that Project PROCEED consider developing a prototype of this (perhaps as soon as next year). We might, for example, develop a prototype of the adaptive reference system for a small range of representative cases on a computer and then take this around to professional societies, the corporate setting, etc. and observe user reaction to, and interaction with it.

The only way we are going to begin to address some of the questions of delivery is by creating prototypes and letting users interact with them.

Stage three of PROCEED development might be where we contemplate a more total delivery of the system through a computer-based format. The issue here is more substantive in that we would write the modules differently if we were going to work on a totally computer system than if we were working on a system where the main use of a computer was to access, through the adaptive reference system, the modules and case study material.

In a total computer format, we are talking about a dynamic environment for learning or for problem-solving. In this stage the modular materials become workbooks to use while interacting with the system.

A fourth stage of development is where you look at the case materials and develop them in such a way that their true dynamic character comes through. I am thinking of some things like case materials that have recently been developed at Minnesota in the area of teaching law students on a national network of some 30 or 40 universities.

The case materials actually lead the learner through the system. There are printed workbooks published commercially that are used in working through the case materials. But they are written in support of the case materials rather than the other way around.

The fourth stage of development for PROCEED might be the development and testing of this kind of system.

If I were to summarize our recommendations, it would be that as we think about these various stages of development and the idea of choosing an appropriate delivery mode, we must be certain not to overlook the needs of the user, the middleman, and the environment within which the users are working.

If we propose to deliver continuing education in a university setting, there is a middleman who is brokering our wares. And that is a college professor or a dean. This individual has need and must get some payoff for brokering our system.

The same thing is true of the corporation and the professional society. If, at any stage in our development we neglect the middleman, then we run great risk that our system will never get off the ground.

Finally, the issue of cost is important. There is no sense in producing a system that people cannot afford to buy. The large corporation can afford to buy the system. General Motors might buy it and might actually put it up on their own computer system and distribute it through their 150 companies. On the other hand, there are individual engineers or small numbers of engineers in settings outside of the large corporations that also have to be considered when we develop cost factors for our product.

Well, I think that is basically what I can say by way of summary of the activities of our group. I would be helped a great deal if some of the individuals who were instrumental in what we did would be willing to comment or provide some support.

PROFESSOR TRIBUS: Would you distinguish between problem-solving and continuing education?

PROFESSOR JOHNSON: Because I make a distinction between the continuing education and the problem-solving mode doesn't mean an engineer using the problem-solving mode, let's say, in the system won't learn. I think that is a subtle and very important way of learning.

I would certainly argue, as I think Professor Katz was arguing, that for the engineer, as well as for many other professionals, problem-solving is at the heart of continuing education. That is what he wants to learn how to do better. The PROCEED system whether you construe it for continuing education or for problem-solving aid has as its core a set of problems and their solution.

PROFESSOR TRIBUS: Let me just see if I can exaggerate the distinction you are making in order to come to grips with the difference. Are you saying that on the one hand we may present Project PROCEED as a system that will help the engineer who discovers he has a problem and he turns to this and it helps him? And if he doesn't happen to know what he needs to know in order to solve the problem, it teaches him. Or we could think of it as a system in continuing education which attempts to teach the engineer things he ought to know in case he runs into a problem. Now is that the kind of distinction you are making?

PROFESSOR JOHNSON: Yes.

PROFESSOR TRIBUS: And what I suggested in my talk was that systems of education that are based on the idea of sort of banking knowledge in case you need it, these systems appeal to about three percent of the population. People when they are adults, don't have a lot of things to do with their time and are disinclined to go to a system which is going to give them some general help and increase their general knowledge in case somebody needs it.

PROFESSOR JOHNSON: I think it is important to distinguish between continuing education as it would be done through Project PROCEED and more standard forms of continuing education.

I think Project PROCEED has a unique contribution to make to continuing education, and that it is not in the form in which you are suggesting.

DR. EDWARDS: Let me suggest, by coining a new phrase like extended education, that what I hear people rather systematically saying is that nobody wants a continuation of the kind of education that they got in college because it is not appropriate. So a continuation or a continuing of that kind of education, Myron would suggest only three percent would even care for. And what you want is an extension of the educational process into differing situations and to the situation on the job and in answering questions and solving problems and thinking through career choices and rather different kinds of forms.

PROFESSOR JOHNSON: That is exactly right.

DR. EDWARDS: Maybe you need to think about a different term when you say continuing -- because when you say continuing education people are going to think of it as a continuation of education as they know it rather than extension into a different area.

MR. FRIEDMAN: What we are thinking of is additional development.

MR. ROBBINS: The group was really only talking about differentiating in the marketplace because people respond at different times to different needs, particularly within a corporation. And this came out of some people around the table who are very experienced in dealing with industry and problem-solving and they are just ready to hear a different kind of thing. And it was only meant as a way of marketing.

DR. BRUDNER: One of the things we are aware of in the several discussions we had is the difficulty of trying to describe what essentially is a multidimensional process oriented concept with kind of two-dimensional words as images. And it really came through as you listened closely in terms of how people interpreted the very meaning of the words "delivery system."

If you looked at it sociologically, say, you had a totally different concept of delivery systems than if you looked at it technologically or economically.

I think the inference that Paul was making -- and by the way, I think the group should applaud Paul's summary, because in no way was our discussion as coherent or as sensible as his summary, but one of the things that came through loud and clear is that this particular set of issues is extremely important to the Project. And perhaps we have underestimated the difficulty of analysis as coherent as Paul has presented.

Also, Dr. Edwards suggested something that I thought was very important. It is the one thing that perhaps was not emphasized enough. Namely, it might be useful to assemble several subgroups that work on these issues in 1978, because they are complex. The success of the Project is intimately related to them, and there is no way one or two people can simply run out the answers.

PROFESSOR TRIBUS: I was waiting to hear you say something about the expectations regarding the computer use. Let me put it a different way.

In my own mind I have been anticipating important developments in computer terminals and output devices that, while not on the market now, are very likely to be on the market in the next few years.

It is part of a revolution and we should, in fact, anticipate that revolution and accede to it. Now there are other people who are more conservative in their views and I would be interested in whether a consensus developed. And if no consensus developed, what advice do you have?

PROFESSOR JOHNSON: I think that is indeed an issue that people divide on and did so in our group.

PROFESSOR TRIBUS: Well, because they divided, where do you stand?

PROFESSOR JOHNSON: Our recommendation was the one that Harvey mentioned; it was that PROCEED needs to have some processes set up in the next year that more systematically and more thoughtfully address the ways in what you suggest what might be done.

In the short space of time we had, it was not something we found achievable.

PROFESSOR TRIBUS: You are referring it to the committee?

PROFESSOR JOHNSON: I didn't say that. If any of the individuals in our group who came down emphatically upon one side or the other of that issue would like to speak, I am sure it would be interesting.

WORKING GROUP III

"MANAGEMENT AND VIABILITY" QUESTIONS

Group Leaders: Myron Tribus
Geoffrey Bock

1. Is a Consortium of universities, professional societies and industry a good management mechanism? What can each contribute in terms of contacts, credibility and support for the Project? Are there better alternatives? If so, what?

2. What are the essential management needs for the Consortium? What tasks should be done by the central Consortium staff? Who pays for what? Who gets what?

3. What are the incentives for participation for each of the four groups -- industry, government, academic and professional societies-- to form and maintain the Consortium?

4. How can the system be continuously evaluated? How can the system be modified to reflect the evaluation? What up-dating procedures should be instituted?

5. How can the PROCEED system be integrated with corporate training programs?

6. How can the Project be made cost effective? What kinds of user charges should be established?

7. What are the advantages and disadvantages of distributing the system through university, professional society or industry in-house courses?

8. What other distribution mechanisms are there?

9. How should the system be marketed?

10. What recommendations should be made to Project PROCEED and the Department of Energy?

WORKING GROUP III

RECOMMENDATIONS AND CONCLUSIONS

The Working Group on Management and Organization developed seven specific recommendations about the formation of a viable not-for-profit company to market and continue to develop the activities of Project PROCEED. These recommendations were presented to the workshop by Dr. Myron Tribus and are as follows:

1. <u>On Organization</u>

   It is recommended that an association be formed, the members to consist of organizations with an interest in continuing education for engineers, such as industries, professional societies, universities and possibly trade associations.

   The members of the association should elect a board of directors which will contain suitable representation from industry, academe, professional societies and possibly trade associations.

   The board of directors should be responsible for selecting the officers of and approving the activities of a not-for-profit company.

   The not-for-profit company shall plan the activities of Project PROCEED, including:

   - Deciding what subjects to cover,
   - Developing educational materials and services either in-house or by contract,
   - Marketing the materials and services either by contract or using its own staff,
   - Developing sources of revenue.

   The company officers will be responsible for all day-to-day operation and for financial and educational integrity.

2. <u>On Sources of Revenue</u>

   The company should take advantage of available Federal resources in starting its projects, especially those in areas of national need. However, in contracting with the Government, care should be exercised not to inhibit the sales and distribution functions. Pricing for all materials and services should be set to recover all costs and permit Project PROCEED to develop new materials and services out of revenue, without further Federal subsidy.

The following sources of revenue should be considered:

- Membership fees in the association,
- Modules sold indiv[illegible]
- Fee for privilege [illegible]ng to adaptive reference system,
- Fee for each service.

As a matter of principle, the company should raise revenues from as many different kinds of services and products as possible.

3. Marketing

Project PROCEED should develop a strong marketing activity. It is likely that the costs of marketing and distribution will be more than three times the cost of initial production. Do not skimp in this area.

4. User Inputs

Project PROCEED should develop procedures to guarantee potential user inputs at an early stage in the development of the system, teaching materials and other services. These procedures include -- among other things -- consultations with plant engineers and managers about the topics for materials and services as well as delivery mechanisms and means.

5. Distribution

The distribution system should be very flexible and may include, for example:

- Utilities,
- State energy conservation offices,
- University extension services,
- Manufacturer's associations,
- Academe,
- Nationwide mail advertising campaigns,
- Presentations at national conferences and trade shows,
- International sales,

- Professional societies,
- National organizations (i.e., energy conservation groups),
- National Association of Manufacturers,
- U.S. Chamber of Commerce.

6. <u>Evaluation</u>

Project PROCEED should establish an evaluation system including:

- Automatic user feedback as part of the educational offerings,
- Studies of effectiveness (including anecdotal information). The Project should establish measures of effectiveness for its educational efforts to see if if the objectives are met;
- Monitoring of activities such as:
  - Sales,
  - Inquiries,
  - Console generated references,
  - Reports from librarians.

The board of directors should periodically appoint ad-hoc topical, self-liquidating advisory committees to examine:

- Topical areas,
- The working of the system as a whole and report back to the board with recommendations for changes or continuation.

7. <u>Recommendation to the Department of Energy</u>

Project PROCEED appears to be a promising approach to the continuing education of practicing engineers. Its plans for materials and services on industrial energy conservation and its planned delivery system promise to fulfill an important national need. The Department of Energy should thus support Project PROCEED for a sufficient time to allow an evaluation to be made of its effectiveness in conjunction with the educational mission of the Department of Energy.

Workshop members discussed each recommendation separately.

Discussion of the first recommendation "On Organization," centered on whether the proposed company should be concerned solely with materials and services for engineers and scientists in industry, or whether it should be concerned with materials and services for a broader range of industrial personnel, including technicians and other technologists. The group decided that the mandate of the company should include all kinds of professional level technically-based personnel working in industry. These could mainly be engineers and other scientists but in some instances, could also include professional toxicologists, and so forth.

The second recommendation "On Sources of Revenue," contained two basic ideas. First the not-for-profit company should not continually rely on federal funding. Second, the company should raise money in every way it possibly can. Hence, the organization should have viability.

The third item was "Marketing." The point that was made here is that when all is said and done the company will be spending a lot more money on getting the material out, developing relations with people, and so forth, than on the original writing of the material or the development of the services. Based on the experiences of a number of members of the working group the cost of distribution will be at least three times the cost of generating the material in the first place. A heavy investment in this area is a prerequisite to success.

Recommendation number four, "User Inputs," emphasizes that the company should take the user into account at a very early stage of the development and have a very strong interaction with users in the developmental process.

The sixth recommendation "Evaluation," really contains three important parts. It says in one part that built into the system should be feedback from the users, so that people using the company can get an idea of how they are reacting to it.

But in addition there should be some attempt to study whether the system as a whole is doing anything. For example, in the field of energy conservation some measure should be made of whether the people who use these services actually go out and do something different.

And the third idea is that while Project PROCEED and this company should be developing all of that, there should be an independent audit of the entire system run under the aegis of the board of directors. That is what the last item is about.

The seventh recommendation is made to the Department of Energy, namely that it cooperate and support Project PROCEED sufficiently to allow some measure of effectiveness to be made to see if it really supports the educational mission of the Department of Energy. Project PROCEED has some promise and ought to be given enough support in order to find out if it's promise will be fulfilled.

Some workshop participants questioned whether Project PROCEED would simply educate scientists and engineers in energy or in other areas as well.

Professor Tribus responded that the Project was broadly construed to apply to other scientifically-based areas as well. The recommendation to the Department of Energy refers only to the Department of Energy's mission but there is an implied endorsement that the Project is a good idea across the board. This doesn't preclude saying some day to EPA or to OSHA or to somebody else something similar.

Dr. Passer added one comment to the general discussion -- the proposed organization is a rather global sort of thing. It covers the whole universe almost, and this is fine. But a lot of thought needs to be given to whether or not the electrical engineers and mechanical engineers and the chemists and all the universities and so on are ready to get involved in such an organization, simply for the very human reason that many of these institutions are heavily committed to these sorts of things. And they may look upon the proposed organization outlined here as possible competition arrival.

A lot of thought should be given to make it clear to the various members of this organization just what they are giving up to become part of it and just what they retain. Clarifying these points could be very crucial to obtaining their support and involvement.

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