Research Proposal Submitted to the National Science Foundation 73-8

Research Applied to National Needs (RANN)

The Environmental Research Institute of Michigan
Name of Organization (including Branch title, if any)

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Address of Organization

Exploratory Technology Assessment of Alternative Strategies and Methods for Conserving Energy.
Title of Proposed Project

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PROPOSAL FOR EXPLORATORY TECHNOLOGY ASSESSMENT IN ALTERNATIVE STRATEGIES AND METHODS FOR CONSERVING ENERGY

ABSTRACT

The Enviromental Research Institute of Michigan (ERIM) submits this proposal in response to the National Science Foundation's RFP 73-8. This program is a recognition of the national importance of the issues of technology management and the systematic exploitation and development of resources. In this regard the exploration of the alternatives, options, and strategies is expected to provide a methodology which is comprehensive in its identification and examination of direct and indirect impacts. This proposal addresses the technical assessment of alternative strategies and methods for conserving energy. Daily we are made aware of the impending "energy crisis" through official statements, scholarly publications, and popular news articles. The need for a rational in-depth analysis of the available options and their full consequence in the technical, economic, social, legal, and environmental spheres is indisputable.

The potential alternatives for energy conservation encompass fields as diverse as thermodynamics and taxation, as housing codes and demand elasticity. The range of competence required to address these areas is exceptionally broad. To insure that they are treated properly ERIM has assembled a research team in cooperation with University of Michigan faculty. Outside consultants have also been recruited and strong interest in participation has been expressed by a petroleum producing company, electric and gas utilities, a labor union, and the Michigan Department of Commerce. The involvement of all these participants is designed to provide the breadth to guarantee that all significant alternatives, interests, and impacts are considered.

ERIM, working with University of Michigan faculty, has had an interdisciplinary team studying the technology assessment of remote sensing under NSF support for almost a year. The philosophy and methodology of technology assessment developed for that study are used as a basis for the specific strategy proposed for this assessment program. That approach is addressed exclusively to the task of identifying all significant impacts of the technology, since the technology itself is well defined. In this study two additional questions must be treated: the identification of all energy conserving techniques of potential significance, and the ordering of these techniques in terms of importance for detailed technical assessment. Since the methodology in these areas is less well

developed at ERIM, this proposal has emphasized their treatment.

In formulating this proposal it quickly became apparent that there is no structure to the research and development of energy conservation, and that a relatively small extension of the work of identifying the significant energy conserving technologies could lead to such a structuring. This additional work is included as part of the proposed effort. Research on the possible use of intervention strategies to evaluate impacts of proposed energy conserving methods will also be studied. Plans for the dissemination of results will be developed at the beginning of the study, and these will include, as one element, continued interaction between the study team and potential users throughout the contract. The following tasks summarize the work to be performed in this energy conservation technological assessment:

1. Refine study plan
   Identify major users and interested parties
2. Identify significant energy conserving technologies
3. Order these technologies according to their first order impacts
4. Perform detailed technological assessment of high priority technologies (identify and analyze impacts)
5. Formulate policy alternatives and recommendations
6. Define structure of energy conserving R&D
7. Disseminate results

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2. NARRATIVE

2.1 ENERGY POLICY

In January 1973 Senator Hollings introduced, on behalf of himself and Senator Magnuson, Moss and Tanney, S.70, a bill entitled "Energy Policy Act of 1973." Although this latest legislative action in the creation of a national energy policy is as visible as was the first Presidential message devoted entirely to energy issues on 4 June 1971, perhaps the action of greatest potential in examination and formulation of a U. S. national energy policy was the establishment under Ford Foundation support of the Energy Policy Project.

The Energy Policy Project (EPP) was established in Washington, D. C. in May 1972 in response to the observation that, of the large number of energy studies underway, much of the work is limited to technical problems and stops short of policy analysis. The Energy Policy Project is an attempt to make a significant contribution to the totality of the energy policy problem. The Project hopes to serve as a focal point for researchers who wish to extend their work into the policy field. The major goal of this Ford Foundation effort is the creation of a comprehensive framework for policy analysis.

S. David Freeman, former director of the Energy Policy Staff of the Office of Science and Technology, and now Director of the Energy Policy Project, recently noted that "...since New Deal days...government policy has been to try to keep energy costs as low as possible in order to stimulate ever-expanding use. This was right for the time, but now times have changed and the policy hasn't. The time has come to change habits and begin practicing energy conservation, even energy frugality." [27]

The need for a national energy policy has been widely acknowledged. Federal legislation is pending in a number of bills such as S-70 the Energy Policy Act of 1973; S-357, the Federal Research and Development Act; and S-1283 the National Energy Research and Development Policy Act of 1973.

S-70 would create a 3-member Council on Energy Policy in the Executive Office of the President to advise him and Congress on all energy policy matters. The Council would be directed to formulate a long-range, comprehensive energy plan and make policy recommendations, coordinate all energy activities of the federal government, and serve as a central collection point for all energy information.

S-357 would create a 5-member Federal Power Research and Development Board to finance R&D programs to develop new clean sources of energy specifically including solar and geothermal. The board would also be directed to investigate more efficient methods of energy transmission and utilization and encourage implementation of energy conservation practices. Funding for the program would be obtained by imposing a 1% surcharge on consumer electric bills.

S-1283, introduced recently by Senator Henry Jackson and 27 co-sponsors, would establish a multi-billion dollar* federal energy research and development program creating five federally funded, single-purpose corporations for development of geothermal, coal gasification, shale oil, advanced power-cycle, and coal liquifaction energy technologies. Mineral resources of the public lands would be available to the corporations whose goals would be to advance the potential energy technologies to the stage of commercial applicability.

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*"taken together, the program I propose...will increase Federal funding of energy R&D from the present level of less than $800 million to about $2 billion annually over a period of 10 years." Senator Jackson's statement [14]

S-70 and S-357 are almost idential to bills introduced in the 92nd Congress. S. David Freeman, frustrated with the slow pace of the legislative process in creating a central energy coordinating agency, suggested to the House Interior and Insular Affairs Committee in May 1972 that "... serious consideration should be given to taking action now to consolidate the significant energy R&D activities of the Federal Government into a single agency. AEC is the one Federal agency which has demonstrated the ability successfully to develop new energy technology. It has the technical talent and the laboratories. There is every reason to employ the AEC national laboratories on all aspects of energy R&D. The new agency would consolidate the many scattered R&D efforts in the Interior Department and the Environmental Protection Agency with the AEC's program. Its mission would be energy R&D, not any particular form." [28]

Freeman pointed out that funding for energy R&D is going to require a much larger financial commitment by the Federal Government as well as by the industry, but it is important that Government and industry both be involved especially as the technologies move closer to commercial reality.

In the same hearings, the late Dr. William T. Pecora, then Under Secretary, Department of the Interior, noted that President Nixon's proposed reorganization of the Executive Branch had "...recommended that the responsibility of energy and mineral resources be centralized in an energy and mineral resource administration within a new department of natural resources. Here, Federal energy policy will be integrated and will be developed..." [28]

The Jackson National Energy Research and Development Policy Act of 1973 (S-1283) represents a more aggressive approach to bridging the gap between

R&D and defusing the energy crisis. As Senator Jackson noted when introducing the Bill, "Even if a favorable 'economic and regulatory climate' were achieved, I question claims that research and development efforts would improve. Quite the contrary, favorable economic climates in the past have encouraged complacency and neglect of potentially favorable technological alternatives. Whatever R&D is being done, has been forced by adversity." [29]

Further evidence of the current unsettled state of affairs regarding federal energy plicy can be found in Congressional Hearings and proceedings of conferences such as Energy and Public Policy - 1972 held by The Conference Board in April 1972 [30]. The objective of The Conference Board Meeting was to attempt to define the complexities of the energy policy problem. The complexities were confirmed but, as noted by one participant, Harry Parry, an energy policy will not be easy to develop even if it could be decided in the absence of political issues that can be expected to influence energy policies in a very broad way. [30, p. 218]

The Senate Committee on Interior and Insular Affairs is about to conclude a comprehensive study of national fuel and energy policy and will begin to deal with specific recommendations for legislation and administrative action. An assessment of the economic, environmental, social, political and legal implications of new energy technologies, especially as related to the total energy problem, would be of great value to the efforts of the committee.

In a special message to the U. S. Congress, delivered 18 April 1973, President Nixon stated as follows, "properly managed and with more attention on the part of consumers the conservation of energy, [or supplies of coal, oil, and natural gas] can last for as long as our economy depends on conventional fuels."

"We must direct attention to conserving the energy available to us today. Energy conservation is a national necessity. I believe that it can be undertaken most effectively on a voluntary basis. If the challenge is ignored, the result will be a danger of increased shortages, increased prices, damage to the environment and the increased possibility that conservation will have to be undertaken by compulsory means."

"The single most effective means of encouraging energy conservation is to insure the energy crisis reflects their true costs."

"As a nation we must develop a national energy conservation ethic. We must explore means to limit the future growth in energy demand."

"We have issued new standards and guidelines, and have taken other action to increase and encourage better conservation of energy. Significant steps to upgrade insulation standards on single and multi-family dwellings were taken at my direction in 1971 and 1972. The General Services Administration is constructing a new federal office building using advanced energy conservation techniques."

"I am directing the Department of Commerce to develop a voluntary system of energy efficiency labels for major home appliances. I am directing that an office of energy conservation be established in the Department of the Interior."

"I urge again that we allow our local officials to use money from the Highway Trust Fund for mass transit purposes. Greater reliance on mass transit will do a great deal to help us conserve gasoline."

"We should not be mislead into pessimistic predictions of an energy disaster. We have the capacity and the resources to meet our energy needs if only we take the proper steps - and take them now. We must work to expand and develop our domestic supplies in order to meet long term energy needs."

"I asked the Congress to extend the investment credit provisions of our present tax law so that a credit could be provided for all exploratory drilling for new oil and gas fields."

"There should be no need for a nation which has always been rich in energy to have to turn to energy rationing."

On 25 March 1973 several weeks prior to the speech above, the acting director of the Office of Emergency Preparedness, Darrell Trent, speaking at a conference had stated that he did not expect the Federal Government, "to be forced to ration gasoline although certain states may have to impose their own restrictions on gasoline use due to short supplies."

A few days later one of the nations' top three oil producers announced that it would restrict gasoline distribution to the same amount purchased in 1972, although gasoline demands had risen by 7%. Earlier in 1973 the nations' largest gasoline marketer had set up a quota system for gasoline

deliveries. Also difficulty in securing supplies of increasingly scarce crude oil already had forced some small refiners in New England and the Midwest to close down operation.

On 1 May 1973 a short time after the speech, mentioned above, by the President, the Chairman of the U. S. Senate Interior and Insular Affairs Committee, Senator Henry M. Jackson, criticized Nixon's program as doing "little more than pay lip service to energy conservation" and criticized as "a passive approach" Nixon's emphasis on the price mechanism and voluntary consumer efforts in reducing energy use.

Earlier, Senator Ernest Hollings, who will preside over the Senate Commerce Committee's hearings on energy, had criticized Nixon's speech for lack of regulations to conserve energy.

Several months earlier, the Chariman of U. S. Senate's Public Works Committee, Senator Jennings Randolph, had indicated that the committee would establish guidelines to incorporate energy conservation practices in all new Federal construction including mandatory standards for Federal and federally insured homes and buildings.

On 1 May 1973 the Secretary of the Interior, Rogers Morton, urged American motorists to consider ways of saving gasoline in the face of a fuel shortage this summer. Morton urged American families to plan vacations closer to home, use trains, busses or airplanes rather than cars on long trips, and use automobiles only when necessary. He urged also that families limit the use of auto air conditioners and other fuel consuming accessories; drive 10 miles below the speed limit on super highways; put greater reliance on small cars; make more extensive use of mass transit; walk or ride bicycles on short trips; and keep car engines properly tuned and car tires properly inflated.

Several months earlier the Secretary of Commerce, Frederick Dent, had appealed to the nations' businessmen to conserve energy to ward off an impending fuel supply cirsis. In a letter to the chief executives of about 45,000 companies, Dent had suggested several ways in which the companies could curb evergy consumption including lowering thermostat settings and cutting off heat in unoccupied areas.

In the meantime many persons in government and in public interest groups were pointing out that long established government policies continued to encourage increasing consumption. For example, the Tennessee Valley Authority and the Rural Electrification Administration continue to provide electric power at subsidized prices to large areas in the nation. Each year, the Federal Government, through depreciation allowances and tax incentives, relinquishes approximately one billion dollars to the oil industry for exploration, development and cost depletion allowances.

To counter the prevailing trends, representatives of public interest groups have asked major changes in policy. Representatives of the Sierra Club, for example, have asked for the ending or drastic reducing of the many biases in public policies which provide incentives to energy growth, maintaining and strengthening environmental constraints on energy growth, reducing energy demands by educating the public to the importance of the conservative use of energy, and discouraging growth in industry as the most profligate users of energy. In a report prepared at the request of Senator Henry Jackson, it is proposed that whatever Government policies and regulations are established they should be designed to achieve reduction in demand at levels required under clearly defined circumstances of conservation need both in the short and long term.

Many means for reducing demands have been proposed; for example, in October 1972 study by the Office of Emergency Preparedness outlined changing energy use patterns and listed numerous specific steps which could be taken to reduce energy useage. Many well known economists have been advocating use of market pricing as a means of carrying out the policy of energy useage reduction. One method for accentuating the role of market pricing in depressing demand is the imposition of excise taxes on fuels and power using devices. In much of western Europe for example, automotive fuel is taxed much more heavily than in America and purchases of automobiles are taxed in proportion to horsepower. It has been suggested that a significant excise tax be applied in the United States to purchases of electric space heating equipment, of water heating equipment, of clothes dryers and electric ranges. Such taxation would tend to cause users to change to gas fuel applicances for the same purpose. Gas fueled units consume far less total fuel.

Other less dictatorial actions can also be effective. For example, the Civil Aeronautics Board some time ago permitted U. S. airlines to reduce competion on four U. S. trans-continential unit routes and the New York to San Juan route. With the reduced competion each aircraft was more fully loaded. The airlines had estimated that approximately 170 million gallons of fuel were saved thereby, and that further extension of this practice could lead to an annual fuel saving of more than 480 million gallons.

Some public utilities already are voluntarily restricting their use of promotional advertising. Some have even embarked on negative marketing, slogans such as "turn off unneeded lights" and "use good insulation."

Although such restrictions on promotional advertising to date have been done voluntarily by the utilities corporations, it is possible that the Federal Government or the State Government should either prohibit promotional advertising, or remove any tax deduction therefor.

At the present time virtually all industries which are intensive users of energy advertise extensively to increase sales. For example, the airlines industry both advertises extensively and also extends credit to its prospective passengers. Meanwhile the cost of constructing airports and of traffic controls systems is borne by the Federal Government which also subsidizes the development of high speed aircraft which are even more intensive users of fuel. Similarly the auto manufacturers advertise extensively to promote increased travel. Meanwhile the Federal Government, state and local governments subsidize the construction of roads and highways and distribute travel literature encouraging travel to their states.

Air conditioning manufacturers advertise intensively in the northern states during the few hot days of summer. In the southern states they have effectively destroyed the ancient tradition of the siesta.

Under these circumstances many interested persons doubt that calls for voluntary reduction of energy useage constitute an adequate response to the existing situation. Unless strong economic inducements and positive leadership are provided from national levels, they believe that energy useage will continue to rise.

In summary. In recent weeks, the President, after considerable delay, has stated his position on energy conservation: gradual price rises, which will be tolerated, should reduce demand; each individual is asked to

voluntarily reduce his energy use. The principal members of the Congress concerned with the subject have begun hearings for the first time on the subject of energy conservation. Initial statements by leading senators indicate that they will expect to consider more demanding economic inducements. Businessmen intimately and painfully effected by fuel shortages are beginning to seek other means of maintaining profits not totally dependent on increased energy useage. But most families and businesses continue to convert increasing yearly income into rapidly increasing purchases of energy intensive good and services. Most policies of Government at all levels encourage this action.

2.2. TECHNOLOGY

At first thought, energy conservation suggests actions such as a campaign for turning off unused lights or rationing of gasoline. However, voluntary campaigns or a new era of rationing or prohibition are not likely to be important aspects of an effective medium-term program to curtail the growth in consumption of energy. In the medium-term, there are many tools society can use to reduce growth in overall energy consumption or in consumption of a particular type of energy. The effectiveness in curbing growth in energy consumption with minimum deleterious impacts depends in part on which social tools are employed. The scope of these social tools is indicated in Table 1. These are price related and non-voluntary tools, legislative, executive, judicial and private tools, and federal, state, and local government tools. Having thus emphasized the scope of social tools we immediately stress the systems view of energy conservation in which social and physical aspect are considered together.

An energy conserving technology is a system for modification or substitution for an energy consuming process in the economy which is designed to satisfy the same general need more efficiently. An energy conserving technology will generally involve a system of both physical processes and related social processes. In practice, the goal of energy conservation as treated here is reduction in the growth rates of energy consumption in the United States, and, in particular, the reduction in the growth of consumption of a particular type of energy, e.g. electricity or natural gas. The primary questions for the assessment concern technological feasibility and

TABLE 1

Categorization by Predominant Conservation Technique

1. Technical
   - Solar appliances
   - Waste disposal and recycle systems
   - Conserving manufacturing techniques

2. Economic
   - Overall price rise
   - Rate structure (utilities)
   - Credits and allowances
   - Subsidies
   - Taxes
   - Internalization of costs (e.g., of pollution costs)

3. Regulatory (legislative or administrative)
   - Restriction of activities or processes
   - Establishment of standards (e.g., housing insulation, appliance efficiencies, etc.)
   - Import regulations and quotas
   - Regulation of promotion of energy consuming activities

4. Government
   - Government market used as test
   - Government provision of services

5. Social
   - Consumer information
   - Public persuasion
   - Institutional development

economic cost, as well as the effectiveness of the technology in diminishing growth of energy consumption. In addition, social acceptance and impact must be considered. The assessment will concern medium range technologies, i.e., not those which might be adopted for a season in the immediate future in order to mitigate an immediate crisis, nor those which would not have significant impact for at least 15 years in the future, but technologies which could be significant in roughly a 1 to 10 year time span.

We include here two independent approaches to the technology of energy conservation, which are interesting for both their similarities and differences. The first, by a project physicist, is highly detailed in nature and probes the technical basis for conservation strategies. The second is an economic analysis prepared by Klauss Heiss (a consultant for the project) in conjunction with Klaus Knorr and Oskar Morgenstern as part of a forecast study (Ref. 23) for the Office of Naval Research. The emphasis here is much more macroscopic. These companion analyses, prepared for entirely different purposes, illustrate the diversity which can be brought to the study by the project members.

Technology of Energy Conservation (Physics):

In Table 2 we list energy comsumption levels by end use. If increased efficiency in use of energy is to have a substantial effect on the growth rate of consumption in energy it must in practice involve major energy use sectors and should moderate the growth in strong growth sectors. In Table 2 we see that residential and commercial space heating, water heating, refrigeration and air conditioning are important areas, with air conditioning, excluding industrial use of air conditioners, estimated as 8% of all growth. End use information in the commercial sector is unfortunately

TABLE 2

Energy Consumption in the United States by End Use*

Sector and End Use	Comsumption 10^{12} BTU 1968	Percent 1958	Annual Rate of Growth	Percent of Total Growth	1973 Estimated Percent of Total Growth**
Residential					
Space heating	6,675	11.0%	4.1%	10.5%	
Water heating	1,736	2.9	5.2	3.4	
Cooking	637	1.1	1.7	0.5	
Clothes drying	208	0.3	10.6	.7	
Refrigeration	692	1.1	8.2	1.8	
Air conditioning	427	0.7	15.6	1.7	4
Other	1,241	2.1	5.5	2.4	
Total	11,616	19.2	4.8	20.9	22
Commercial					
Space heating	4,182	6.9	3.8	6.1	
Water heating	653	1.1	2.3	0.6	
Cooking	139	0.2	4.5	0.2	
Refrigeration	670	1.1	2.9	0.8	
Air conditioning	1,113	1.3	8.6	3.1	4
Feedstock	984	1.6	3.7	1.4	
Other	1,025	1.7	28.0	5.0	
Total	8,766	14.4	5.4	17.3	19
Industrial					
Process steam	10,132	16.7	3.6	14.2	13
Electric drive	4,794	7.9	5.3	9.3	
Electrolytic processes	705	1.2	4.8	1.3	
Direct heat	6,929	11.5	2.8	7.9	7
Feed stock	2,202	3.6	6.1	4.8	
Other	193	0.3	6.7	0.5	
Total	24,950	41.2	3.9	37.9	36
Transportation					
Fuel	15,038	24.9	4.1	23.9	
Raw materials	146	0.3	0.4		
Total	15,184	25.2	4.1	23.9	23
National total	60,526	100.0%	4.3	100.0%	100.0%

Footnotes for Table 2

*Source: "Patterns of Energy Consumption in The United States," Stanford Research Institute, Office of Science and Technology, U.S. Government Printing Office, (Jan. 1972).

**Estimates based on a continued exponential growth model are shown only in cases where over one percent change is indicated going from 1960-68 to 1973.

very crude because of the very widely ranging business and institutional entities represented. Lighting is an important sector but has not been accurately isolated in the commercial area. The "other" category is undoubtedly in error. The commercial feedstock item mainly involves road construction and maintenance. The importance of process steam in the industrial sector shows possibilities for use of low quality energy and a large potential for fuel savings. A great deal of averaging is involved in information on the industrial sector so that no area of very rapid growth is apparent.

The Federal Power Survey has presented a history in constant dollars of the average price of electricity in the 20th century. The declining rate is only a part of the story. The cost of energy used within a sector is relatively low. Consider basic steel, an energy intensive industry, it directly used 0.16×10^6 BTU per dollar added in 1968, or an energy cost of about 11 cents per dollar added. The average industrial activity in the U. S. involves a 4 1/2% direct cost for energy. It is reasonable to infer that since energy has been of minor economic importance in most activities, its use is often inefficient from an energy view point and is sometimes wasteful.

Here waste refers to energy whose use is only haphazardly related to needs, for example because of ignorance. Efficiency refers to energy consumption required to carry out a particular function. Efficiency can be discussed from a physical standpoint. The absolute efficiency of a power plant, of lighting and of certain industrial processes, e.g., in chemicals, is a powerful quantitative concept. Many such efficiencies have gradually been brought to a high level. e.g., 40% for a fossil fuel fired steam electric plant. Further improvement can still be anticipated. The scope

for such improvement can be discussed in terms of the absolute efficiency. In many areas of energy conversion absolute efficiency is not a very meaningful concept. In most of these areas it is clear that the same functions could be served with much much lower energy consumption. Consider space heating as an example. The consumption of space heat depends on loss of heat from the space in question. Very effective insulation and locks for ingress and egress could reduce the need for added heat to an arbitrarily small value. Quite aside from this lack of definition, if the heat loss from the space is specified there is still not a unique definition of the minimum energy needed to make up this loss. The more conventional definition is typically ten times that which a thermodynamicist would prefer.* Thus a statement that a good furnace is 70% efficient does not begin to suggest the improvements in efficiency which might in principle be effected in space heating. We conclude that only in a few important areas is absolute efficiency a useful guide to the savings which might ultimately be achieved by technological developments. In most end uses very substantial improvment of energy efficiency is possible in principle.

We categorize energy conserving technology in the sectors: residential and commercial, and industrial, singling out the energy industry and agriculture for separate attention. In Table 3. residential and commercial

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*The most conventional minimum equates the heat value ΔH of fuel to the loss. Another minimum is obtained by multipling the maximum work ΔG inherent in the fuel by the coefficient of performance of a perfect heat pump, $T_i/(T_i - T_o)$, where T_i is the inside absolute temperature and T_o the outside. The fuel heat value in the latter will typically be less than one tenth the former.

are tabulated. The industrial technologies are presented in Table 4. Only limited aspects of, or somewhat vague generalities concerning, the complex commercial and industrial areas will be presented here. Detailed knowledge is lacking for many aspects in these two areas and so the technology assessment will of necessity involve a heavy effort in data collection in these areas as compared to the residential sector. Transportation, except for transport of energy, is omitted from consideration, as a practical response to the requirement of the request for proposal to omit road vehicle energy consumption.

These lists are not claimed to be complete. There was no desire to include any type of technology with clearly small impact on the growth in energy consumption. Furthermore the set of important energy technologies which are good candidates for feasibility is certainly not established. Research is needed to make it unlikely that important possibilities will not be overlooked. For simplicity of presentation, we have not placed emphasis on substitution for scarce fuels (OEP2) in our compilation.

One pervasive energy conserving "technology" is increase in the price of energy to buyers at various levels. General price increases will be discussed here while specific regulations or taxes impacting particular customers are listed as separate items in Tables 3 and 4. An increase in the price of energy will, in time, lead to a reduction of consumption, compared to expectations in the absence of price increase. Elasticities of energy demand are not well known, although some studies have been made of residential consumption of electricity. As an energy conservation measure, price increase has the advantage of allowing consumers to make their choices

and to make them in a multitude of complex ways. This behavior contrasts with regulation which involves the cost of a bureaucracy and a relatively simple pattern in the change in consumption.

The price of energy, the structure of prices and possible general increases in price, is impacted by government in many powerful ways: (1) imposition of an "energy tax", perhaps at the level of initial fuel production to enhance efficiency at all stages, (2) change in controls which immediately affect prices, e.g., prorationing, import controls, depletion allowance, fast tax write-offs, price controls at retail and at well-head, (3) changes affecting the availability and price of investment capital, and (4) change in other practices eventually affecting cost of extraction, processing and transport of energy, e.g., lease of public lands and off-shore areas, environmental regulations, subsidies of, or federal participation in, energy supply facilities, government provision of development cost, and anti-trust regulation.

The number appearing in parentheses for each major category in Tables 3 and 4 is an estimate of the percentage of total growth in U. S. energy consumption which takes place in that category.

TABLE 3

Residential and Commercial Energy Conservation

A. Space Heating and Cooling and Water Heating (28%)

A1. Improved Conventional Space Conditioning Systems

a. Insulation-infiltration Controls

Existing structures (NMWI 34), New Structures (RAND57,NMWI 31)

Mobile homes (Tansil) (NYLB A1, A-5)

Tax, mortgage incentives (NYLB 15, NMWI 9)

Consumer information

Construction, performance standards (NYLB 15, NMWI 8)

b. Improvement of conventional heating system technology.

Maintenance of furnace and air conditioner (OCA7, OCA11)

Develop easily cleaned furnace, Heat recovery devices (RNAD78), develop control technologies

Performance, maintenance standards

Tax incentives

R & D support

Consumer information (RAND45)

Government maintenance services

Government operations

c. Direct impact on installation of efficient vs. inefficient systems.

Deter electric heating (Perry A, NYE), Deter inefficient air conditioners (NYE)

(continued)

Construction, performance standards

Consumer information

Restrict promotion, rebates (RAND33)

Government operations (NYLBA2)

d. Increase operating cost of inefficient electric systems

Rate structure basis

Rate structure, special categories (FPC2, RAND42)

Rate structure, block (NYIR, DE, FPC1)

Rate structure, peak (RAND100)

A2. Non-Conventional Technologies

Building design adapted to sun and climate (RAND54,56,79,85)

Solar devices, esp. water heaters (Berg30, RAND59)

Total energy - waste heat system (Berg21, NYLB A-53, Perry 54)

Heat pump

Taxes, subsidies

Institutional R & D (JPL)

Equipment R & D

Consumer information

A3. Energy Efficient Buildings

a. Enhance energy efficient multiple-unit housing

(RAND55, Hitt, Peoples)

Planning, zoning

Construction standards

Taxes, subsidies

Institutional R & D (JPL)

(continued)

b. Replace energy inefficient structures

A4. Moderate Operating Temperatures

Persuasion (OCA7, OCA11)

Rate structure, peak

B. Major Appliances (Stoves, Dryers, Refrigerators, Freezers) (4%)

B1. Improved Design

a. Insulation

Performance standards

Consumer information

b. Improved efficiency through design (OEP1 D-7)

Access to commercial cold Storage, Heat loss in stoves, dryers,

Ease of maintenance

Tax incentives

Equipment R & D

c. Pilot light improvement

Construction standards

B2. Purchase of Efficient vs. Inefficient Devices (See A1c and A1d)

C. Lighting (2%)

R & D efficient lighting (NYLB A-31)

Reduce lighting level standards (Dubin5, Stein 4)

Building design adapted to daylight

Restrict illuminated advertising

D. Municipal Organic Refuse

Use as a fuel (Perry 54), Feedstock to make fuel (Perry 59, USBM)

Subsidies

Government R & D

TABLE 4

Industrial Energy Conservation

A. Efficiency in Manufacturing

A1. Individual Manufacturing Processes

a. Modern techniques

Enhance capital investment in energy efficient recent technologies

R & D on energy use in industry (Berg 12,20)

Investment incentives (OEP1 E-15)

b. Clean burning of abundant fuels

R & D on physical Technology (Hottel)

Regulations

Tax incentives

c. Increase cost of inefficient or scarce fuel systems

Restrict availability of fuel (RAND 42)

Interruptable service

d. Relax pollution constraints where they impose a large energy burden (Hirst, NPC)

A2. Waste Heat Utilization

R & D (Berg 21)

Tax incentives

A3. Recycle of Materials (OEP E-17, Bravard)

Institutional R & D

R & D on physical technology

(continued)

Regulation

Tax incentives

Government services

Government operations

A4. Durability of Products

Regulation

Tax incentives

Consumer information

Government operations

A5. Inhibit Sale of Energy Intensive Goods and Services

Taxes (see text)

Persuasion

Regulation

Government operations

B. Efficiency in Agriculture

B1. Fertilizer Management

B2. Agricultural Waste -

Especially feedlot waste (USBM)

C. Efficiency in the Energy Industry

C1. Electric Utilities

a. Central station efficiency

Enhance short term storage to smooth peak (Perry 33)

Expedite completion of new efficient plants (OEP F-19)

Rates and regulation to smooth peak (OEP F-23)

Relax pollution constraints (see III A1d)

(continued)

b. Transmission improvements (Perry 29)

c. Dispersed generating systems

Total energy system (see IIIA2 and IVA2)

Fuel cell installations

d. General price increase (see text)

C2. Fossil Fuels Price

a. Extraction (Perry 19)

b. Processing (Perry 24)

c. Transport (Perry 27)

d. General price increase (see text)

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Technology of Energy Conservation (Economics):

There is ample room for adaptation between different energy resources in final demand patterns, and in conversion and distribution systems. Figure 1 shows the situation for the United States, in 1970, in the use of energy resources, their transformation to final demand, useful work and waste. Within the circles, numbers within parentheses show the energy contribution in units of 10^{15} BTU, while numbers within rectangles give the percentage contribution made at that stage. The total contribution (in units of 10^{15} BTU) at each stage is given in the rectangle at the bottom of the column. The numbers above the lines from one stage to the next are percentages, and the numbers in parentheses below each line give the amount. From Fig. 1 it can be seen that about 50% of the total energy resources consumed in the United States in 1970 were, ultimately, wasted. This was about 1.1 billion tons of coal equivalent, to which the ecological costs must still be added. However, in order to gain a better insight into useful versus waste energy in the United States, one has to look at the particular transformation process, first in a very aggregate sense, within the United States. In Fig. 1 is shown the rough breakdown of energy resources supplied for United States' energy consumption: natural gas and natural gas liquids, petroleum, and coal, hydroelectric power and nuclear power. The two major sources of the United States energy supply, namely natural gas and petroleum, are the resources identified as particularly scarce over the next 10 to 20 years, even within the United States. Nuclear power and hydroelectric power make up only minor amounts within the overall supply of energy resources to the U.S.

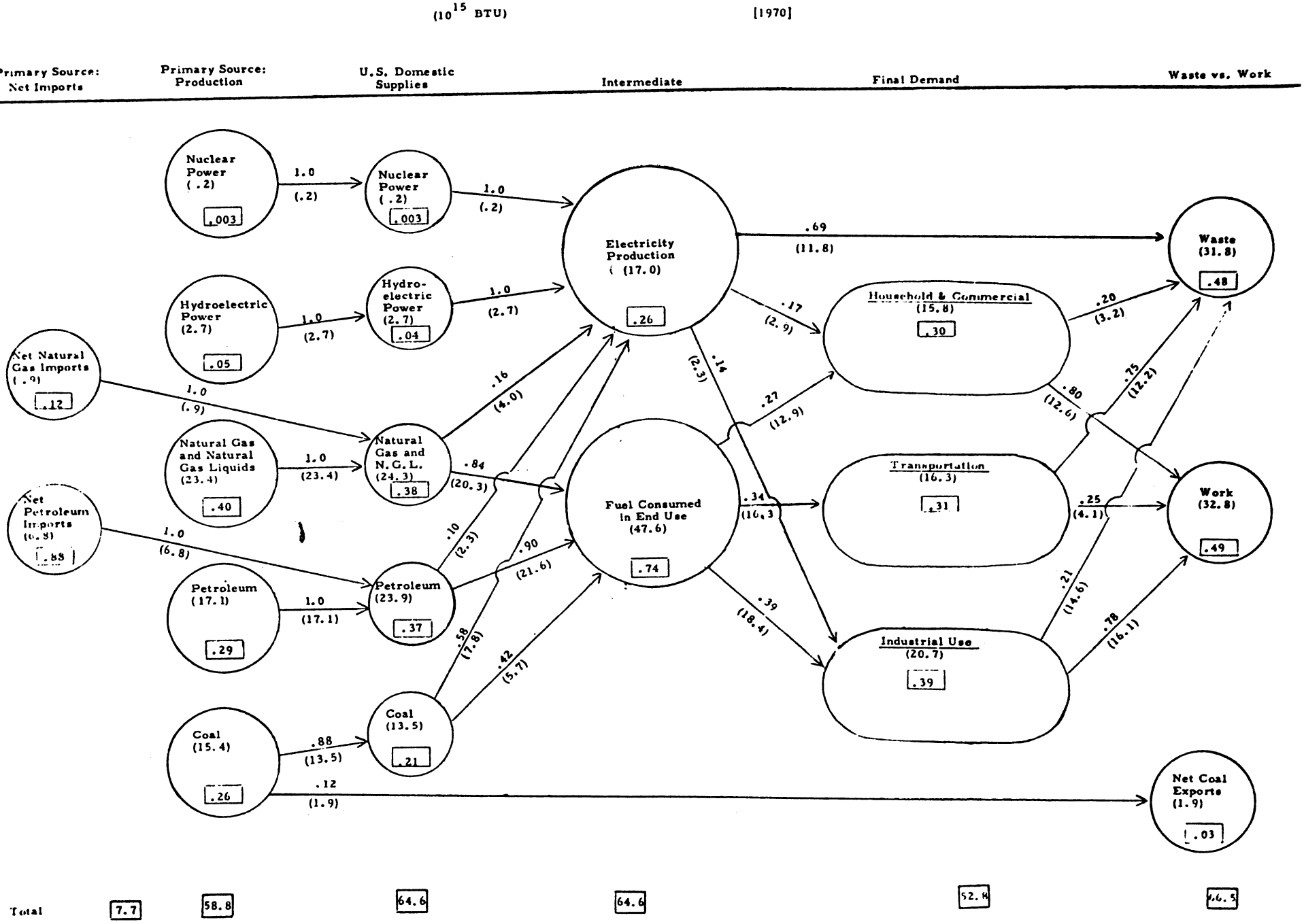


FIGURE 1. U. S. Flow of Energy Resources From Production to Final Use

Any one of these sources is then put to two possible uses: production of electricity and fuel for direct consumption. Roughly, 25% of all the energy resources produced in the United States go into the production of electricity. From Figure 1 we see that, of the total electricity produced, a very large amount, that is, 70% is energy lost in the process of generation and transmission of electricity. Only about 30% of the electricity is finally used in households and by commercial as well as industrial users. There seems to be a major opportunity in research and development as well as price policy for energy resources, to either restrict the consumption and production of electricity substantially, or (a much more likely and desirable way) to increase the efficiency of electricity generation, transmission and use. For example, doubling the overall price of energy or of electricity alone, would lead to completely different benefit-cost analyses results of research and development projects. Electricity generation, electricity transmission, and final uses of electricity, which were more efficient through introduction of new technology, could be justified with the new price system, even though more costly and expensive. Similarly, with the introduction of an energy waste penalty function a similar effect would be induced.

Given the wate pattern of United States energy use, there seems to be a particular opportunity for further benefit-cost and economic analyses as to the price structure, (the introduction of political prices!) which would lead to a new pattern of electricity generation and electricity transmission to final use.

More than two-thirds of the total energy resources produced go now to the production of fuel for end uses. Of these, the demands for fuel by household and commercial users, for transportation, and for industrial users are about equally large. Household and commercial users as well as industrial users incur a relatively small amount of waste: the former waste about 20% of their energy inputs, the latter waste about 25% of the inputs.

For the third major user of fuel -- the transportation sector -- (about 30% of the total energy consumed in the United States), we notice that about 75% of the energy inputs used for transportation are wasted. Only 25% of the energy used for transportation is transformed into useful work energy under a hypothetical 100% efficient -- zero loss -- transformation of the energy inputs. Again, it seems to us that through an improved price policy or a waste energy penalty function, the introduction of more efficient systems can be brought about.

2.3. PHILOSOPHY OF TECHNOLOGY ASSESSMENT

Technology assessment is a rapidly growing field. Appropriately defined as "the systematic study of the effects on society that may occur when a technology is introduced, extended, or modified, with emphasis on the impacts that are unintended, indirect, and delayed" [4], technology assessment is not merely a scholarly investigation of cross impacts between technology and society, although such an investigation is an essential part. More importantly, technology assessment is policy-and action-oriented. The results of technology assessment are expected to change or influence policy decisions. This orientation stems from the milestone events that contributed to the establishment of technology assessment as legitimate and substantive programs within the realm of governmental activities in the United States. These milestone events were the proposal in Daddario's bill to establish a Technology Assessment Board [5] and the formal establishment of the Office of Technology Assessment in the U. S. Congress [6].

The policy and action orientation makes technology assessment itself more a technology than a science, with all the implications of the difference between science and technology. Consequently the philosophical and methodological approaches to technology assessment are multifarious, as a review of the many on-going and recently completed projects [7] would reveal. The conclusions of recent methodological studies [8], [9], as well as those of earlier reports by blue-ribbon panels [10], [11], [12], are similar and congruent in terms of the general steps to be taken and the general considerations to be included. However, the specific methods for determining the unintended, indirect, and delayed social effects of a given technology are

diverse, unrigorous, and judgmental so that different teams of equal competence are likely to give different results of technology assessment -- results which are different in emphasis and are of different usefulness to the decision makers.

Additional complexity, and even confusion, arises as the scope of technology is defined differently by different people. This is particularly important in the present proposal as the scope of "technology of energy conservation" must be clearly defined before one can do technology assessment of energy conservation methods. There is nearly universal agreement that technology includes physical artifacts, such as the use of thermal insulation materials and techniques in building construction, the use of waste heat from power plants as space heat, etc. However, of at least equal importance, social technology for energy conservation must be considered as well. Examples of using, and stopping the use of, social technology to conserve energy include:

1. Increase foreign oil imports;
2. Ration gasoline and other fuels;
3. Remove artificial support or limitation imposed by the government on fuel market price;
4. Impose building codes on thermal insulation, use of glass, etc.
5. Establish an inverse rate structure for energy pricing.

We agree with the statement that "just as a minor alteration in a physical technology may have profound side effects, so a minor alteration in a nation's social technology can have many important consequences undreamed of by the legislators or others who approve the alteration" [4].

In our proposed work, both physical and social technologies of energy conservation will be assessed.

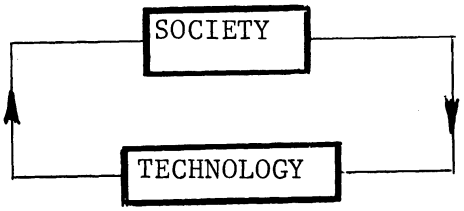
In terms of more general philosophy, one can argue that technology is a part of our metaphysics -- a part of our intellectual heritage, a component of our view of man and of society. Such an argument leads to the conclusion that "valid" technological knowledge must be "both technologically possible and socially desirable when it does not result in long-range, unintended, detrimental social and individual consequences" [13, 14]. These views are entirely congruent with, and indeed espoused by, technology assessment. Although the National Academy of Sciences report [11] did not discuss those ultimate philosophical issues posed by such philosophers as Ellul [15] and Ferkiss [16], the report referred to this part of the literature and made recommendations which are clearly though tacitly based on the following philosophical assumptions [17]:

1. Technological innovation can be both beneficial and disruptive to social and environmental systems.
2. Regulation, control, and planning of technology are necessary, rational and moral.
3. Technological impacts can be rationally forecasted and controlled.
4. Only some forms of technological growth are necessary and good.
5. Technological change is necessary for societal survival.

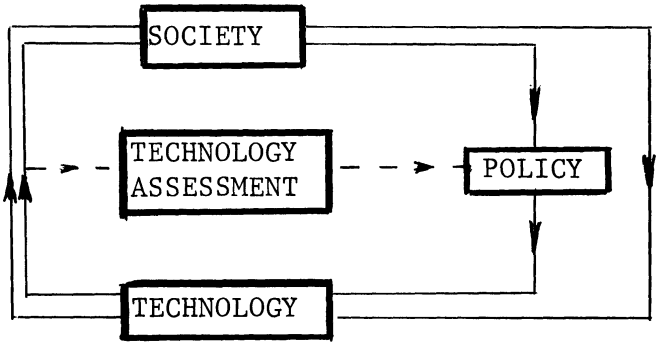
This new image of technology and society contrasts with the traditional image which is characterized by a complete faith in progress through science and technology and by the extollment of laissez faire technological development.

The above philosophical underpinning of technology assessment is important. For it can be used to both suggest and evaluate methodologies for technology assessment. For example, the first assumption leads to the suggestion of a mixture of members on the technology assessment team so that both positive and negative side effects of technology (both physical and social) in a number of aspects will be ascertained. The second point suggests an early involvement of policy decision makers and the choice of time horizon and schedule of technology assessment such that the results will be useful for timely decisions. The third point requires technological forecasting as a part of technology assessment and that the results be utilized to control or redirect the technology under assessment. The fourth point suggests the identification of social groups affected by the technology, the impacts on them, and the subjective evaluation of the impacts by these groups. The fifth point suggests that, in case of fundamental conflicts, societal survival be used as an ultimate criterion for judgment.

The above philosophical approach would interject technology assessment as a conscious effort to modify the process of certain technological development, as conceptually shown in Figure 2. The reciprocal relationship between technology and society is extremely complex and there is no proven theory for predicting the cross impacts between technological and social changes [18]. Even limited respects in which technology can bring about change in society can only be suggested on a speculative basis [19]. In terms of achieving its ultimate objective of insuring the social desirability of technology (even if we can agree on what is socially desirable), technology assessment faces at least two major practical limitations. First, in the foreseeable future, only a very small fraction of all technological development



(a) Reciprocal relationship between technology and society without technology assessment.



(b) Technology assessment modifies certain technological development.

FIGURE 2 The Role of Technology Assessment

can be assessed. Second, our knowledge of technology-society relationships is too limited to permit any thorough and reliable assessment.

To alleviate the first limitation, the effort of technology assessment in the near future should be focused on those technologies which are likely to exert very significant impacts on society and which are in sufficiently early stage of development still subject to effective control. Based on these criteria, energy conserving methods certainly rank very high as compared to any other technology in the contemporary society. Whether these methods succeed or fail to achieve their primary objectives of conserving energy, the direct and indirect impacts on society will be profound.

The second limitation is a serious one. The lack of a good understanding of technology-society relationships means that technology assessment cannot be conducted entirely in a rigorous scientific manner. Many important side effects may not be discovered until too late in spite of conscientious efforts; some predicted side effects may not come true; and recommended policy reforms may either be ineffective or produce detrimental side effects themselves. Yet the side effects of technology are too urgent to delay effective control of technological development. To wait for much better understanding of technology-society relationships before conducting technology assessment is to ask time to stop.

To cope with this second limitation, technology assessment must be imbedded in a social learning process [20]. The decision making organizations involved in the process must be adaptive, eager to use feedback, and "error-embracing" [21]. The intellectual process in technology assessment should not be undertaken as a once-through exercise. Rather, after the initial effort,

a monitoring and surveillance program must be set up to update and implement the results of technology assessment on a continuing basis [4]. For this reason, a major effort of our proposed work will be devoted to a feasibility study and a preliminary design of a monitoring study and surveillance program, which will include a mixture of consumer survey, data gathering from selected communities in the U. S. and abroad, and deliberate social experimentation.

2.4. METHODOLOGY

General Methodology:

Technology assessment has been defined as the "...systematic identification, analysis, and evaluation of the potential impacts of technology on social, economic, environmental, and political systems, institutions, and processes." (24) This analytical process intends to identify along with the obvious and direct consequences, those unintended consequences, whether detrimental or beneficial, of new technological developments through a consideration of the second and higher order impacts on society resulting from the utilization of new technologies or a significant change in the application of an existent technology. The desired results of a technology assessment include information on options, useful to decision makers. The performance of these impact analyses can help policymakers to recognize the potential ability of certain action options to constrain negative impacts and exploit the beneficial aspects of new technologies in as many different fashions as possible. Although the narrowly defined primary effects of new technologies are usually well known, technological and social innovations may now be necessary in order to modify, block, establish controls, stimulate research and development, and/or maintain constant surveillance over new technologies whose utilization may have potential benefits or unwanted consequences on society. To be credible a technology assessment must provide a balanced look at all alternatives, options, and possible outcomes.

Inherent in the philosophy of technology assessment, as it has developed so far, is the underlying assumption that the technical activity being assessed is rather narrowly defined, and that the options to be considered are primarily technical. The overriding emphasis

of the technology assessment is then placed upon the determination and analysis of all relevant consequences of importance. Technology assessments of the impact of remote sensing of the environment and of terrestrial solar energy resource development have this character, and fairly represent the emphasis of the studies which have been done.

The methodology developed for technology assessment has, as a consequence, also concentrated upon impact analysis. In the brief period of time since technology assessment has been recognized as a distinct discipline an extensive literature has developed. The MITRE Corporation report (25) on their methodology of technical assessment and the National Academy of Engineering report (12) are basic studies in the field. At The University of Michigan and at ERIM there has been a concern with technological assessment methodology for more than a year (22). The principal participants in this work have been Kan Chen of the Electrical and Computer Engineering Department at The University and George Zissis at ERIM. Both are available to this study of the technological assessment of energy conservation; Chen as a formal consultant, and Zissis for informal consultation as Chief Scientist of the ERIM Infrared and Optics Division.

Chen (22) has suggested two basic types of methodological structures for use in technological assessment: scanning methods, which employ a direct, intuitive, single-stage approach to the problem; and tracing methods, which use an analytical, multi-stage progression to uncover potential impacts. There are several techniques available for each general method, and any technique can be used by individuals or groups. (For technologies which have a broad range of impacts, an individual expert is clearly at a disadvantage due to the limitations in his expertise.) Chen has identified five scanning techniques. These are:

1. Examining the ability of a technology to generate some major impact.
2. Identifying a range of social problems, and examining the effects of directing the technology to solve these problems.
3. Starting with various disciplines considered appropriate (e.g., economic, environmental, social, political, legal, etc.), and examining the effects of a technology in these disciplinary fields.
4. Establishing a comprehensive checklist of potential consequences, and examining the ability of a technology to produce these outcomes.
5. Idenfifying a set of major social values, and examining the effects of a technology upon this set.

The tracing method techniques include relevance tree structuring, used in decision analysis; selective sequence techniques, which isolate one branch of the tree structure for more thorough analysis; dynamic system modeling; input-output analysis; simulation modeling, for investigating the interactions in a complex feedback system; and morphological analysis, which lists all important dimensions of a problem, lists all possible outcomes along each dimension, and then examines them for feasibility, plausibility, and desirability. The ERIM project working on a technological assessment of remote sensing has extended a decision tree analysis originated by MATHEMATICA, Inc., has generated scenarios, and has also begun an input-output analysis in that study. In this technological assessment of energy conservation we will examine these efforts and their results for applicability.

Specific Methodology for Technology Assessment of Energy Conservation:

The technology assessment of alternate strategies and methods for conserving energy is made difficult by several factors. The most

significant are:

1. The technology of energy conservation extends overs an extremely wide range of technical disciplines, in contrast to specific technologies, such as solar energy.
2. Economic, social, political, and legal factors enter not only in the consideration of impacts, but can also be important methods or techniques of energy conservation. The "technology" involved now extends far beyond the bounds of the conventional technology.
3. Energy conservation is not a well-defined discipline in itself. As a result the pertinent activities, literature research sponsors, and decision makers are diffuse, and identifying the significant energy conserving methods and the appropriate decision makers is a highly complex task.

Three major problem areas have been recognized to exist in the performance of the study. These are:

1. the identification of all significant energy conserving techniques
2. the selection of the most promising of these for detailed technical assessment
3. the determination - for each selected technique - of all relevant effects and consequences

The essence of our approach to these problems is the assembly of a study team with demonstrated competence in a wide range of specialties and which represents a diverse range of interests. The core group of the team includes an energy technologist, a systems analyst, an economist, a lawyer, a social researcher, an environmentalist, and a former Representative and currently business executive and engineer. These participants are from ERIM and The University of Michigan.

Discussions have also been initiated with a major petroleum company, electric utility, gas utility, a labor union, and a state administrative unit and each organization has expressed strong interest in providing a participant in the study at its own expense. In addition, consultants with competence in energy technology, economics, technological assessment, urban administration and communication arts have made commitments to participate.

It is the third of the problems listed above which is the normal domain of technology assessment. For this study of energy conservation, the first two problems also loom large. A block diagram of the study methodology to deal with these problems is shown in Fig. 3. Time begins at the top of the diagram and progresses downward. The study will be partitioned into a number of tasks, each of which corresponds to a specific portion of the diagram. These tasks are discussed below.

Task 1. Refine the study plan

This task includes blocks 1, 2, and 4 of the diagram. The team will be organized and a common philosophy and language for the technology assessment will be developed. Several intensive seminars will be held to develop a unified understanding of energy consumption and technological assessment. A morphology of energy consumption will be constructed, initially as shown in Table 2 of Section 2.2. This morphology will be expanded in detail and also extended backwards to include energy consumption in the production, transportation, and storage of energy commodities.

In parallel with these efforts, representative decision makers who have an interest in the study outcomes will be identified. They will be associated with legislative and administrative functions of federal, state, and local government, with concerned industry and labor entities,

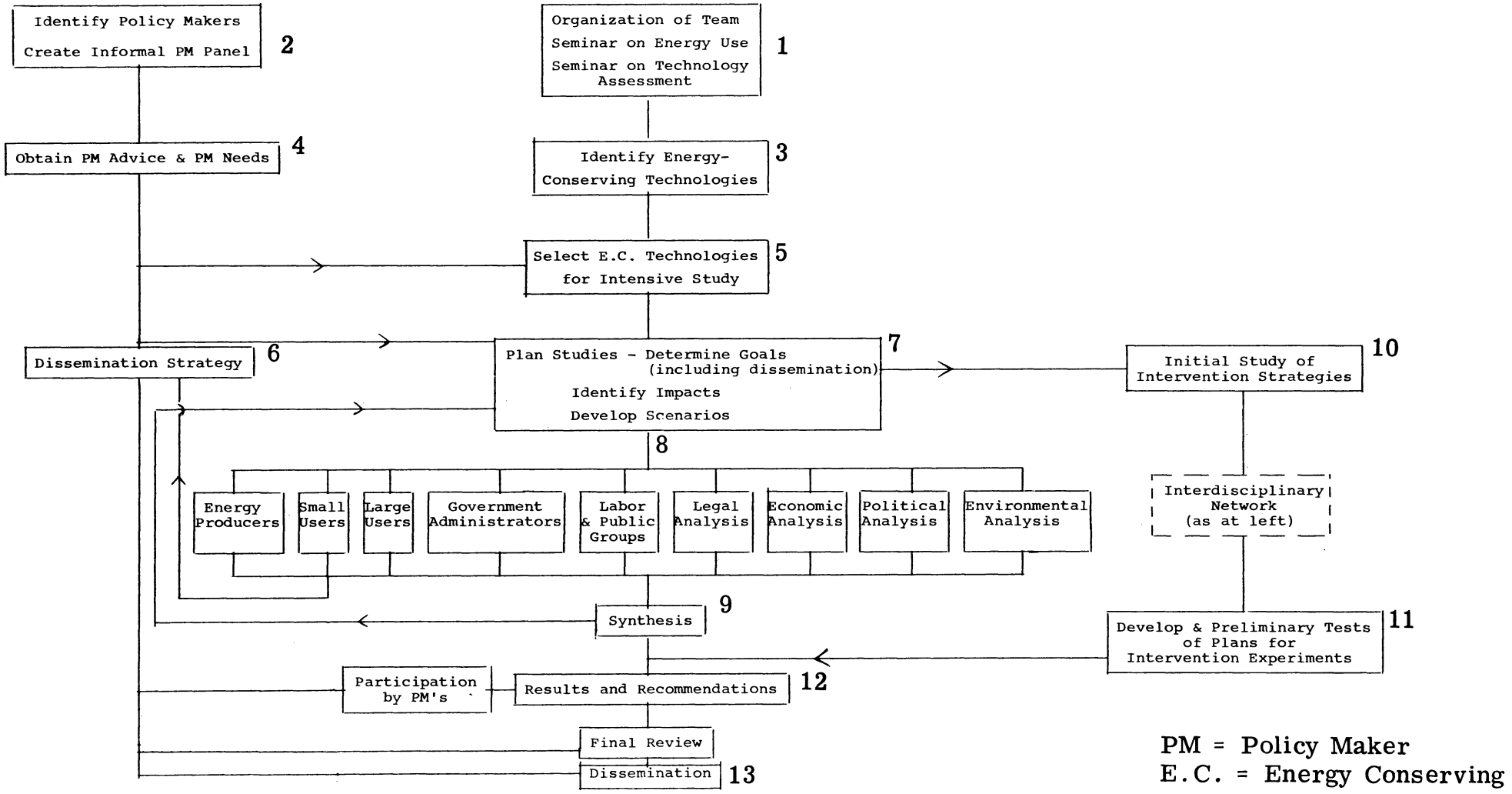


FIGURE 3 Block Diagram of Study Methodology

and with R & D sponsorship. (See Table 6). Contact will be maintained with them throughout the study on an individual basis, and — where possible and desirable – in groups. These people will be asked at appropriate points in the study to help in: (1) specifying desirable study outputs, (2) defining criteria for choice of energy conserving techniques, (3) specifying useful reporting formats, and (4) providing realistic political and administrative insights. This continuing interaction throughout the study will also be a major element in the dissemination process.

Task 2. Identify potentially significant energy conserving technologies

The technologies of energy production and conversion are highly active ones, and are constantly subjected to review and evaluation [1, 2, 3, 28]. Though the emphasis of these reviews is not upon energy conservation per se, their treatment includes most technological energy conservation techniques applicable within their domain of interest. Similarly, the literature on industrial technology provides a satisfactory basis for selecting the available techniques for energy conservation in specific industries, including the building industry and agriculture. Because of the availability of this material, this technological assessment will concern itself with a critical review of already proposed energy conserving physical technologies and evaluation of their potential applications.

As stated in Section 2.2 only medium range technologies will be considered for assessment, i.e., those which could have a significant effect on energy consumption within a decade (or at most two). For these technologies, the social and economic impacts might extend still farther into the future. For long range technologies whose significant effect on energy consumption is beyond about 15 years, analysis of the

TABLE 6

POTENTIAL USERS

1. Federal Departments and Agencies

Department of the Interior, Office of Energy Conservation
Department of Commerce
Environmental Protection Agency
Department of the Treasury, directing the Oil Policy Committee
Office of Management and Budget
Atomic Energy Commission, Office of Technical Assessment and Laboratories
Department of Transportation
Department of Agriculture
Department of Housing and Urban Development
Department of State
National Bureau of Standards
National Science Foundation
National Aeronautics and Space Administration
Office of Naval Research
Federal Power Commission
Department of Defense, DARPA

2. Michigan State Agencies

Department of Commerce
Department of Natural Resources
Department of Attorney General
Executive Office
Department of Labor
Department of State Highways

3. Industrial

A. Primary — Energy Generators
The Petroleum Industry
The Natural Gas Industry
Electric Utilities
The Coal Industry

B. Secondary — Intensive Energy Utilization

Primary Metals
Food and Agricultural Products
Stone and Clay Products
Petroleum Manufacturing
Chemical Manufacturing

higher order effects takes on a very different character because of the uncertainties in estimates of the economic, social, and political environment, as well as uncertainties in the technology. For these reasons we exclude long range technologies from consideration.

The identification of energy conserving techniques will then be undertaken. This is shown in block 3 of Fig. 3. Energy conserving techniques may include economic, legal, government, and social activities as shown in Table 1, Section 2.2, and not just narrowly technical measures. To structure this effort the potential energy conserving techniques will be categorized in several ways. One form of categorization is by fuel source, another is by energy form, a third is by end use, and a fourth is by predominant conservation technique. Each approach emphasizes different aspects of energy conservation, and so they tend to be complementary. In this study, all will be used in order to provide the widest generality in identifying potential energy conserving methods and higher order effects. Most attention will be given to the third and fourth methods of categorization. Categorization by predominant conservation technique is shown in Section 2.2, Table 1. The diversity of potential methods is striking. Law and economics play a strong role in addition to technology. Categorization by end use is shown in Section 2.2, Tables 3 and 4.

To generate a sufficiently complete list of energy conserving methods a number of approaches will be used. The initial approach will be based upon a critical review of the energy literature. This will be supplemented by discussions with experts in the fields of energy, law, economics, and social action. Relevant experience in other countries will be considered, as will the analogous experience with other technologies (most notably pollution control). The bringing together of a team with varied backgrounds may produce synergistic effects, since

suggestions by one may stimulate a response by another. These techniques all have the common element of being grounded in the present and moving toward the future. Another technique for generating energy conservation methods is to postulate a desired future state, and then attempt to create the energy conserving actions which would lead back to the present. This too will be tried.

Task 3. Select energy conserving technologies for intensive study

Having identified potential energy conserving methods, the second problem is to select the most promising for detailed technical assessment (c.f., block 5 of Fig. 3). This selection will be based upon the first order measures (the effectiveness in conserving energy, the cost and time) and a rapid survey of the existence of any other major impediment to implementation. The selection process will be justified to the oversight committee, and will be discussed with other interested parties to the greatest extent possible.

Task 4. Perform detailed assessment of high priority technologies

This task encompasses blocks 7, 8, and 9 of Fig. 3 and can be undertaken following the selection of candidate energy conservation methods. For each candidate method a specific analysis team will be created from among the study members and consultants. The work of each team will be regularly reviewed by the core group. The specific users and decision makers of a particular assessment as well as those most likely to be affected by the implementation of the method will be identified at the outset, and continuing dialogue will be maintained with them to assure that the work is relevant and that the results will be understood.

Since the primary impacts of an energy conserving method will have been determined in Task 3, the technical assessments now to be performed will be mainly concerned with the higher order effects of the method. These will include effects such as shown in Table 5.

TABLE 5

POTENTIAL HIGHER ORDER EFFECTS
OF AN ENERGY CONSERVING TECHNIQUE

1. Economic

   Price of other goods and services
   Profitability of an industry
   Ability of an industry to attract capital
   Employment (in an industry, region, or the nation)
   Gross national product
   Economic growth
   Structure of the economic system

2. Social

   Availability of products and services (universally or among specific regional or economic groups)
   Increased governmental authority over individuals and business entities
   Changes in attitudes and values
   Changes in risk and health
   Equity in distributing costs, unemployment

3. Environmental

   Pollution, gains and losses
   Direct impacts on ecology

4. Institutional

   Relative powers of different levels of government
   Changes in relationships between business, labor, consumers, and government

5. International

   Balance of payments
   Political relationships
   Defense posture

The energy conserving techniques to be assessed are expected to be extremely varied in nature. Some may be technical, some economic, some regulatory, etc. The nature of the impacts will also be quite varied, and the emphasis of each assessment will be different. In these circumstances, it does not appear fruitful to impose a common methodology upon all the intensive assessments. In some cases a value oriented assessment may be more appropriate, in others a checklist. Of the scanning techniques described previously, we expect the disciplinary aspects, major impact, and checklist methods to be most frequently used; since, as in the speaking of prose, the members of the project have been doing these things — to some high degree — all their lives. In some of the assessments more than one of the scanning techniques may be used. In any event, the technology assessments are looked upon as iterative processes in which initial results may be used to modify the approach of the study teams.

In the case of our study teams, the list of disciplinary aspects will include the technical, economic, legal, social, environmental, and political, since these disciplines are all represented on the project. In addition we hope to have the following interests represented on the research teams: utility and oil producing industries, labor union, government administration, and public action.

The project has not yet come to a position on the use of the tracing methods discussed in the General Methodology Section. We expect to examine these with the assistance of Chen during Task 1 of the study. At that time we will also review the specific applications of these techniques being employed in the ERIM assessment of remote sensing.

The social impacts of the technology assessments are a major concern of the project. To assess these impacts three members of the Institute for Social Research have joined the project (on part-time

basis). They intend to devote their efforts to three primary tasks: (1) surveying the literature for past and ongoing research that may be relevant to the development of energy conservation strategies, (2) surveying existing intervention data* for tested strategies that may be relevant, and (3) conceptualizing into measurable behavioral terms those intervention strategies which the project decides to recommend. As with the other members of the study, they will also be fully involved in all phases of the work from initial planning to final dissemination.

The survey of relevant social research and theoretical work can be organized into four categories, differing in the social unit which is the focus of concern:

1. Energy producers: Literature search here would concern organizational theory and the "behavior" of firms, particularly of the electricity and natural gas producers. Relevant questions would include the organizations' response to such diverse phenomena as changes in regulations, indirect economic incentives, market fluctuations and changing usage rates.

2. Heavy-use consumers (e.g., industries and municipalities): Here again organizational research and theory would be surveyed, but this time focusing on those organizations which are the largest users of energy, for example, in manufacturing processes or in providing community services (lighting, etc.).

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*An intervention or dynamic systems experiment acquires data during naturally occurring or deliberately created changes in the social environment.

3. Small consumers: Here the focus would be on the behavior and attitudes of individual private consumers, especially regarding their own energy use. Emphasis will be given to what impact new information regarding energy conservation might have on subsequent usage, or the effect of other types of incentives (pricing of products, altering rate structures for energy usage, etc.).

4. The final category would focus on both the small consumer and product manufacturers. Primary questions here would involve: (a) whether, given new information regarding energy use implications of different products, the small consumer will alter his purchasing habits sufficiently in the direction of selecting products which either require less energy in their manufacture or require less energy in their operation, which will in turn affect (b) whether such changing buying practices by consumers will affect manufacturers' choices of what products to produce and how to produce them.

Relevant areas in which the investigators have had direct experience include the following: (a) Caplan's research on knowledge utilization patterns among top—level decision-makers in the federal government, (b) Caplan's experience with interdisciplinary assessments of technological impact, and with policy issues regarding the production and use of energy (Argonne National Laboratories), (c) Lingwood and Morris's experimentation with knowledge utilization formats in the U.S. Forestry Service, and (d) Caplan and Nelson's work in the area of causal attribution and the public perception of social and environmental problems (the perceptions of cause, responsibility, and solutions).

There are also a number of areas of immediate relevance which have been or are being investigated by the Institute: (a) the long series of consumer attitudes and behavior by George Katona and his colleagues, (b) early studies by Kurt Lewin and his colleagues on

changing behavior, (c) "quality of life" and social indicator studies, (d) the effects of communications via the mass media, (e) technology forecasting, future forecasting, and the "cross-impacting" of future trends, and (f) "Life styles" and environmental usage.

Other areas which are more indirectly related (but no less importantly) to energy conservation issues include: (a) the vast literature and research on social influence in general and attitude and behavior change in particular, (b) Rokeach's work on values and factors that affect long-term changes in values, (c) studies of the degree to which one's attitudes and behavior will be consistent or inconsistent with each other, (d) studies of the conditions under which persons will behave according to their values or according to their perceived interests when the two diverge, and (e) the attitudinal and behavioral effects of perceived threat.

In addition, of course, the investigators, as members of the Center for Research on Utilization of Scientific Knowledge, bring to the study a serious concern for and experience with the issues associated with knowledge utilization.

While the social science group does not intend to conduct extensive field research, it may carry out some brief studies using archival data or other unobtrusive, cooperation-free (i.e., non-survey) data. For example, New York City has required by law that all air conditioning units be tagged with the intensity of energy required to operate each unit. Since the energy requirements differ by make, a few phone calls to distributors would determine whether there have been any changes in purchasing patterns in New York City, and possibly, any transfer effects to neighboring states. Similarly, it may be quite feasible to obtain energy usage records for various communities,

enabling us to examine issues such as (a) whether short-term energy crises (e.g., "brownouts") have any subsequent effect on a community's level of energy usage; (b) whether intensive efforts at informing the public on energy conservation issues (e.g., Earth Day activities or more long-term local environmental organizations) have any significant effect on a community's energy usage; and (c) whether energy rate increases have any impact on energy use levels. Studies of this kind, which are designed to explore the application of the methodology of intervention to energy conserving technology assessment, are indicated by blocks 10 and 11 of Fig. 3.

Task 5. Formulate policy alternatives and recommendations

No plan has been developed at this time for this Task (Fig. 3, block 12). Because of the diversity of disciplinary techniques involved, the formulation of policy alternatives and recommendations is expected to be both interesting and complex.

Task 6. Define the structure of energy conservation R&D

The ordering of potentially effective energy conserving techniques (Fig. 3, block 5) will be accompanied by a parallel analysis of energy conservation research and development (not shown in Fig. 3). While the technology of energy production, conversion, and utilization does include some techniques for energy conservation, the primary driving forces are economic. Potentially effective energy conserving methods often may be either discarded or pursued at low levels of effort, because greater activity is not economically justified. In many respects the research situation is analogous to that existing in pollution control a decade ago. An analysis of research and development in energy conservation is sorely needed. Such an analysis should treat the amounts and sources of funding, the technical directions which are slighted, and the influence of economic, social, and institutional factors in

determing research activities. This analysis should also consider the support given to non-technical areas (social, economic, and regulatory) which are important in energy conservation. In short, it would be illuminating to consider energy conservation as a technological activity in its own right in order to understand how research and development in this field may be more effectively conducted. As part of our study we include such an analysis.

The selection of energy conserving technologies for full assessment together with this study of research and development will together provide a significant output of the study. The integration of these elements should provide the necessary comprehension of energy conservation research and development to permit a more effective structuring of this work.

Task 7. Disseminate result

This Task is treated in Section 2.5 of this proposal.

2.5. DESIGN FOR DISSEMINATION AND UTILIZATION OF RESULTS

The fact that the National Science Foundation has included this item in a number of RFP's attests to the need for improved communication of study results and recommendations. For this particular study the problem is more severe due to the wide range of disciplines involved in the project and among likely decision makers, and due to the notorious difficulty encountered in communicating across disciplinary boundaries. Since this problem exists within the project itself, it will have to be solved internally for the study to succeed. The preliminary discussions held so far give every evidence that internal communication will be successful, and study outputs which are internally acceptable have great likelihood of being acceptable to the using community. In short, we believe that the breadth of the project membership mirrors well that of the decision makers interested in the study, so that sound internal functioning of the project will afford useable outputs.

Though we believe this to be true, we do not take it for granted. The study plan includes three specific actions aimed directly at establishing communication with interested parties and decision makers, including research sponsors. These actions are:

1. The use of two, quite different, professional organizations to assist in communication. One of these, the Creative Advertising Workshop in The University of Michigan Department of Art, teaches creative communications by means of major projects on real problems undertaken by groups of students*. The composition of each group includes students majoring in Art, Journalism, Creative Writing, Film or TV, Photography,

*See Appendix I for a more complete description of Workshop activities.

and Business Administration. Each group develops a strategy and creative concept appropriate to the problem and develops the finished exhibits (written, artistic, photographic, and TV) required for a solution. Though the problems typically have been in the realm of advertising to the general public, the Workshop is keenly interested in the unusual problem of communicating to decision makers, and their work on this study would be directed to that end.

The second professional group involved in the communication of study results is the Institute for Social Research. This Institute has long specialized in the study of social attitudes and behavior. As one part of the Institute's work on this contract, there will be examinations of the information needs of decision makers and their satisfaction with the study outputs. The former will serve as an input to the Workshop, while the the latter will assist in the evaluation of the output.

2. Attention to communication with decision makers from the beginning of the study. A communications plan will be generated in the first phase of the study, and will be modified throughout the project as required. Communication will not be left as an ad hoc activity at the end of the study.

3. Continuing interaction with decision makers and interested parties throughout the study. We expect that many of the decision makers who use the study can improve its quality by providing data and critical evaluation during its conduct. We would like to maintain contact with them for that purpose on a continuing basis. In so doing the study outputs will also be shaped to better meet their needs, and communication to them will be improved. The presence on the study team of industry, labor

and local and state government members should greatly assist in the communication to those interested parties.

The emphasis of dissemination planning has been upon communication to decision makers and specialized interested parties. With the resources available for dissemination we felt that this emphasis is proper. The Workshop and the Institute for Social Research have considerable experience in dealing with the public at large. The study members will use any guidance they can provide (based on past experience) in shaping plans to disseminate information to the public, but we do not anticipate the spending of contract money to develop new or different techniques of public communication.

2.6. PERSONNEL

Professor Marc Ross of The University of Michigan's Physics Department has accepted an appointment with the Environmental Institute of Michigan in order to serve as Co-Principal Investigator on the research project. Professor Ross is currently Principal Investigator of an energy study funded by the Ford Foundation.

Dr. Stanley Marder will also serve as Co-Principal Investigator. Dr Marder brings to the program some 12 years experience as a senior scientist with the Institute of Defense Analysis.

Dr. Nathan Caplan is currently a Program Director in the Center for Research on the Utilization of Scientific Knowledge, one of the centers within the Institute for Social Research. He has been on the staff of the Institute since receiving his Ph.D. in 1961.

Prof. William Pierce is Associate Dean of The University of Michigan Law School and is Director of the Legislative Research Center. Prof. Pierce is interested in the legal implications inherent in energy conserving technology.

Dr. Weston Vivian will bring to the project a wealth of experience drawn from his political, academic and industrial executive experience.

Dr. Richard B. Mancke has a joint teaching appointment in The University's Department of Economics and Law School. As his biography indicates, he has had extensive experience in energy studies.

Considerable effort has been made to assure that the interests of the many facets of Society affected by energy conversion stratagies are integrated into the research program. To this end we have discussed with officials of a major petroleum company, a natural gas distribution company and a electric utility the notion of supporting an

industrial "Sabbatical". The suggestion here is that a promising middle management level employee from these companies to be assigned to ERIM for a year in order to participate in this research program. The idea has been greeted with considerable interest by the industry people with whom we have talked, and we expect some positive responses in the near future.

We have also discussed a similar plan with officals of the AF of L and CIO Union. Here the impacts of energy conservation strategies on the employment market are of interest. We are confident that we shall have labor union participation in the research effort.

Anticipating a good deal of activity in investigating rate change strategies, we have been in touch with the Michigan Public Service Commission. We have been assured by the chairman of the Commission, Mr. William Rosenberg, of full cooperation with the program and active participation in the research by people from the Michigan Department of Commerce. We have also talked with Mr. Guy Larcom, former Ann Arbor City Administrator who has agreed to serve as consultant on the project. Mr. Larcom's past experience will be invaluable in assessing the impacts of energy conservation schemes at the Municipal level.

Through a sub grant to the Institute of Social Research of The University of Michigan, there will be active participation in the research program by distinguished scholars of that Institute. Specialized areas of interest such as law, energy economics, macro social systems, etc., will be examined with the assistance of appropriate consultants (see Biographical section).

Dr. Virginia L. Prentice, Associate Research Geographer with ERIM will act as the environmental advocate on the project. She is currently the Conservation Chairman of the Mackinac Chapter of the Sierra Club.

Dr. Robert B. Digiovanni will be in charge of writing the final report. He will be assisted by the Creative Workshop described in Appendix I.

You will find the biographical information which applies to the principle participants in this program in Appendix II.

RESEARCH TEAM

Stanley Marder*	Scientific Advisor - ERIM
Marc H. Ross*	Professor of Physics
William J. Pierce*	Assoc. Dean and Prof. of Law
Weston E. Vivian*	Adjunt Prof. Elec. Eng. and former Congressman - U.S. House of Representatives
Nathan S. Caplan*	Program Director - Institute of Social Research
Richard B. Mancke*	Asst. Prof. of Economics
Kan Chen	Prof. of Elec. and Comp. Eng.
Klaus P. Heiss	Director, Advanced Technology, Mathematica, Inc.
Gunter Schramm	Assoc. Prof. of Resource Ecology
Guy Larcom	Former Ann Arbor City Administrator
Stephen D. Nelson	Project Director - Institute of Social Research
David A. Lingwood	Project Director - Institute of Social Research
Virginia Prentice*	Assoc. Research Geographer ERIM and Sierra Club
Chauncey F. Korten	Director - Interdisciplinary Workshop School of Art

Representatives* from:

- Petroleum Industry
- Natural Gas Industry
- Electric Utility
- AFL/CIO
- Michigan Public Service Commission

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* Members - Core Group

OVERSIGHT COMMITTEE

Mr. Gary Gunther	Michigan Department of Natural Resources - Bureau of Water Management
Mr. Lee E. Jaeger	Michigan Department of Natural Resources - Air Pollution Control Division
Mr. Harry J. Hardenberg	Michigan Department of Natural Resources - Assistant State Geologist
Dr. Charles T. Black	Michigan Department of Natural Resources - Office of Environmental Review
Mr. Raymond J. Smit	Registered Engineer - Representative of the 52nd District - Michigan State House of Representatives
Dr. Ali B. Cambel	Vice President - General Research Corporation

2.7. MANAGEMENT PLAN

The ERIM Organization:

As a result of a cooperative effort between the State of Michigan and the University of Michigan, the Environmental Research Institute of Michigan (ERIM) was established in June 1972 as an independent not-for-profit corporation to carry on the research activities of the University's Willow Run Laboratories. ERIM's activities cover a broad range of scientific and technical disciplines, with emphasis on the physical sciences, optical and hybrid processing, earth sciences, computer sciences, engineering and mathematics, and in the application of these disciplines to the solution of a variety of broad problems facing our society.

ERIM's organizational structure is shown in Figure 4. All key personnel identified in the ERIM structure, except the Vice-President for Finance and Administration (Mr. Rosenblum), held comparable positions in the organization while under University auspices, and hence are well experienced in the management and conduct of both large and small research activities. ERIM's current level of research business is approximately $7 million per year. Mr. Rosenblum has held an analogous position at the Riverside Research Institute, a comparable organization to ERIM, for five years.

The ERIM staff consists of full-time researchers, part-time employees who are graduate or undergraduate students at various Universities, and a few faculty members from neighboring Universities who choose to pursue a portion of their professional activities within the framework of this institute. ERIM has an overall staff approaching 400 employees. Of this total, the technical staff consists of approximately 190 full-time employees and 75 part-time employees.

This distribution of personnel and the disciplinary depth is depicted in Figure 5. The figures shown relate to all of ERIM.

Program Organization:

The energy conservation technology program will be located in ERIM's Radar and Optics Division, directed by Dr. Leonard J. Porcello. (See Fig. 6) This Division specializes in synthetic aperture radar, and optical and hybrid processing, and contains ERIM's prime capabilities in active remote sensing. The Genessee County Project* of this Division is a $560,000, two-year program sponsored by the National Science Foundation through the RANN program. A third year is now in negotiation.

While ERIM prefers to have programs managed by a single Principal Investigator, in this case we have chosen to depart from that practice in order to provide more effective management. Professor Marc Ross of the University of Michigan's Physics Department and Doctor Stanley Marder, Scientific Advisor of ERIM's Radar and Optics Division will act as co-Principal Investigators. This arrangement has worked well during the proposal preparation and we anticipate that it will be equally satisfactory during the program management. Each Principal Investigator has and will be given full authority to act invidiually when individual action is required. If the National Science Foundation prefers an alternate project management approach, we will give it full consideration.

*The precise title of this project is "Application of Remote Sensing Technology to Local Environmental Planning and Public Policy."

As Principal Investigators, Dr. Marder and Professor Ross will be responsible for the overall direction of the program and the coordination of all participants. Specifically their functions will include:

a. Definition of Program Plans, Organization and Schedules

b. Program Staffing, both internal and consultants

c. Technical Guidance

d. Coordination and Liaison

e. Cost Control

f. Deliverable Items

Professor Ross will receive a 40% appointment at ERIM during the course of the program , and he and Dr. Marder will each devote at least 40% of their time to this project.

Key personnel for the program will be drawn from the ERIM staff, primarily from the Radar and Optics Division and from The University of Michigan. The close proximity of ERIM and the University, coupled with the historic tie which exists between the two organizations, contribute to the ease of such a working arrangement. University personnel will cooperate with ERIM under four established working arrangements: 1) as consultants to ERIM or 2) as temporary hourly ERIM employees, 3) under an arrangement which provides fractional appointments with ERIM and 4) under subcontract to the University from ERIM. The specific arrangement for each individual depends on his position in the University and on his personal preference. Considerable flexibility exists in acquiring and scheduling the great depth of expertise available from the University staff.

It is also planned to em ploy consultants from other organizations under usual consulting agreement contracts. The specific personnel, their capabilities and specific roles are discussed in Section 2.5. These, as well as

all other key personnel employed on the program will work under the supervision of the Principal Investigators.

The Overview Committee suggested in the RFP will be established early in the program. Although their expenses will be covered by the Project budget, they are to operate as an independent group and are free to make their recommendations to either the Principal Investigator or directly to NSF. The responsibility for providing this Committee with timely information on the purpose, scope and progress of the program lies with the Principal Investigators.

Program Control:

Program control rests with the Principal Investigators. To assist them, ERIM provides the necessary tools and support for handling administrative matters such as contract and subcontract negotiations, purchasing, cost accounting and reporting (to the Sponsor and to the Principal Investigator). ERIM administrative and control procedures are the same as those used for many years while associated with The University of Michigan.

For the work performed within ERIM, the Principal Investigators have direct control over job assignments, budgets, and expenditures, so that immediate response is possible in making any necessary changes in the conduct of the program. Formal paperwork for the technical direction of the program is purposely held to a minimum.

Upon contract award, the Contract Administration Group authorizes work to begin by assigning an account number against a budget consistent with the cost/task structure of the negotiated contract. Where necessary or desirable to identify costs against separate tasks of a highly complex project, (such

as our AMOS, BAMIRAC or NASA multispectral Imaging projects) multiple sub-accounts are established, each treated as a separate cost center. The Principal Investigator provides a list of personnel authorized to commit funds on each account and no service unit will honor financial commitment orders lacking the required authorized signature. Cost accounting within ERIM is performed on a weekly basis to provide the Principal Investigator with the timely information needed to make sound decisions on cost control.

Program staffing and personnel assignments are made by the Principal Investigators in concert with the Division Head and the second tier managers. Technical personnel and specialists will be phased in and out as the need arises and will not be carried over periods of time when their expertise is not required. Biographies of personnel expected to be employed on this program are presented in an appendix.

The program schedule is shown in Figure 7.

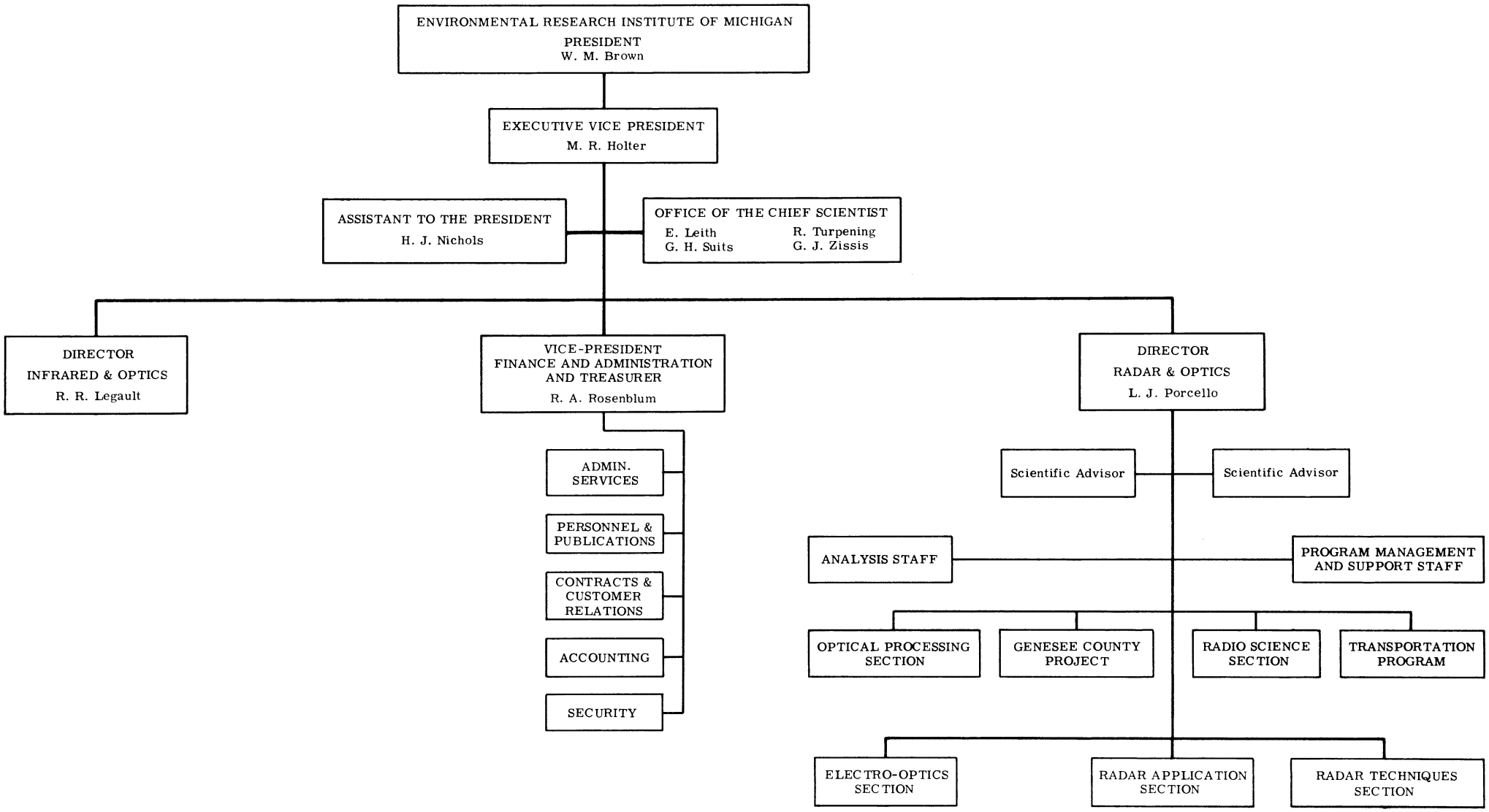
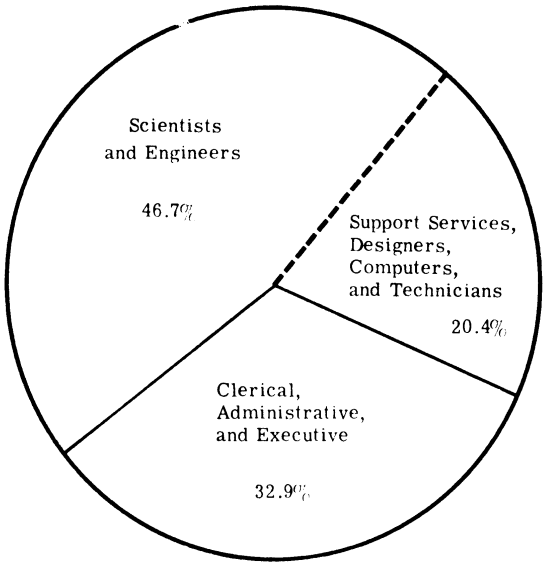
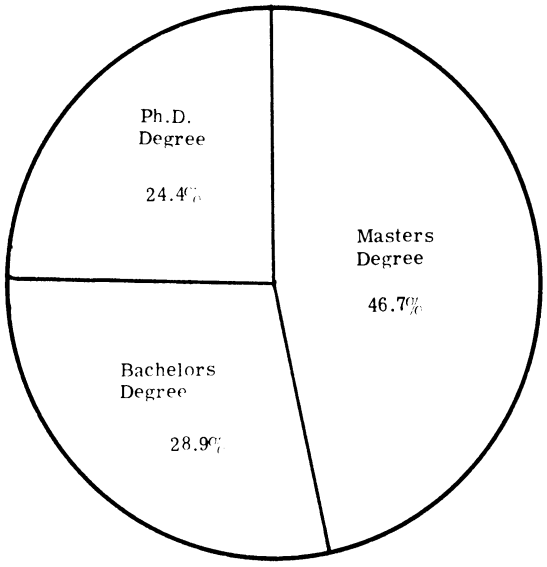


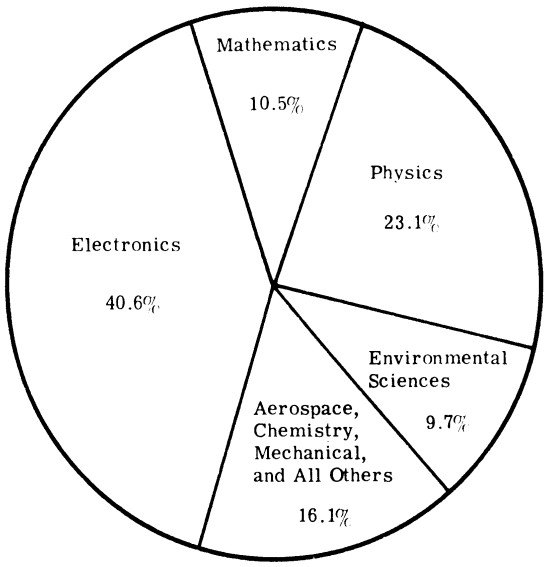
FIGURE 4. Organization of the Environmental Research Institute of Michigan



TOTAL PERSONNEL



SCIENTISTS AND ENGINEERS
BY DEGREES HELD



SCIENTISTS AND ENGINEERS
BY FIELD OF SPECIALIZATION

FIGURE 5. DISTRIBUTION OF PERSONNEL:
ENVIRONMENTAL RESEARCH INSTITUTE OF MICHIGAN

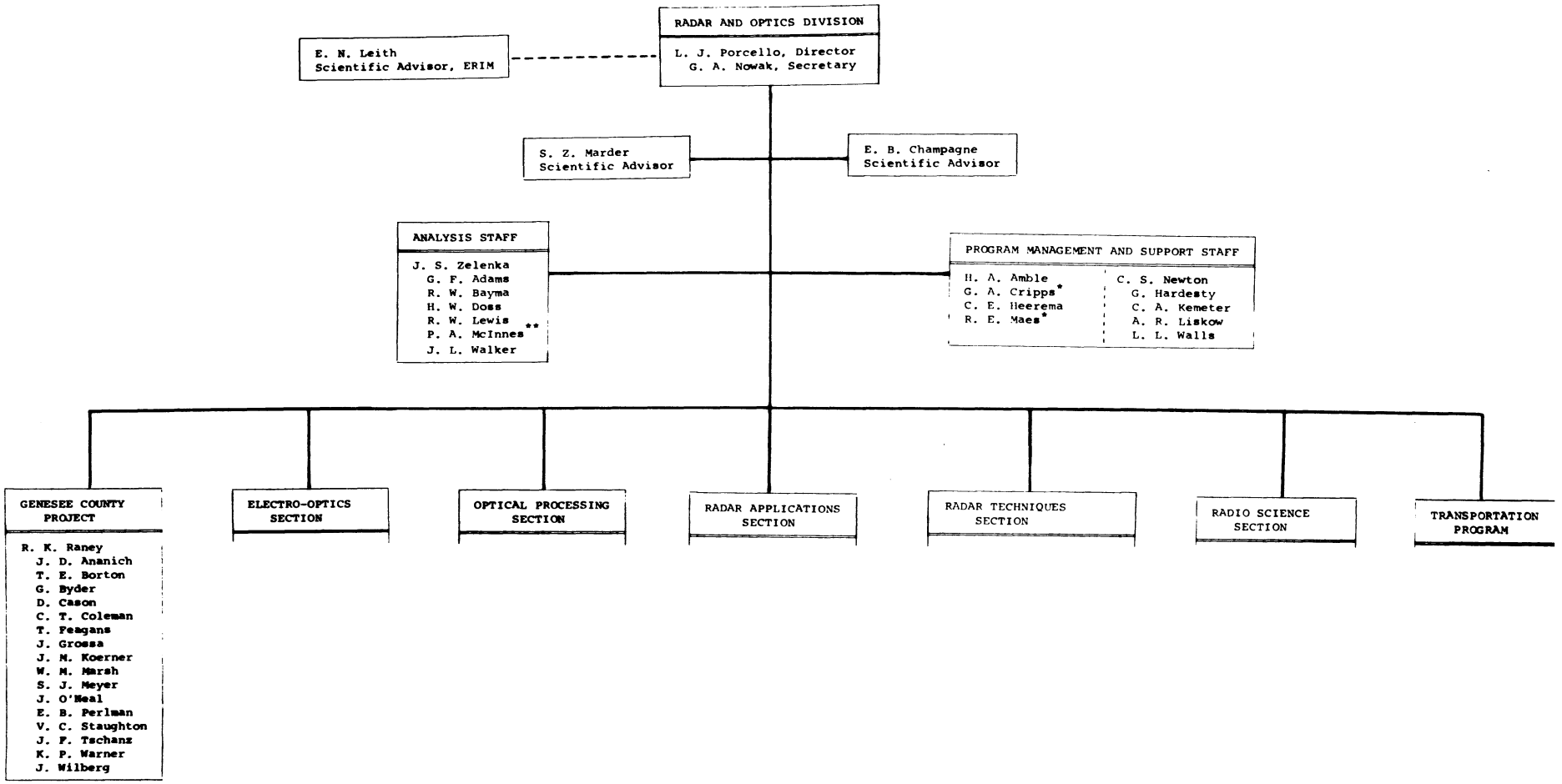


FIGURE 6. Organization of the Radar and Optics Division

PROGRAM SCHEDULE

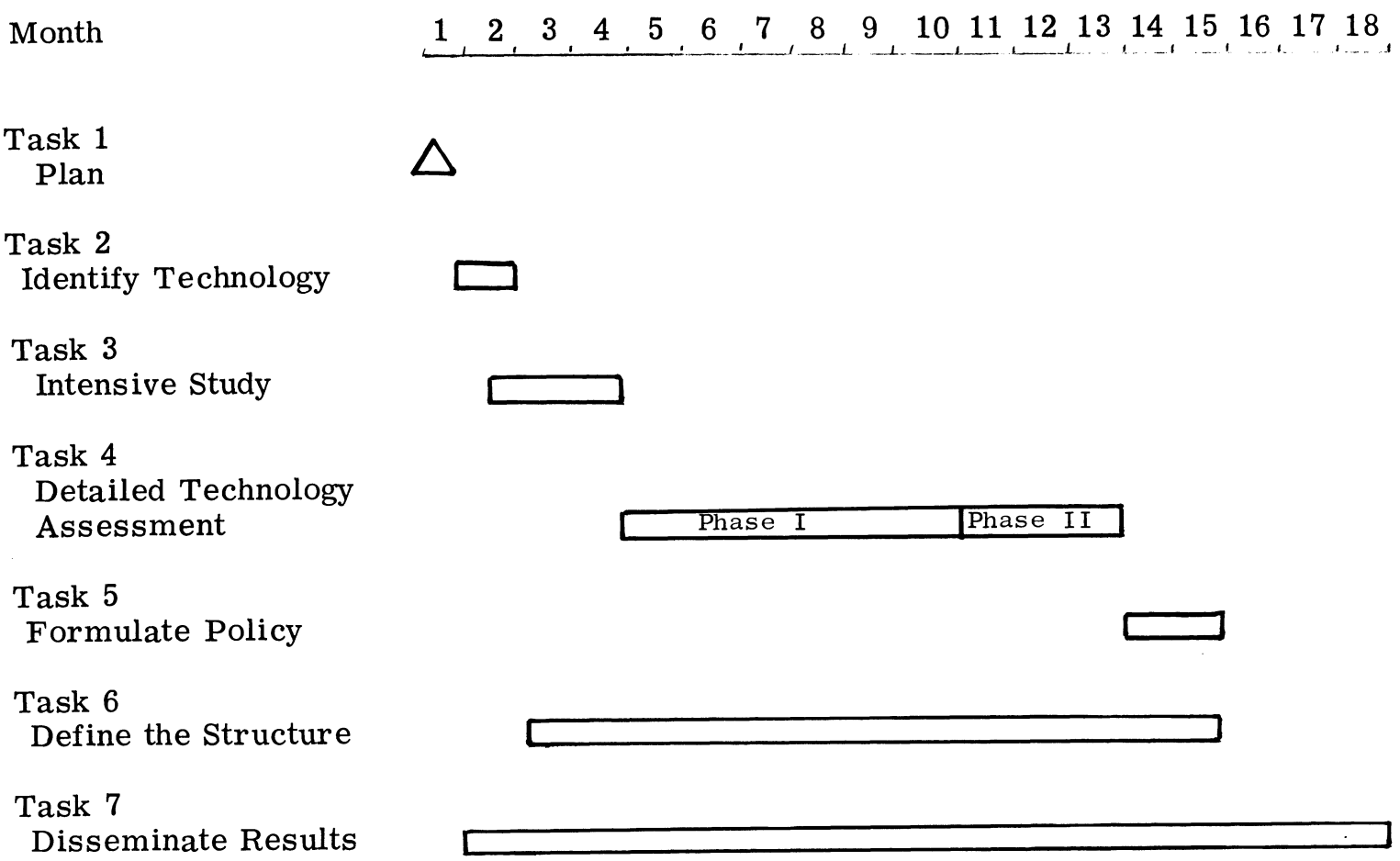


FIGURE 7.

2.8. RELATED PROGRAMS AND ACTIVITIES

Through its status as a not for profit research organization, ERIM has amassed a wealth of experince to qualify for performing this proposed study. We have worked cooperatively with many government agencies including: National Science Foundation; U.S. Department of Agriculture; U.S. Geological Service; National Aeronautics and Space Administration; many agencies of the U.S. Air Force; U.S. Coast Guard; Naval Oceanographic Office; and many other defense and non-defense related offices and projects. The central focus of most of these efforts has been to study the feasibility of solving problems with remote sensing systems. We have also worked with private corporations and foreign investigators seeking to apply remote sensing data collection and processing techniques. We have developed, and are continuing to develop, data processing techniques for satellite and aircraft data. We have an acquaintance with about fifty investigations now proposed for ERTS-1, a direct involvement in nine investigations, a good working relationship and free information exchange with many of the investigators and an excellent background of experience which will be invaluable when trying to assess the likelihood of a successful outcome of the experiments and of the impact of results of sensor performance.

ERIM (formerly Willow Run Laboratories) has long been known as a pioneer in techniques and procedures for the accumulation, processing and analysis of both synthetic aperture radar and multispectral data. It was here that the first such radar and multispectral scanner were invented, designed and built. It was here that both digital and analog techniques for the processing multispectral data were first established. Moreover, the application of remote sensing techniques to specific applications has been a long standing activity of the organization.

In addition to furthering vital aspects of infrared and remote sensing technology, ERIM is widely recognized as a center for the exchange and dissemination of information relative to all aspects of remote sensing. This recognition results from our well known data banks, information centers and symposia sponsorship. The following section describes two current Technology Assessment Programs.

A. Project Summary: "Assessing the Impact of Remote Sensing of the Environment". This technology assessment program is being conducted by ERIM under Grant No. G1-34899 from the National Science Foundation. The program covers the period from July 1972 through September 1973. Dr. George Zissis is the Principal Investigator.

This project was undertaken to explore and evaluate the social, economic, political and environmental impacts of remote sensing of the environment on both national and international scene. This project aims to develop a technological assessment methodology that can be used to indicate alternatives and influence policy making decisions concerning the application of this new technology. Through analyse of the economic effects, political feasibility, and social acceptability of remote sensing applications, both beneficial and detrimental consequence will be identified or predicted, thus permitting timely remedial or preventative action.

These studies involve the determination of the current status of remote sensing technology, and today's use of remote-sensing information. An examination is being made to identify current economic, legal, and political ramifications. In parallel with these efforts is an exploration of predictive technique available for impact assessment. Those found to be valuable will be applied.

The methodology of this current program closely parallel the work proposed herein. Specific references to the applicability of this work have been made in the technical section of this proposal.

B. Project Summary: "Application of Remote Sensing Technology to Local Environmental Planning and Public Policy". The project is sponsored by the National Science Foundation through its program for Research Applied to National Needs (RANN). Other participants include personnel from the Program in Urban Studies and the Department of Geography, both from the Flint College, The University of Michigan, and members of the Department of Urban Planning of the Ann Arbor campus, and the Genesee County Metropolitan Planning Commission (GCMPC), Flint, Michigan. The contract period is June 1971 -- June 1974.

The objective is to assist in increasing the effectiveness of public planning agencies to be achieved by a three-part program: (1) continue to introduce the information gathering and processing capabilities and potential of remote sensing systems to selected planning agencies; (2) determine the present information flow within and between selected agencies; and (3) measure the changes and improvement in information utilization in public decision making brought about by the remote sensing information system. The resources and methodology being employed include: (1) infrared, optical, multispectral, and imaging radar remote sensors, automatic spectral recognition and data interpretation, basic cartographic analysis and presentation, and information formatting to agency specifications; (2) determination of the present data needs, the utilization and assessment of available data, and the transformation of information by decision processes into agency policy, identification of anomalous or disadvantageous information utilization, and identification of unmet or unrecognized

data needs for which remote sesnsing technology would be potentially suitable; and (3) use of the descriptive model of information utilization and decision making developed in (2) to measure changes in the agencies, use of corporative cost accounting and where feasible, cost benefit analyses to measure relative costs and benefits of remote sensing information systems, and development of normative models that would increase the effect of comprehensive planning guidelines on the formation of public policy and decisions.

The subtasks in support of this objective include three specific topical investigations, a bibliographic task, and supporting analysis. These are summarized below. The principal investigator for this project is Dr. R. Keith Raney.

HIGHWAY CORRIDOR LOCATION

Objective: Determine the extent to which information derived through remote sensing can assist location of major highway corridors.

Preliminary Results: Two problems are perceived by highway planning personnel in the State Agency for corridor location: (1) generalized corridor and corridor selection, and (2) preparation of Environmental Impact Statements pertaining to corridor selection and the eventual highway alignment. Remotely sensed information has been judged by Agency personnel as being potentially helpful in addressing these problems. The capability to automatically classify and calculate the extent of certain physiographic features and land use, and the capability to gather data not readily available by other means (such as being particularly pertinent to help meet these problems.

Future Work: Cooperate with highway planning personnel in the Department of State Highways in gathering and interpreting information for alternate corridors in a generalized corridor to be specified, and

to evaluate the impact of said information on the means employed to meet the two problems cited above.

LAND USE POLICY DECISIONS IN INLAND LAKE AREA

Objective: Determine the impact of information derived from Remotely Sensed data and other technological sources on the formulation of land use, policy and practice for an inland lakes region being subjected to urbanization pressures.

Preliminary Results: Residential development and other aspects of urbanization in a once rural and recreational inland lakes region is proceeding subject only to piecemeal policies. The region is politically and socially disaggregate, yet the environmental consequences of the accelerated eutrophication of subject lakes as a function of land use and development is a problem common to (if not yet perceived by) all regional residents. The role of technology is to (1) help focus local concern for the problem, (2) provide quantitative data on the extent of the problem and (3) suggest more technically desirable alternatives. Locally in the test area, bonding issues for additional sewerage have been challenged in spite of the closure to "partial body contact" by the health department last season of one of the lakes.

Future Plans: Complete identification of local opinion leaders, inform them (through GCMPC) of the consequences of action or inaction on land uses policies and consequential water quality, and observe the effect of this information on problem perception and land use and development policy formulation.

TECHNOLOGY/AGENCY LINKAGE

Objective: To formulate methodological conclusions pertaining to the coupling of remote sensing technology to public decision making.

Sub-Objective: To create interactive linkage between this project and the Genesee County Metropolitan Planning Commission (GCMPC) to study the flow of innovative information (derived from remote sensing) into the decision making process. To respond to particular data needs of GCMPC, specifically in the preparation of a township master plan, using as appropriate remotely sensed data.

Preliminary Results: The interface between technology resources and public agencies is difficult. More blockages to linkage exist for less specialized and for less mission oriented agencies than for the converse, e.g., it is easier to establish and maintain linkage between technology and an agency if the agency is "water resources" rather than "county planning". One methodology to improve the interface is to concentrate on one topical problem of concern to the planning agency, e.g., "township land use and land capability" for a specific township, in concert with the township's plicy makers. Linkage is slowly developed, and is within its growth, cyclical. Linkage between this Project and GCMPC has grown to the working level of problem formulation and participatory interaction on data utilization.

Future Work: Continue to deepen and utilize the linkage between the Project and GCMPC. Provide remotely sensed land use inventory of Vienna Township. Evaluate the impact and cost of that output on GCMPC, and on the township planners. Cooperate in evaluation of the utility and cost of remote sensing information for problems of county planning. Formulate linkage methodological conclusions.

ANALYSIS

Objective: To formulate evaluative conclusions regarding the costs, utility, and impact of remotely sensed information in meeting the needs of public planning and decision making.

Preliminary Results: Cost accounting for the collection, processing, and dissemination of selected remotely sensed information has been completed. Flow of information within GCMPC for sample planning tasks has been described. Specific analyses are proceeding in the three topical investigations noted above.

Future Work: Continue to monitor and interact with the three tasks to assure experiment progress that should facilitate analysis, and to complete said analyses.

BIBLIOGRAPHY

Objective: Perform literature search to determine state of knowledge of (1) technology utilization in public decision making; (2) technological innovation in local and regional governmental jurisdictions; (3) role of remote sensing in planning and public policy formulation; and (4) remote sensing technology.

Preliminary Results: Very little has appeared in the literature on the first three topics. Research to date has emphasized points (2) and (3) above. Under point (2), many articles have appeared dealing with the theory or intent of such innovation, but very few studies are reported dealing with results, either as case studies or as broader empirically based conclusions. Under point (3), many articles have appeared dealing with aspects of the technology, some articles report pilot studies with operational agencies, many articles exist that discuss aerial photography in the planning process, but no papers have been discovered that report results of the application of more comprehensive remote sensing to meet planning data needs in an operational or quasi-operational sense. There is a large literature on remote sensing technology. The bibliographic task is concentrating on listing bibliographies, compendia, and relatively unusual selected articles.

Future Work: Continue to search the literature in the cited areas, prepare a bibliographic summary report, and use the findings in continually updating Project research.

Other related efforts include:

C. Energy Policy Project

The Energy Policy Project (EPP) was established in Washington, D.C. in May 1972 in response to the observation that, of the large number of energy studies underway, much of the work is limited to technical problems and stops short of policy analysis. The Energy Policy Project is an attempt to make a significant contribution to the totality of the energy policy problem. The Project hopes to serve as a focal point for researchers who wish to extend their work into the policy field. The major goal of this Ford Foundation effort is the creation of a comprehensive framework for policy analysis.

A specific study for the EPP is now underway at The University of Michigan. The Project Director of the study is Prof. Marc Ross, Co-Principal Investigator for the study of this proposal. An inter-disciplinary team has been formed to focus on the accurate determination of the total energy costs required to clean up the environment. These costs are to include the energy needed to operate the pollution control equipment and the energy required for its production. The study will also consider an environmental problem which could become an asset, i.e., it will examine the potentially beneficial uses of waste heat from power plants, uses such as residential heating and cooling, steam for industrial processes, and fuel production from agriculture and organic wastes.

D. Technology Assessment Proposals

In April 1973, ERIM submitted two proposals for technology assessment to the National Science Foundation in response to

RFP 72-123. One dealt with the Technology Assessment of Terrestrial Solar Energy Development, and the other was directed toward Technology Assessment of Geothermal Energy Resource Development. Dr. George Zissis will serve as Principal Investigator for these studies, if ERIM's proposals are selected.

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RANN PROPOSAL BUDGET

3. BUDGET SUMMARY - NONACADEMIC ORGANIZATION

A.	Salaries and Wages		
	1. Senior Staff (32MM)	$70,831	
	2. Clerical Staff	6,863	
	3. Students	6,960	
	4. Publications	4,500	
	5. Staff Benefits	9,323	
B.	Total Salaries, Wages & Staff Benefits		$ 98,477
C.	Consultants		
	1. Fees	24,250	
	2. Domestic Travel	4,080	
D.	Expendable Equipment and Supplies	1,760	
E.	Travel		
	1. Domestic	2,782	
F.	Publication Supplies	500	
G.	Computer Costs	1,885	
H.	Other Costs		
	1. Subcontracts - The University of Michigan		
	a. Institute for Social Research	50,200	
	b. College of Architecture & Design	6,000	
I.	Indirect Costs 60% of $98,477	59,086	
J.	Total Costs (C through I)		150,543
K.	Total Program Costs		249,020
L.	Fee 9.15% of $192,820		17,643
M.	Total Costs		$266,663

APPENDIX I

THE INTERDISCIPLINARY WORKSHOP IN CREATIVE ADVERTISING AND COMMUNICATION ARTS

The Creative Advertising Workshop, an expansion of a successful program in advertising design that had been offered since 1930, was established by the Department of Art in 1967. The Workshop is a three- to six-hour program that teaches creative communications by means of a major project undertaken by the students for, and in cooperation with, a business, agency, or other institution outside the University. The program is currently being taken by about forty junior, senior, and graduate students primarily from art, but also from jouralism, English, speech, and business administration. The Workshop program has amply proven its worth as a means of preparing students from these fields for careers in advertising, public relations, promotional and political campaigns, and other professions involving a creative approach to communication.

How the Present Workshop Functions

The Workshop, designed for junior, senior, and graduate students majoring in advertising design, television/film, creative writing, journalism, or marketing takes as its province the total creative process in communications.

Its objective is twofold: (1) to introduce the student to and involve him in the functioning of creativity in the advertising and communications fields, and (2) to involve him in the group technique for creative problem solving. Properly used, the group system is an unsurpassable method for solving problems. "Committee" thinking leading to compromise decisions can be less than satisfactory, but creative group thinking can be synergistic and produce results beyond the capabilities of its individual members. In the course of learning this approach to thinking, the student will inevitably broaden his view. The business-oriented student develops a deeper insight into creativity; the writer learns to think graphically; and the art student sharpens his sense of verbal effectiveness.

Each Workshop term deals exhaustively with a single project. It begins with the introduction of a current on-going advertising/marketing problem by a participating company or institution. In briefing sessions representatives from the company and from its advertising agency discuss the problem in considerable depth, giving market information, consumer research, current and projected sales figures, information on product distribution, advertising objectives, and a tentative budget. If advertising campaigns have been conducted previously, agency representatives present a historical review of the campaign and of the agency recommendations that led to them. The students are divided into four to six groups of about seven students each. Each group includes art students, creative writers, business administration majors, and students studying TV and radio. After preliminary analysis, each group writes a comprehensive statement of the communications problem,

then develops an advertising/marketing/communications strategy, and implements that strategy by producing the materials for a compaign in as complete a form as the available time and money permit. This includes designing comprehensive layouts, writing copy, and preparing illustrations. It includes location photography, both for print ads and for TV commercials. At the end of the term, each group presents its campaign recommendations to a group of executives from the sponsor and the sponsor's advertising agency. The actual work of the students--photographs, films, art, etc.--remains the property of the University, but the sponsor is permitted to develop any of the ideas created by the student teams. In such cases, the sponsors are encouraged to offer summer internships to the students responsible for the ideas to be developed so that the students gain further valuable practical experience.

The Workshop has many advantages. It provides real, not hypothetical, problems. Attacking these problems, the students have the extra motivation of knowing that their solutions may be adopted, and--at the very least that their solutions will be evaluated by persons to whom the problems are very real indeed. The Workshop has demonstrated its ability to teach general principles of creative problem solving through particular instances of real communications needs. Because each Workshop term deals with a separate problem, students by continuing the program can become familiar with a broad range of creative problems involving different types of products, concepts, audiences, marketing practices, and media. In short, the Workshop integrates theory and practice in a manner best calculated to produce creative and well-trained practitioners for the communications industry.

Student Responsibilities in the Workshop

Each student in the Workshop has both group and individual responsibilities. The class is divided into groups as equitably balanced in personnel as possible. Art students usually form a majority of each group, most of whom will be Advertising Design majors. Cognate students from Journalism, Creative Writing, Photography, Film or TV, and Business Administration are assigned to each group. A senior or graduate student with previous Workshop experience is assigned as a group leader or coordinator.

The group is responsible for the following assignments:

1. A statement of the problem.
2. A strategy to solve the problem.
3. An advertising concept to implement the strategy.
4. All necessary finished exhibits to express the group's recommended campaign plan.
5. A written advertising plan that includes (1), (2), (3) plus a simplified media and budget proposal.
6. A formal sales presentation to the client in which every member of the group participates.

Advertising Design majors participate in all the group's creative activity prior to production. They are responsible for producing and/or directing the graphic and/or audio-visual exhibits including layout, photography, illustration, and typography as assigned by the group coordinator and as approved by the instructors.

Business administration students act as Account Executives for the groups to which they are assigned. They become thoroughly familiar with the general field of concern, the client's products and/or problems and provide the group with needed information on markets, products, customers, and research. They also provide liaison between the group and the client. (Frequent telephone contact is maintained between the participating client and the Workshop.) They are responsible for preparing the final problem statement, strategy statement, and media and budget proposals, and they present them in the final presentation to the client. (They may be assisted in the writing of these statements by the writing cognate.) They participate in the group development of the strategy and the creative concept and may participate in the development of the finished exhibits. They, along with the group leader, are responsible for keeping the group on strategy and within the agreed-upon budget.

Writing students participate in all of the groups' creative activity in the development of the advertising plan preceding the production period, at which time they write complete copy for the advertisements in each category of proposals presented by the group. The writers, together with design majors, are responsible for creating individual advertisements in appropriate media. They also assist in writing the advertising plan. They may also assist in the creation and production of final exhibits.

Film, photography, and/or TV students participate in all of the groups' creative activity. They are responsible for planning and producing, in consultation with other members of the group, the photographic and/or film requirements necessary to carry out the group's concept. They may also help create individual creative exhibits.

Group leaders/coordinators, in addition to their creative group participation and individual creative assignments, will coordinate their groups' activities throughout the semester and distribute the production load equitably among the members of the groups. They must keep the efforts of their groups consistent with the group strategy, concept, and budget. In order to keep the efforts in focus during the semester, they keep a log of all group sessions. They are responsible for organizing the rehearsal and final presentation at the end of the semester.

Clients of the Workshop

Fall 1967	Kaiser Jeep, Toledo, Ohio Compton Advertising, New York City
Winter 1968	Gerber Products, Inc., Fremont, Michigan D'Arcy Advertising, New York City
Fall 1968	Eastman Kodak (Educational and Professional Division), Rochester, New York J. Walter Thompson Co., New York City
Winter 1969	U.S. Plywood/Champion Papers Inc., New York City Young & Rubicam, Detroit and New York City
Fall 1969	Triumph Marketing Corporation (Birmingham Small Arms Ltd.), Birmingham, England Interpublic, New York City
Winter 1970	The American Cancer Soceity No agency
Fall 1970	Ford Division, Ford Motor Co., Dearborn Michigan J. Walter Thompson Co., Detroit
Winter 1971	Hallmark Greeting Card Co., Kansas City, Missouri Foote, Cone & Belding, Chicago
Fall 1971	The State Departments of Public Health and Natural Resources in cooperation with Governor Milliken's Council on Environmental Quality No agency

Winter 1972	Olin Ski Company, Inc., Division of Olin Corporation, Middletown, Connecticut Van Leeuwen Advertising Agency, New Haven, Connecticut

APPENDIX II - Vitae

ENVIRONMENTAL RESEARCH INSTITUTE OF MICHIGAN
FORMERLY WILLOW RUN LABORATORIES, THE UNIVERSITY OF MICHIGAN
P.O. BOX 618 • ANN ARBOR • MICHIGAN • 48107 PHONE (313) 483-0500

MARDER, STANLEY Z. RESEARCH PHYSICIST

EDUCATION

BA	Physics	University of Pennsylvania, 1950
PhD	Physics	Columbia University, 1958

EMPLOYMENT

Teaching and Research Assistant, Columbia University, New York, July 1950 - November 1956
Research Physicist, Carnegie Institute of Technology, Pittsburgh, Pennsylvania, November 1956 - March 1960
Research Staff Member, The Johns Hopkins University, Operations Research Office, Bethesda, Maryland, March 1960 - July 1960
Staff Member, Institute for Defense Analysis, Arlington, Virginia, July 1960 - October 1972
Research Physicist, Radar and Optics Division, The University of Michigan, IST, October 1972 - December 1972
Research Physicist, Radar and Optics Division, Environmental Research Institute of Michigan, Ann Arbor, Michigan, January 1973 - present

EXPERIENCE

Professional experience: Dr. Marder's experience includes 12 years with the Institute of Defense Analyses (IDA) where he served in the Science and Technology Division. As a member of this Division, he was directly involved in the formulation of new research and development programs, the review and redirection of existing programs, the comparison of alternative systems, and the design of test programs. The primary orientation of the programs were to support the Office of the Secretary of Defense, the Joint Chiefs of Staff, and the Advanced Research Projects Agency (ARPA).

Principal studies have encompassed a broad range of reconnaissance systems--optical, infrared, and radar--with particular emphasis upon synthetic-aperture radar systems. The technical analysis of imaging radar systems and the study of the utilization of radar and other systems have been the primary interests.

MARDER, STANLEY Z. RESEARCH PHYSICIST

EXPERIENCE (continued)

Examples of specific activities include:

- the formulation of a program leading to the establishment of the ARPA Advanced Sensors Office
- the preparation of a Technology Coordinating Paper establishing direction for the Defense Department program in synthetic aperture radar
- the analysis of Manned Orbiting Laboratory systems and ground-based simulators
- the comparison of proposed Mobile Medium Range Ballistic Missile systems
- the development of a research program for the detection of concealed hand guns to aid in the protection of public figures
- the analysis of operational performance of reconnaissance systems and of air-to-air fire control systems
- the design of test facilities and test procedures for synthetic aperture radar systems
- the analysis of radar systems designed to detect moving targets
- the comparison of proposed drone and manned aircraft reconnaissance systems
- review of papers by other IDA staff members
- service on internal IDA committees
- interview and evaluation of prospective staff members
- review of proposals to ARPA
- service on government advisory committees
- initiation of new tasks in reconnaissance
- task leadership on reconnaissance and sensor studies
- organization of technical meetings and planning sessions

MARDER, STANLEY Z. RESEARCH PHYSICIST

EXPERIENCE (continued)

Teaching experience: Throughout the period of his graduate studies at Columbia University, Dr. Marder was employed in a variety of teaching and research assistantships. He taught recitation and laboratory sections in elementary physics, performed microwave tests and experiments in the Columbia Radiation Laboratory, and performed experimental research in atomic physics and in low-energy nuclear physics.

He assisted in the supervision of graduate students participating in meson physics at the Nuclear Research Center of the Carnegie Institute of Technology. He also taught undergraduate physics classes and supervised the library.

PROFESSIONAL AND HONORARY SOCIETIES

Member, American Physical Society
Member, Philosophical Society of Washington
Member, Institute of Electrical and Electronics Engineers
Member, Society of Sigma Xi
Member, Phi Beta Kappa
Receipient of Certificate of Distinction, University of Pennsylvania

PUBLICATIONS

Doctoral Dissertation

Effects of Electric and Magnetic Fields on Positronium and the Hyperfine Structure of Positronium, Columbia University, 1958

Books and Journal Articles

"Helicity of Negative Muons from Pion Decoy," W. A. Love, I. Nadelhaft, R. T. Siegel, and A. E. Taylor, Physical Review, Letters, 2, 107, 1959

"B^{12} Formation by Absorption of μ-Mesons in C^{12}," W. A. Love, I. Nadelhaft, R. Siegel, and A. E. Taylor, Bull. Am. Phys. Soc., Ser. II, 4, 81, 1959

MARDER, STANLEY Z. RESEARCH PHYSICIST

PUBLICATIONS (continued)

Books and Journal Articles

"Hyperfine Structure of Positronium in its Ground State," V. W. Hughes and C. S. Wu, Physical Review, 106, 934, 1957

"Effect of an Electric Field on Positronium Formation in Gases: Experimental," W. Bennett, V. W. Hughes, and C. S. Wu, Physical Review, 103, 1258, 1956

"Static Magnetic Field Quenching of the Orthopositronium Decay. Angular Distribution Effect," V. W. Hughes and C. S. Wu, Physical Review, 98, 1840, 1955

Dr. Marder has been the major author of or contributor to approximately 15 published, limited-distribution, reports. Among the most recent of these are:

"Technology for the Prevention of Airliner Hijacking and Bombing," J. Henry, et al., IDA P-817, February 1972 (Unclassified)

"Avionics Performance and Costs: Vol. III, Air-to-Air Performance Analysis," with R. D. Turner, IDA S-393, December 1971 (Secret)

"ALARM System Performance Analysis," with R. D. Turner and A. Krinitz, IDA S-376, December 1971 (Secret)

"Promising Areas of Research and Development for Tactical Operations in an Overseas Urban Environment," with W. S. Payne, et al., IDA S-345, May 1970 (Secret)

"Report of the Ad Hoc Committee on Surveillance," with F. R. Naka, et al., MITRE Corp., 8320 - B0052, March 1969 (Secret)

MARC ROSS

Professor of Physics, University of Michigan

EDUCATIONAL BACKGROUND

B.S. Queens College, New York, 1948
Ph.D. University of Wisconsin, 1952

Thesis area: Theoretical low energy nuclear physics

PAST EXPERIENCE

Research Associate, Brookhaven National Lab., 1953-55
Assistant Professor - Professor, Indiana University, 1955-63
Professor of Physics, University of Michigan, 1963-present
Visiting Professor of Physics, M.I.T., Spring 1966
Visiting Professor, University of London, Spring 1971
Summer positions at Brookhaven, Argonne, and SLAC Laboratories, at Florida State University, University of Colorado, University of California, University of Washington.

PROFESSIONAL SOCIETIES

Member, Argonne ZGS Program Committee, 1963-69
Member, Executive Committee, American Physical Society Division of Particles and Fields, 1969-70. Chairman, Publications Committee.
Consultant to University of Missouri on evaluation of Physics Program, March, 1972.

PUBLICATIONS

Non-Additivity of Nucleon Moments, Phys. Rev. 84, 379 (1951).

Nucleon Moments in Heavy Nuclei, Phys. Rev. 88, 935 (1952).

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Photon Dissociation Model for Vector-Meson Photoproduction, (with L. Stodolsky) Phys. Rev. 149, 1172 (1966).

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PUBLICATIONS (Continued)

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Phenomenology of Multiperipheral Processes, contribution to Proceeding of the Boulder Conference on High Energy Physics, K. T. Mahanthappa, Ed., Colorado Associated University Press (1970).

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VITA

NAME: Nathan Caplan

BORN: March 29, 1930; Richmond, Virginia

ADDRESS: 1904 Austin, Ann Arbor

MARITAL STATUS: Married; 3 children

PHONE: Office: (313) 764-2554
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EDUCATION: BA, University of Richmond, (Va.), 1951
MA, University of North Carolina, 1953
Ph.D., Western Reserve, 1961

EMPLOYMENT: Chief Psychologist, Cuyahoga County Juvenile Court (Cleveland), 1956-61

Assistant Professor, University of Illinois, Chicago Circle, 1962-63

Program Director, Institute for Social Research, University of Michigan, Center for Research on Utilization of Scientific Knowledge, 1961 - present

Lecturer, Department of Psychology, University of Michigan. Coordinator, Honors Introductory, Psychology as a Social Science

PUBLICATIONS: Caplan, Nathan S., and Marvin Powell. "A Cross Comparison of Average and Superior-IQ Delinquents." Journal of Psychology, 1964, 57, pp. 307-318.

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--Readings in Social Problems: Dissenting Groups. Edited by Carl Bersani. Holdbrook Press, Inc. 1972.

--To appear in a college test, Reason, Freedom, and Rebellion: A reader in social psychology. Edited by Richard Flacks. Little, Brown and Co.

--To appear in Sociology of Deviant Behavior. Clinard, Marshall B. Holt, Rinehart & Winston, Inc.

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Caplan, Nathan, et al. Social Experimentation for Evaluation and Planning. Seminar Press. In press.

MISCELLANEOUS: Consultant, National Advisory Commission on Civil Disorders (Kerner Commission), August 1967 - March 1968.

Panel Member, proposal review committee, Center for Studies of Metropolitan Problems, NIMH, 1969 - 1971.

Member, Task Force on Urban Employment Studies, Manpower Administration, U.S. Department of Labor, 1969 - 1972.

Member, Environmental Study Group, National Academy of Science, 1970 - present.

Member, SSRC, Committee on experimentation as a method for planning and evaluating social intervention, 1971 - present.

Member, Board of Trustees, Argonne National Laboratory (AEC), 1971 - present.

Member, National Research Council, Panel on Manpower Training Evaluation, 1973 -

PIERCE, WILLIAM J., Prof., Assoc. Dean, and Dir. of Legislative Research Cntr. c) Univ. of Michigan Law School, (313) 764-0336. b. 1921. A. B., 1947; J. D., 1949, Univ. of Mich. Admitted: Michigan, 1949. Assoc., N. Y. Law Rev. Comm., 1949-50; Ex. Dir., Nat' l Conf. of Comm. on Unif. State Laws, since 1969. U. S. Army, 1943-45, 1st Sgt. Subjects: Legislation; Legislation, (S). Atoms and the Law (with Stason and Estep), 1959; Michigan Probate Guide for Gen. Practitioner, ed. 1962, 1964; Apportionment: The Mich. Experience (with Lamb and White), 1963. Member: Am. Law Inst., Coif. Exec. Sec., Mich. Law Rev. Comm., 1966-69; Bd. of Dir., Council of State Gov' ts., 1966-69; House of Delegates, Am. Bar Ass' n, 1966-69; Vice Chairman, Governor' s Task Force Water Pollution, 1965-69; Mem., Mich. Comm. on Unif. State Laws, 1953-69; Pres., Nat' l. Conf. of Commissioners on Unif. State Laws, 1967-69.

From Who's Who in America
1970-71 edition

VIVIAN, WESTON EDWARD, congressman: b.Hermitage Bay, Newfoundland,Can., Oct.25,1924;s. N.Gardner and Bess (Rowsell)V.; came to U.S., 1929, naturalized citizen; B.S., Union Coll., Schenectady, 1945; M.S.,Mass.Inst.Tech., 1949; Ph.D., U. Mich., 1959; m. N. Anne Biggs, Aug.17,1946 (dec.); children--Byron G., Alice B., Leslie L., Sarah J. Engaged as electronics engr., 1946-60; v.p.Conductron Corp., Ann Arbor, Mich., 1961-64, 67, dir., 1961-65; mem.89th Congress 2nd Dist.,Mich; cons. Nat. Council Marine Resources and Ocean Engring., Exec. Office Pres., 1967; v.p.,co-funder KMS Industries, Ann Arbor, 1967-68; mgr. Astrotype div. Information Controls Systems, Ann Arbor, 1968--. Chmn. Com. Adminstrn. Tng.Programs, Washington, 1967--. Bd. dirs. United Fund Ann Arbor,1962-64, United Fund Mich., 1964. Chmn. Ann Arbor Democratic Committee, 1959-60, vice chairman, 1964. Served with USNR, 1943-46. Mem. Ann Arbor C. of C., Am. Inst.Physics, N.A.A.C.P., Sigma Xi. Home: 2717 Kenilworth Dr. Office: Wolverine Bldg., Ann Arbor, Mich.

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or Department of Economics
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Office Phones: Law School: (313) 764-3149
Economics: (313) 764-9480

Undergraduate Studies: Colgate University, B.A. 1965
Graduate Studies: Massachusetts Institute of Technology, Ph.D. 1969
Thesis Title: The American Iron Ore and Steel Industries: Two Essays

Teaching Experience

1. Massachusetts Institute of Technology
   1967-68 Teaching Assistant
   1968-69 Instructor
2. Graduate School of Business, University of Chicago
   1969-71 Assistant Professor of Business Economics
3. University of Michigan
   1971-present Assistant Professor Economics; half-time in Economics Department and half-time in Law School.

Government Service and Testimony

1. Staff Economist, U.S. Cabinet Task Force and Oil Import Controls, June 1969 to March 1970.
   See A. U.S. Cabinet Task Force on Oil Import Controls, The Oil Import Question (Washington: U.S. Government Printing Office, 1970).
   B. U.S. Cabinet Task Force on Oil Import Controls, Estimated Wellhead Costs of North Slope Alaska Crude. Reprinted in M.A. Adelman (ed.) Alaskan Oil: Costs and Supply (New York: Praeger, 1971).
2. Statement presented to the Subcommittee on Priorities and Economy in Government of the Joint Economic Committee, Hearings, January 10, 1972.
3. Invited statement for the Senate Committee on Interior and Insular Affairs, Study of National Fuels and Energy Policy, January, 1973.
4. Expert witness for the Environmental Protection Agency in US v. Reserve Mining Company. (January 1973).
5. Consultant to U.S. Federal Trade Commission, for US v. Xerox.

Miscellaneous Public Service

1. Author of two background papers for Resources for the Future's Energy Policy Study. See Resources for the Future, Energy Research Needs (October, 1971).
2. Consultant to Natural Resources Defense Counsel and the Center for

Law and Social Policy (1971-1972) in their attempt to block construction of the Aleyska (Trans-Alaskan) Pipeline. See R. Mancke and T. Stoel, Comments on National Security Aspects of Proposed Trans-Alaska Pipeline, submitted to Secretary of Interior Rogers Morton (May 3, 1972).

Private Consulting

1. Employed by Peter Steiner (for Kirkland-Ellis) in FTC v Marshall Field.
2. Tuttle and Taylor representing ARCO Pipeline in ARCO Pipeline v. Alaska (April 1973).

Publications:

I. Published articles:

1. "The Determinants of Steel Prices in the U.S.: 1947-1965," The Journal of Industrial Economics (April 1968), pp. 147-160.
2. "The Longrun Supply Curve of Crude Oil Produced in the United States," Antitrust Bulletin (Winter, 1970), pp. 727-756.
3. Journal of Economics (February, 1971), pp. 187-193.
4. "Lower Pay for Women: A Case of Economic Discrimination," Industrial Relations (October, 1971), pp. 316-326.
5. "The Cost of Oil Import Controls," in Oil Prices and Phase II, Hearings before the Subcommittee on Priorities and Economy in Government of the Joint Economic Committee, 92nd Congress, First Session (Washington: G.P.O., 1972), pp. 56-61.
6. "Which Pipeline?" (with Barbara Hobbie), The New Republic (June 24, 1972), pp. 16-18.
7. "Lower Pay for Women: A Reply," Industrial Relations (May, 1972), pp. 285-288.
8. "The Allocation of US Oil Import Quotas," Journal of World Trade Law (September/October, 1972), pp. 565-573.
9. "Iron Ore and Steel: A Case Study of the Economic Causes and Consequences of Vertical Integration," Journal of Industrial Economics (July, 1972), pp. 220-229.
10. "An Alternative Approach to Auto Emission Control," California Management Review (Summer, 1972), pp. 82-86.
11. "Federal Regulation of Whiskey Labelling: From the Repeal of Prohibition to the Present," (with Raymond Urban), Journal of Law and Economics (October, 1972), pp. 411-426.

II. Published book reviews:

1. Peter Asch, Economic Theory and the Antitrust Dilemma, reviewed in the Journal of Business (October, 1971).
2. Donald N. Thompson, Franchise Operations and Antitrust, reviewed in Journal of Business (April, 1972).

III. Articles accepted for publication and forthcoming:

1. "Causes of Interfirm Profitability Differences: A Reinterpretation of the Evidence," Quarterly Journal of Economics.
2. "Oil and the National Security," Senate Committee on Interior and Insular Affairs Study of National Fuels and Energy Policy.

IV. Book contracted for and forthcoming:

1. Energy Crisis: The Failure of U.S. Oil and Gas Policy (Columbia University Press, forthcoming 1973).

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PRENTICE, VIRGINIA L. ASSOCIATE RESEARCH GEOGRAPHER

EDUCATION

BA	Geography	Michigan State University, 1944
MA	Geography	Northwestern University, 1947
PhD	Geography	The University of Michigan, 1972

EMPLOYMENT

Engineering Aide, U. S. Geological Survey, Washington, D.C., 1944-194
Graduate Assistant & Library Assistant, Northwestern University, Evanston, Illinois, 1945-1947
Instructor, Michigan College of Mining & Technology, Houghton, Michigan, 1948
Geographer, Central Intelligence Agency, Washington, D.C., 1948-1949
Instructor (part-time), University of Denver, 1950
Military Pay Clerk, U. S. Army, Ft. Sheridan, Illinois, 1950-1953
Clerk-Typist, U. S. Snow Ice & Permafrost Res. Establishment, Wilmette, Illinois, 1953-1955
Geographer, USA Cold Regions Res. & Engineering Lab., Hanover, N. H., 1955-1964
Research Associate, The University of Michigan, IST, 1964-1968
Associate Research Geographer, The University of Michigan, IST, 1968-1972
Associate Research Geographer, Environmental Research Institute of Michigan 1973-

EXPERIENCE

Miss Prentice is assigned to the Infrared and Optics Laboratory. A major responsibility is in the collection and analysis of digital ground measurement data extracted from infrared and other imagery. Current projects include developing a methodology for assessing the impact of remote sensing technology on society. She is involved in the remote sensing programs of the laboratory, and has been coordinator and co-director respectively, of the 1966 and 1967 NSF Summer Short Courses on Remote Sensing of Environment for College Teachers, and coordinator of the 1968 and 1969 Institutes on Geographic Applications of Remote Sensing. Miss Prentice has also participated as an instructor in the University Center for Adult Education. She is a member of the Ottawa National Forest Multiple Use Advisory Committee at request of U. S. Forest Service. She has testified at U. S. House of Representatives hearings on Sleeping Bear Dunes National Lakeshore and at numerous other national and state level hearings on conservation and environmental issues.

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PRENTICE, VIRGINIA L. ASSOCIATE RESEARCH GEOGRAPHER

PROFESSIONAL AND HONORARY SOCIETIES

Association of American Geographers -
Member, Commission on Geographic Applications of Remote Sensing 1967-70
Sigma Xi
American Society of Photogrammetry
President, Great Lakes Region, 1969
Chairman, Remote Sensing Committee, Remote Sensing & Interpretation Division, 1970
Society of Women Geographers
American Association for the Advancement of Science-Fellow
Graduate Women in Science (formerly Sigma Delta Epsilon)
Glaciological Society
Michigan Academy of Science, Arts & Letters
The University of Michigan Women's Research Club-President 1969-1970

CIVIC AND SERVICE ORGANIZATIONS, ETC.

Sierra Club - National Bulletin Advisory Committee 1969-1970
Nominating Committee 1970-1971
Chairman, Mackinac Chapter 1967-1970
Michigan Natural Areas Council -
Board of Directors, 1972
McCormack Tract Ad Hoc Citizens Advisory Committee - 1970
Ottawa National Forest Multiple Use Advisory Committee 1972-1973

HONORS

Presidential Citation for Meritorious Service - American Society of Photogrammetry, March 1967
Meritorious Service Award - Sierra Club - 1971

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PRENTICE, VIRGINIA L. ASSOCIATE RESEARCH GEOGRAPHER

PUBLICATIONS

"Photo Interpretation of Vegetation. Literature Survey and Analysis", Technical Report 69, USA Snow Ice and Permafrost Research Establishment, Corps of Engineers, Wilmette, Illinois, 1960.

Background Study of Puerto Rico. Briefing Report for use in Aerial Sensing Studies of Tropical Areas. USA Cold Regions Research and Engineering Laboratory, Special Report 71, 1965, 75 pp., Hanover, New Hampshire.

"General Description of Raytran Study Sites", USA Cold Regions Research and Engineering Laboratory, Technical Note, 1964, Hanover, New Hampshire, (not for general distribution).

"Airphoto Analysis of Willmar, Minnesota", USA Cold Regions Research and Engineering Laboratory, Technical Note, 1964, Hanover, New Hampshire, (not for general distribution).

"Air Photo Interpretation", The Professional Geographer, Vol. XVI, No. 2, March 1964, Review Article.

"Comparison of Terrain Analysis from Side Looking Radar with Visual Aerial Photography", co-author, USA Cold Regions Research and Engineering Laboratory, Technical Report (SECRET).

"Aerial Photographs as Basic Source Materials in Geographic Research: An Example from the Grand Coulee Area", paper read at the Annual Meeting of the Association of American Geographers, Santa Monica, California, 1957, Abstract published in the Annals of the AAG, Vol. 48, 1958.

"Contributions of Air Photo Interpretation to the Study of the History of Man", Paper read at the Annual Meetings of the American Society of Photogrammetry, Washington, D. C., March 7, 1967.

Remote Sensing of Environment, Report No. 4864-12-P, Institute of Science and Technology, Willow Run Laboratories, The University of Michigan, April 1967, 22 pp.

"Scale, Detail and the Fine Art of Generalization", Paper presented at the Ninth Annual Meeting of the American Institute of Aeronautics and Astronautics, Anaheim, California, October 1967, 11 pp.

"Multisensor Aerial Reconnaissance of Salmon Event Underground Nuclear Explosion", co-author, USNRDL-TR-67-131, U. S. Naval Radiological Defense Laboratory, San Francisco, California, 20 October 1967, 182 pp., (CONFIDENTIAL).

"Selected Bibliography of Remote Sensing", co-author, Inter-agency Report NASA-129, U. S. Department of the Interior, Geological Survey, 1938, 34 pp.

"Time Periods and Spectral Regions: Implications for Geographic Investigations Utilizing Infrared Imagery," co-author, Paper prepared for the International Geographic Union Meetings, New Delhi, India, December 1968, Report No. 4864-15-Sa, The University of Michigan, Willow Run Laboratories.

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PRENTICE, VIRGINIA L. ASSOCIATE RESEARCH GEOGRAPHER

PUBLICATIONS (continued)

"Progress in Remote Sensing and Its Application to Highway Engineering and Research", Remote Sensing and Its Application to Highway Engineering, co-author, Highway Research Board, National Research Council, Washington, D. C., Highway Research Board Special Report No. 102, pp. 38-48, 1969.

"Sleeping Bear Dunes....A National Lakeshore for Michigan", Sierra Club Bulletin, Vol. 54, No. 6, June 1969, pp. 8-11.

Infrared Survey for Kimberlite Deposits in Botswana, co-author, Report No. 3047-1-L, Willow Run Laboratories, Institute of Science and Technology, The University of Michigan, December 1969.

"Multispectral Remote Sensing Techniques Applied to Salinity and Drainage Problems, Columbia Basin, Washington", PhD Dissertation, 1972.

"Effective Environmental Action," Sierra Club Council Newsletter, Vol. IV, No. 2, 1972, pp. 4-5, 8.

GUNTER SCHRAMM

Personal Data

Date of birth: February 14, 1929
Place of birth: Beuthen, Germany
Married, two children
Citizenship: Canadian
U.S. resident since 1969

Education:

	Institution and Field	Degree and Year
1938-1945	High School Germany	
1958-1960	The University of British Columbia School of Commerce, Vancouver, B.C. Junior Executive Training Program	dipoloma, 1960
1960-1964	The University of British Columbia, Vancouver, B.C., Economics	B.A.(honors), 1964
1965-1967	The University of Michigan, Ann Arbor, Natural resource economics	M.A.(Economics), 1965 Ph.D. (Natural resource economics), 1967

Academic Honors and Fellowships:

British Columbia Government first-class academic scholarship, 1963-64.
Horace H. Rackham graduate fellowship, The University of Michigan, 1964-65
Resources for the Future, Inc. dissertation fellowship, 1966/67

Occupational and Professional Data:

Business:

1946-56	Various positions in accounting, sales and engineering sales in West Germany.
1956-57	A. Simpson and Company, Vancouver, B.C. Chemical Worker.
1957-59	Hydraulic Service and Eqpt. Co., Ltd., Vancouver, B.C. Mechanical draftsman.
1959-64	Pohlig-Heckel-Bleichert AG. Köln, West Germany and Voest AG. Linz/Austria, Western Canadian engineering sales representative.

Academic:

1965-66	Research Assistant, The University of Michigan, Rampart Dam project analysis.
1967-69	Associate Professor of economics, The University of Manitoba, Winnipeg, Canada
1969-	Associate Professor of resource economics, The University of Michigan, School of Natural Resources and Department of Economics, Ann Arbor, Michigan.
1970-72	Adjunct Professor of Economics, The University of Manitoba, Winnipeg, Canada.

Publications

(a) MONOGRAPHS

"Electric Power Demand and Supply in Alaska and the Pacific Northwest," Vol. IV of Stephen H. Spurr, et al, Rampart Dam and the Economic Development of Alaska, The University of Michigan, March 1966, pp. 119.

Economics of Water Resource Planning, Agassiz Center for Water Studies, The University of Manitoba, Research Report, No. 4, Vol. 3, 1970, Winnipeg, 183 pp.

An Analysis of the Electric Power Sector in Haiti, Organization of American States, 1968-70 Technical Assistance Mission to Haiti, Washington, D. C., 1971, pp. 290.

An Analysis of Federal Water Resources Planning and Evaluation Procedures, (with R. Burt), the University of Michigan, School of Natural Resources, Ann ARbor, June 1970, pp. 108.

(b) ARTICLES:

"Economics Research," Praerie Water Symposium: The Souris River Basin, Agassiz Center for Water Studies, The University of Manitoba, Winnipeg, June 1968, pp. 5.

"Taxation, Expenditure Needs and Fiscal Equity," Canadian Tax Journal, Vol. XVI, No. 5, Sept.-Oct. 1968, pp. 379-394.

"The Economics of an Upper Yukon Basin Power Development Scheme," The Annals of Regional Science, Vol. II, No. 1, Dec. 1968, pp. 214-228.

"Economic Principles of Water Resource Planning," 1968 Annual Report, Agassiz Center for Water Studies, The University of Manitoba, Winnipeg, 1969, pp. 9-15.

"The Effects of Low-Cost Hydro Power on Industrial Location," Canadian Journal of Economics, Vol. II, No. 2, May 1969, pp. 210-229.*

*A more detailed version of this paper was published in T. G. Nelson and M.J. Chambers, eds., Water, Methuen Publications, Toronto, 1969, pp. 121-150.

"Relative Price Changes and the Benefits and Costs of Alternative Power Projects," The Annals of Regional Science, Vol, III, No. 2, Dec. 1969, pp. 27-46.

"Elettricita e localizzazione industriali," Mercurio, Vol. XII, No. 4, April 1970, pp. 7-12.

"Regional Versus Inter-Regional Efficiency in Resource Allocations", The Annals of Regional Science, Vol, IV, No. 2, Dec. 1970, pp. 1-14.

"Servizi pubblici e risorse locali: un problema di programmazione regionale," Mercurio, Vol. XIV, No. 3, March 1971, pp. 23-26.

"Regional Benefits in Federal Project Evaluations," The Annals of Regional Science, Vol. VI, No. 1, June 1972, pp. 84-95.

"The Design of a Resource Allocation Function," Canadian Journal of Economics, Vol. V, No. 4, 1972, pp. 515-530.

"Regional Economics," (with Martin J. Beckmann), Regional and Urban Economics, Vol. II, No. 3, 1972.

"Economic and Social Issues of Alternative Resource Allocations," Proceedings of the Symposium on Copper-Nickel Mining, St. Paul, Minn., Aug. 26, 1972 (forthcoming).

"Accounting for Non-Economic Goals in Benefit-Cost Analysis," Journal of Environmental Management, Vol. I, No. 2, 1973 (forthcoming).

Book Review

Charles W. Wixom and Karl F. Zeisler, "Industrial Uses of Water in Michigan," Natural Resources Journal, Vol. 8, No. 4, July 1968, pp. 356-358.

Gilbert F. White, "Strategies of American Water Management," The Annals of Regional Science, Vol. IV, 1970, No. 1, June 1970, pp. 160-161.

VITA

NAME: Stephen D. Nelson

BORN: September 1, 1943; Hays, Kansas

ADDRESS: 1025 Berkshire Road, Ann Arbor, Michigan 48104

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EDUCATION: BA in Psychology, Kansas State University, 1965
Ph.D. in Social Psychology, University of Michigan, 1970

EMPLOYMENT: Project Director, Center for Research on Utilization of Scientific Knowledge, Institute for Social Research, University of Michigan, 1/71 - Present. Conducted studies of social conflict, problem definition, and social policy formulation processes.

Assistant Project Director, Center for Research on Utilization of Scientific Knowledge, Institute for Social Research, University of Michigan, 3/69 - 12/70. Conducted studies of social conflict and experimental game research.

Research Assistant, Center for Research on Utilization of Scientific Knowledge, Institute for Social Research, University of Michigan, 7/68 - 8/68. Review of evaluations of Job Training Corps, with Nathan Caplan.

Research Assistant, Department of Psychology, University of Michigan, 1/68 - 5/68. Investigated attitude change processes and social influence, with Herbert Kelman.

PUBLICATIONS: Interpreting the effects of asymmetric matrices on behavior in the Prisoner's Dilemma game. (Co-authored with Nathan Caplan) University of Michigan, 1969.

The effects of power and resource inequalities on interaction in a mixed-motive situation. Doctoral dissertation, University of Michigan, 1970.

The concept of social conflict. Published in the Working Paper Series of the Center for Research on Utilization of Scientific Knowledge, Institute for Social Research, University of Michigan, 1971. 104 pages.

Chairman's introductory remarks to a symposium, "Problem Definition and Reality Negotiation in the Formulation of Social Policy", 79th Convention of the American Psychological Association, held in Washington, D.C., September 3-7, 1971. Unpublished.

(With Nathan Caplan) On being useful: The nature and consequences of psychological research on social problems. American Psychologist, 1973, 28 (3), 199-211.

VITA

Name: David A. Lingwood

Place and Date of Birth: Seattle, Washington; April 18, 1941

Social Security No.: 532-40-7852

Wife: Donna A. Lingwood

Universities attended:

University of Washington, 1959-63 (B.A. 1963); English, with substantial course work in Communication.
Stanford University, 1965-1969 (A.M. 1963; Ph.D. 1969); Communication Research

Relevant work experience:

Radio announcing and programming, KMCS (FM), Seattle, Washington, 1960-63.
Technician, educational television project, U.S. Peace Corps, Colombia, South America, 1963-1965.
Research Assistant, Institute for Communication Research, and ERIC Clearinghouse, Stanford University, 1965-1969; duties in survey research administration and analysis, computer programming, and information retrieval; ETV research project, El Salvador, 1969.
Project Director, Center for Research on Utilization of Scientific Knowledge, Institute for Social Research, and Lecturer, Department of Journalism, University of Michigan, (CRUSK 1969-present, Jour. 1969-1972.)

Research interests:

Flow of scientific communication (in horizontal and vertical systems).
Communication behavior within professions and public in the field of environmental pollution.
Communication and national development.
Research methods: multivariate analysis; sociometric methods; computerized data analysis and information retrieval.

Professional associations:

American Sociological Association
Association for Education in Journalism

CONSULTING ACTIVITIES

National Council for Exceptional Children; studies of conventions, 1970-1971.

American Dental Association; national caries program planning, 1972.

U.S. Navy Postgraduate School; dissemination and utilization, 1972.

Michigan Nurses Association; continuing education survey, 1972-1973.

RESEARCH CONTRACTS AND GRANTS

Michigan Seagrant Program; social science for environmental problems -- a pilot study; with Donald N. Michael, Robert Ross, and James Swan, 1970-1971.

Manpower Administration, Dept. of Labor; exploratory case studies of inter-system linkage and research utilization; with Ronald G. Havelock, 1971-1972.

U.S. Forest Service, Dept. of Agriculture; (a four or five year action-research project to survey and improve organizational effectiveness and research utilization in the Forest Service Research branch); with William C. Morris, 1971 -- .

Social and Rehabilitation Service, HEW; knowledge utilization systems for Federal R&D programs; Ronald G. Havelock, principal investigator, 1972 -- .

BIBLIOGRAPHY -- David A. Lingwood

(In chronological order)

Chu, Godwin, and Lingwood, David A., Some psychological and sociological predictors of foreign events knowledge. Paper read at the annual convention, Association for Education in Journalism, Boulder, Colorado, 1967.

Lingwood, David A., Item nonresponse in interview data. Proceedings of the 1967 Conference of Pacific Chapter American Association for Public Opinion Research, 1967, 87-92.

-------- Interpersonal communication, scientific productivity, and invisible colleges: studies of two behavioral science research areas. Paper read at the colloquium "Improving the social and communication mechanisms of educational research", Washington, D.C., American Educational Research Association, 1968.

Lingwood, David A., and Funkhouser, G. Ray, Institute for Communication Research Program Library, Stanford Univ., 1968 (mimeo).

Parker, Edwin B., Lingwood, David A., and Paisley, William J., Communication and research productivity in an interdisciplinary behavioral science research area. Stanford, Calif.: Institute for Communication Research, Stanford Univ., 1968.

Lingwood, David A., Apuntes sobre analisis de datos y programas estadisticos basicos en la investigacion social. Educational Television Project, USAID, San Salvador, El Salvador, 1969, (mimeo).

-------- Interpersonal communication, research productivity, and invisible colleges. Unpublished doctoral dissertation, Stanford Univ., 1969.

-------- Communication behavior of communication researchers: a review of three studies. Paper read at the annual convention, Speech Association of America, New York, December, 1969.

-------- An informational demography of educational researchers. Paper read at the annual convention, American Educational Research Association, Minneapolis, Minn., March, 1970.

-------- Survey of student media use, and attitudes/behaviors regarding environmental topics. Dept. of Journalism, Univ. of Michigan, 1970 (mimeo).

Dershimer, Richard A., Paisley, William J., and Lingwood, David A., The 1970 national CEC convention as an information dissemination device. Kensington, Md.: Professional Society Services, for the Council for Exceptional Children, December, 1970.

Lingwood, David A., Invisible college studies: one short summary, and several notes for the future. In proceedings of the conference: Informal Communication Among Scientists: Conference on Recent Work. Chicago: American Medical Association, February, 1971.

Dershimer, Richard A., Lingwood, David A., and Paisley, William J., Evaluation of Chicago, San Antonio and Vancouver CEC Meetings. Kensington, Md.: Professional Society Services, for Council for Exceptional Children, April, 1971.

Lingwood, David A., A research cube for environmental social science: I. Introduction and survey research. Ann Arbor, Mich.: Center for Research on Utilization of Scientific Knowledge, May, 1971 (mimeo).

--------, and Ross, Robert, Progress report: Pilot study of environmental officials in Michigan. Ann Arbor, Mich.: Center for Research on Utilization of Scientific Knowledge, August, 1971 (mimeo).

-------- Environmental education through information-seeking: The case of an "environmental teach-in", Environment and Behavior, 3, 1971, 230-262.

KAN CHEN

Paul G. Goebel Professor of Advanced Technology
Professor of Electrical and Computer Engineering,
University of Michigan

EDUCATIONAL BACKGROUND

BEE	Cornell University	1950	(Power Systems)
SM	Massachusetts Institute of Technology	1951	(Power Systems)
ScD	Massachusetts Institute of Technology	1954	(Automatic Control Systems)

RELEVANT BACKGROUND

Consultant, Environmental Research Institute of Michigan, working on a current project on the technology assessment of remote sensing.

Director, Project PROPE (Policy Research on Population and Environment), an interdisciplinary project at the University of Michigan, supported by the National Science Foundation (1971-73).

Teaching courses in Macro Societal Systems Engineering, and Social Decision making at the University of Michigan, including technology assessment as a topic.

PAST EXPERIENCE

Professor of Environmental Systems Engineering
University of Pittsburgh, Pittsburgh, PA (1970-71)

Director, Institute-wide Program on Urban Development
Stanford Research Institute, Menlo Park, CA (1966-70)

Manager, Systems Technology Research and Development
Westinghouse Electric Corportation, Pittsburgh, PA (1954-65)

Trainee, Detroit Edison Co., Detroit, Mi (1950)

PROFESSIONAL SOCIETIES

Institute of Electrical and Electronic Engineers (IEEE)
President, IEEE Systems, Man and Cybernetics Society (1973)
IEEE Fellow

KAN CHEN

PUBLICATIONS

Books

National Priorities, San Francisco Press, 1970

Urban Dynamics: Extensions and Reflections, San Francisco Press, 1972

Growth Policy: Population, Environment, and Beyond, with K. F. Lagler, et. al., (in press), University of Michigan Press, 1973

Technical articles (see attached list)

Dr. Kan Chen

PUBLICATIONS

1. "Testing of D.C. Interrupters on A.C. Test Circuits," (co-authored with E.W. Boehne), AIEE Transactions, 1955.

2. "Quasi-Linearization Techniques for Transient Study of Nonlinear Feedback Control Systems," AIEE Transactions, 1956.

3. "A Single-Transistor Magnetic-Coupled Oscillator," (co-authored with A. J. Schiewe), AIEE Transactions, 1956.

4. "Analogue Multiplying Circuits Using Switching Transistors," (co-authored with R. O. Decker) IRE Convention Record, 1956.

5. "Analogue Logarithmic and Antilogarithmic Circuits Using Switching Transistors," (co-authored by A. J. Schiewe), Proceedings of Western Joing Computer Conference, 1957.

6. "A Quick Method for Estimating Closed-Loop Poles of Control Systems," AIEE Transactions, 1959.

7. "A Standard Transistorized Optimum Response Controller," (co-authored with D.R. Little), AIEE Transactions, 1959.

8. "Analysis and Design of Feedback Control Systems with Gain and Time Constant Variations," IRE WESCON Record, 1960.

9. "Design of Non-Interacting Control Systems Using Bode Diagrams," (co-authored with R.A. Mathias and D.M. Sauter), AIEE Transactions, 1961.

10. "Process Optimization by Combining the Model and Experimental Approaches," (co-authored with R.O. Decker), ISA Instrument-Automation Summer Conference Record, 1961.

11. "Modern Research in Automatic Control," an invited address delivered at the plenary session of the 1961 Joint Automatic Control Conference.

12. "A Method for Solving the Noise Problem in Process Optimization," (co-authored with K.H. Bhavnani), Control Engineering, 1962.

13. "Industrial Internship in System Engineering--A Joint Industry-University Venture," (co-authored with W.K. Linvill). AIEE ITG Automatic Control, Vol. 1, No. 3, 1962.

14. "Dual of the Optimality Principle in Dynamic Programming," (co-authored with K.W. Bhavnani), Westinghouse Research Scientific Paper 62-163-292-pi, 1962.

15. "Some Special Problems of Electric Power Expansion in Developing Countries," (co-authored with W.K. Linvill). Symposium on Possibilities of Operations Research in Developing Countries, organized by the French Society of Operational Research, 1963. Paris Conference co-sponsored by TIMS, ORSA, ORS, and French Society of Operations Research. (Colleque de Paris Juin) 1963.

16. "Quasi-Linearization Design of Nonlinear Feedback Control Systems" IEEE Transactions, Applications and Industry, May, 1964.

17. "The Role of Large Industry in Underdeveloped Areas", Eastern Intercollegiate Conference on Industrialization of Underdeveloped Areas, 1964.

18. "Computer Simulation of a Steel Mill Ingot Processing Area", (co-authored with E.Y. Kung and P.B. Skov), Record of the 19th Annual ISA Conference, 1964.

19. "Models for Integrated Control," Record of the 2nd Systems Engineering Conference, 1965.

20. "Decision Analysis for Industry," Record of the 21st Annual Meeting of the SRI Associates, 1966.

21. "Objective-Setting in a Large Industrial Firm--Case Study in Steel," (co-authored with T.E. Dancy, O.C. Gochenour, and E.Y. Kung), IEEE Transactions on Systems Science and Cybernetics, Vol. SSC-3, No. 2, 1967.

22. "Optimization of Time-Dependent Systems by Dynamic Programming," (co-authored with K.H. Bhavnani), ISA Transactions, Vol. 6, No. 2, 1967.

23. "A Portable Interpretation of Quality", Record of the 1st International Conference on Systems Sciences (Hawaii), 1968.

24. "The Need for Change Agents in Urban Development", (co-authored with R.C. Amara), Record of the IEEE Systems Science and Cybernetics Conference, 1968.

25. "Private-Public Sector Partnerships in Urban Affairs--The National Perspective," (co-authored with R.C. Amara), Record of the 23rd Annual Meeting of the SRI Associates, 1968.

26. "An Interdisciplinary Team Approach from the Nonengineering Point of View--A Commentary", Industrialization and Development, (a book edited by H.E. Hoelscher and M.C. Hawk), San Francisco Press, 1969.

27. "Branch and Bound Approach for Decision-Tree Analysis", (co-authored with G.T. Patton), Record of the 1970 Operations Research Society of America Meeting, October, 1970.

28. National Priorities (ed.), San Francisco Press, 1970.

29. "Prolegomenon to Value-Oriented Social Systems Analysis", Battelle Seminar Paper, 1970.

30. "Exploring New Directions in Engineering Education", Technological Forecasting and Social Change, Vol. 3, No. 3, 1971; also in Engineering Education, Vol. 63, No. 2, 1972.

31. "A Macrosystem Analysis of the Human Environment", Journal of Environmental Systems, Vol. 1, No. 2, 1971; also in the Record of Joint National Conference on Major Systems, 1971.

32. "Subjectivity in Decision Analysis for Public Policy Planning", Record of the 1971 Joint Automatic Control Conference.

33. "The Role of Science and Technology in Less-Developed Countries--A Systemic Analysis", (co-authored with H.E. Hoelscher), Woods Hole Conference on the Role of Science and Technology in International Development in the 1970's, August, 1971.

34. "Dynamics of Less Developed Countries" (co-authored with H.E. Hoelscher), Proceedings of the 1971 Allerton Conference on Systems and Control.

35. "Environmental Effects of Techno-Economic Systems: A Systems Engineering Interpretation of the Input-Output Approach", Proceedings of the 1971 IEEE Conference on Decision and Control, December 1971

36. "Urban Modeling", (co-authored with W.L. Garrison), IEEE Transactions on Systems, Man and Cybernetics, April, 1972

37. Urban Dynamics: Extensions and Reflections (ed.), San Francisco Press, 1972.

38. "Growth Policy and Alternative Futures", Proceedings of the Third World Future Research Conference (Bucharest, Romania), 1972.

39. "Socially Oriented Engineering Education", Proceedings of the 1972 IEEE Conference on Decision and Control, December 1972.

40. Growth Policy: Population Environment, and Beyond (with K. F. Lagler, et. al.), University of Michigan Press (in press), 1973.

41. "Methodological Approach to Technology Assessment of Remote Sensing", (co-authored with G. J. Zissis), accepted by the First International Congress of Technology Assessment, May, 1973.

KLAUS P. HEISS
DIRECTOR
ADVANCED TECHNOLOGY ECONOMICS

BORN: August 21, 1941

EDUCATION:

1970-1971	Graduate Course on Space Propulsion Systems (AMS-591) Aerospace and Mechanical Science, Princeton University
1964	Ph.D., Hochschule for Welthandel, Vienna, Austria Economics
1962-1963	University of Bocconi, Milan, Italy Economics
1962	B.A., Hochschule for Welthandel, Vienna, Austria Economics

POSITIONS:

1966	MATHEMATICA	Director, Advanced Technology Economics 1971 Senior Economist 1967-1971 Economist 1966-1967
1965-1966	Research Associate and Lecturer in Economics Econometric Research Program, Princeton University	
1964-1965	Research Assistant, Econometric Research Program Princeton University	

EXPERIENCE:

Dr. Heiss has had extensive experience in economics, covering the most recent developments in economic theory and policy. In two years at Princeton University his major fields of research were mathematical economics, econometrics and game theory. In addition to this, his European education gives him a strong background and understanding of international finance, the role of inflation and economic policy planning at a national level.

Since joining MATHEMATICA, Dr. Heiss has worked with success in the economic evaluation of major new technological systems for various U. S. Government Agencies including the U. S. Atomic Energy Commission, the U. S. Department of Transportation, the Office of Naval Research, and the National Aeronautics and Space Administration. Some of this work had a major impact on actual policy decisions.

EXPERIENCE (cont'd)

In the past 15 months, Dr. Heiss has been directing a study for the National Aeronautics and Space Administration on a New U. S. Space Transportation System for the 1980's, including the Space Shuttle System and the Space Tug. The study incorporated important innovation in benefit-cost analyses.

Dr. Heiss was called before the U. S. Senate to testify on the Space Shuttle program evaluation. Also, Dr. Heiss gave various presentations to the President's Science Advisory Committee and the National Academy of Engineering on the Space Shuttle Program.

PUBLICATIONS:

"On the Measurement and Evolution of the Powers of Nations," paper presented to the Economic Seminar at Princeton University, 1966.

"The Economics of the Peaceful Uses of Underground Nuclear Explosions," with Oskar Morgenstern, co-author, prepared for the Atomic Energy Commission, MATHEMATICA, PNE-3005, August 31, 1967.

"Technical and Economic Potential of Gas Stimulation by Nuclear Explosives," prepared for the U. S. Atomic Energy Commission, MATHEMATICA, PNE-3007, August 31, 1967.

"Game Theory and Human Conflicts," Research Memorandum, No. 80, Econometric Research Program, Princeton, March 1966, Published in Festschrift fur Prof. Waffenschmidt, 1968.

"Rodolfo Benini," article for the International Encyclopedia of the Social Sciences, 1968.

"Wilhelm Lexis," article for the International Encyclopedia of the Social Sciences, 1968.

"Technical and Economic Potentials of the Shale Oil Production by Nuclear Explosives," prepared for the U. S. Atomic Energy Commission, MATHEMATICA, PNE-3006, August 31, 1967.

"The Economic Feasibility of Mining Operations with Nuclear Explosives," prepared for the U. S. Atomic Energy Commission, MATHEMATICA, 1968.

"An Econometric Study of Small and Intermediate Size Diameter Drilling Costs for the United States," with E. B. Dagum, prepared for the U. S. Atomic Energy Commission, MATHEMATICA, 1968 (2 vols).

"Cost-Benefit Study of the Earth Resources Satellite Program: Grazing Land Applications," with Charles Frank Jr., prepared for RCA-ASTRO Electronics Division, MATHEMATICA, August 1968.

PUBLICATIONS (cont'd)

"Cost-Benefit Study of the Earth Resources Satellite Program: Extramarine and Coastal Management," with Edward J. Greenblat, prepared for RCA-ASTRO Electronics Division, MATHEMATICA, June, 1969.

"Theory and Implementation of Cost-Benefit Analysis of Transportation Systems," prepared for the Department of Transportation under subcontract from the Resource Management Corporation, December, 1969.

"Long Term Projections of Power: Review and Outline," with Klaus Knorr and Oskar Morgenstern, prepared for the Office of Naval Research, March, 1970.

"Estimating the Economic Benefits of Surveying Earth's Resources," in: The Proceedings of the Princeton University Conference on Aerospace Methods for Revealing and Evaluating Earth's Resources, The Princeton University Conference, 1970.

"On the Principals of Public Project Evaluation," volume I of Cost Benefit Analysis of New Launch Systems; with Uwe Reinhardt: prepared for the National Aeronautics and Space Administration, July, 1970.

"The Economics of the Space Program," in Organizing Space Activities for World Needs, E. A. Steinhoff, editor, Pergamon Press, Oxford & New York, 1971

"Cost Benefit Analysis of New Launch Systems -- Results of Economic Evaluation," volume II, prepared for the National Aeronautics and Space Administration, July, 1970.

"Benefit-Cost Analysis of New Space Transportation Systems," 2 volumes, main investigator prepared for the National Aeronautics and Space Administration, March, 1971.

Economic Analysis of New Space Transportation Systems, 2 volumes, prepared for the National Aeronautics and Space Administration, June, 1971.

"Our R & D Economics and the Space Shuttle," in Astronautics and Aeronautics, October, 1971, Volume 9, No. 10, pp. 50-62.

Economic Analysis of the Space Shuttle System, with Oskar Morgenstern, et.al., 3 volumes, prepared for the National Aeronautics and Space Administration, January, 1972.

CONFERENCES AND SYMPOSIA:

"The Economics of the Space Program," XIX Congress of the International Astronautical Federation, New York, October, 1968.

"Estimation of Drilling Costs in Unconventional Applications," The Offshore Exploration Conference, OECON, San Diego, California, March 7, 1969.

"Planning Space Activities in the 1970's," American Astronautical Society -- Operations Research Society, Denver, Colorado, June 19th through June 20th 1969.

"Estimating the Economic Benefits of Surveying Earth's Resources," The Princeton University Conference on Aerospace Methods for Revealing and Evaluating Earth's Resources, September 25th through 26th, 1969.

"Wealth, the World Oceans and Economics," The Oceanic Maritime Symposium of the Navy League of the United States, February, 1970.

"Die Wirtschaftliche Planung cines Technischen Fortschrittes: Raumfabrt Transportsysteme fur die achtziger jahre (The economic Planning of Technical Change: Space Transportation Systems of the 1980's)", Conference on Economic and Social Effects of Technological Change, University of Mannheim, Mannheim, Germany, November, 1970.

"Economic Principles for the Evaluation and Pricing of Transportation Systems," Session Chairman, Corridor Symposium, College of Europe, Bruges, Belgium, June, 1971.

To be published: Book on Antonio Serra, an Italian Economist, 1971.

Dissertation (in German):
"On Models of Economic Growth," Vienna, 1964.

Scientific Paper for B. A. (in Italian):
"Efficiency, Rate of Interest, and Growth of Capital," 1962, Vienna.

"Orbit to Orbit Shuttle Economics," XXIIIrd International Astronautical Congress, Vienna, October, 1972.

"An Economic Research and Development Policy for Austria," prepared for the Exploratory Conference on the Future of Science and Technology in Austria, Vienna, October, 1972.

TESTIMONIES AND PRESENTATIONS:

Senate Committee on Appropriations-Subcommittee on HUD-Space-Science, Economic Evaluation of Reusable Space Transportation Systems, June 29, 1971.

President's Science Advisory Committee, Space Shuttle Panel, "The Economics of a Fully Reusable Space Transportation System," WoodsHole, Massachusetts, August 15, 1971.

U. S. Senate Committee on Aeronautical and Space Sciences, Economics of the Space Shuttle, Washington, D. C., April 12, 1972.

TEACHING COURSES:

On the Accuracy of Economic Observations (1968-69)
The Economics of Weapons Acquisitions (1968-69)
National Economic Policy (1969-70)
The Technique of "Learning Curves" (1969-70)
Input-Output Analysis (1970-71)
Evaluation of Technological Forecasting Techniques (1970-71)

AFFILIATIONS:

American Economic Association
Atomic Industrial Forum
American Astronautical Society
Honorary Faculty Member of the U. S. Army Logistics Management Center.

PORCELLO, LEONARD J.

DIRECTOR, RADAR AND OPTICS DIVISION

EDUCATION

BA	Physics	Cornell University, 1955
MS	Physics	The University of Michigan, 1957
MSE	Electrical Engineering	The University of Michigan, 1959
PhD	Electrical Engineering	The University of Michigan, 1963

EMPLOYMENT

Teaching

Instructor, Department of Electrical Engineering, The University of Michigan, 1958-1961
Lecturer, College of Engineering Summer Intensive Courses, The University of Michigan, 1963-1970
Co-Chairman, College of Engineering Summer Intensive Course on Imaging Radar, 1966-1970
Lecturer, University of California Extension Program, Statewide Lecture Series, Spring 1968
Associate Professor, Department of Electrical Engineering, The University of Michigan, July 1969-June 1972
Professor, Department of Electrical and Computer Engineering, The University of Michigan, July 1972-December 1972

Research

Research Assistant, Radar and Optics Laboratory, The University of Michigan, WRL, 1955-1957
Graduate Research Assistant, Radar and Optics Laboratory, The University of Michigan, WRL, 1957-1958
Senior Scientist, Lockheed Missile and Space Company, Research Division, Palo Alto, California, Summer 1960
Research Engineer, Radar and Optics Laboratory, The University of Michigan, IST, 1961-1969
Assistant Head, Radar and Optics Laboratory, The University of Michigan, IST, 1963-1968
Head, Radar and Optics Laboratory, The University of Michigan, IST, July 1968-December 1972
Associate Director, WRL, The University of Michigan, IST, August 1970-December 1972
Director, Radar and Optics Division, Environmental Research Institute of Michigan, January 1973-present

PORCELLO, LEONARD J. DIRECTOR, RADAR AND OPTICS DIVISION

EMPLOYMENT (continued)

Other

Consultant to Radar and Optics Laboratory, The University of Michigan, IST, 1958-1961
Consultant, Lockheed Missile and Space Company, Sunnyvale, California, 1960-present
Consultant, IBM Federal Systems Division, Owego, New York, 1960-1961
Consultant, Perkin-Elmer Corporation, Norwalk, Connecticut, 1964-1967
Consultant, Conductron Corporation, Ann Arbor, Michigan, 1966-1967
Consultant, KMS Industries, Ann Arbor, Michigan, 1967-1968
Consultant, Institute for Defense Analyses, Washington, D.C., 1969
Consultant, Goodyear Aerospace Corporation, Phoenix, Arizona, 1970

EXPERIENCE

Research experience: Research on synthetic-aperture radar systems; coherent optical systems and their application to synthetic-aperture radars; optical processing of planetary radar data. Radio wave propagation in the troposphere and in the ionosphere; effects of atmospheric inhomogeneities on synthetic-aperture performance; application of fine-resolution radar to earth-resource survey; application of fine-resolution radar to subsurface lunar sounding.

Teaching experience: Undergraduate courses in circuit analysis, electronics, and introductory communication theory. Graduate courses in radar for electrical engineers and for natural scientists; intensive courses on optical data processing, radar and remote sensing applications.

Management experience: Technical management of fine-resolution radar research program for ten years; overall management of radar, optics, and countermeasures program, with responsibility for developing new disciplinary research programs in these general areas, and interdisciplinary programs related to these areas.

Other experience: Consultation on fine-resolution radar for government and industry.

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PORCELLO, LEONARD J.

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OPTICS DIVISION

PROFESSIONAL AND HONORARY SOCIETIES

Senior Member, Institute of Electrical and Electronics Engineers; Information Theory Group, Aerospace and Electronic Systems Group, Antennas and Propagation Group
Member, Optical Society of America
Member, Sigma Xi
Member, Eta Kappa Nu
Member, American Association for the Advancement of Science

PATENT

No. 3,427,104, "Optical Plural Channel Signal Data Processor," co-inventor, issued February 11, 1969

PUBLICATIONS

Doctoral Dissertation

"An Experimental Study of Rapid Phase Fluctuations Induced Along a Satellite-to-Earth Propagation Path," The University of Michigan, November 1963

Books and Journal Articles

"Optical Data Processing and Filtering Systems," L. J. Cutrona, E. N. Leith, C. J. Palermo and L. J. Porcello, IRE Trans. Info. Theory, Vol. IT-6, No. 3, pp. 386-400, June 1960

"On the Application of Coherent Optical Processing Techniques to Synthetic-Aperture Radar," L. J. Cutrona, E. N. Leith, L. J. Porcello, and W. E. Vivian, Proc. IEEE, Vol. 54, No. 8, pp. 1026-1032, August 1966

"On the Observed Fine-Structure of a Phase Perturbation Induced During Trans-Auroral Propagation," L. J. Porcello and L. R. Hughes, J. Geophys. Res., Vol. 73, No. 19, pp. 6337-6346, October 1968

"Optical Processing of Planetary Radar Data: Preliminary Results," L. J. Porcello, C. E. Heerema, and N. G. Massey, J. Geophys. Res., Vol. 74, No. 4, pp. 1111-1115, 1969

PORCELLO, LEONARD J. DIRECTOR, RADAR AND OPTICS DIVISION

PUBLICATIONS (continued)

Books and Journal Articles (continued)

"Microwave Holography and Imaging Radar, L. J. Porcello, contrib. to Holography and Its Applications, J. Barnes, ed., John Wiley and Sons, Inc. (in publication)

"An Introduction to Synthetic-Aperture Radar," W. M. Brown and L. J. Porcello, IEEE Spectrum, Vol. 6, No. 9, pp. 52-62, September 1969

"Non-Optical Electromagnetic Sensing," L. J. Porcello, contrib. to Remote Sensing Principles and Applications to Earth Resources Survey, a collection of papers presented November 4-6, 1969 at a Seminare sponsored by Centre National d'Etudes Spatiales, Paris

"Turbulence-Induced Phase Errors in Synthetic Aperture Radars," L. J. Porcello, IEEE Trans. Aerospace and Electronic Systems, Vol. AES-6, pp. 636-644, September 1970

Papers Presented at Government Symposia

"Resolution Estimates for an Aerospace Synthetic-Array Radar System," L. J. Porcello, presented at 8th Annual Radar Symposium, Ann Arbor, Michigan, June 1962; published in 8th Annual Radar Symposium Record, pp. 209-226, August 1962 (SECRET)

"Atmospheric Effects on Synthetic Aperture Radar Systems," L. J. Porcello, presented at classified session in conjunction with IEEE 1965 Winter Convention on Military Electronics, Los Angeles, California, February 1965 (SECRET)

"Diversity and Mixed-Integration Processing in Synthetic-Aperture Radar," L. J. Porcello, N. G. Massey, R. B. Innes, and J. M. Marks, presented at the 14th Annual Radar Symposium, Ft. Monmouth, New Jersey, June 1968; published in 14th Annual Radar Symposium Record, pp. 114-142, October 1968 (SECRET)

"Synthetic-Aperture Radar Performance in the Presence of Atmospheric Phase Errors," L. J. Porcello and W. M. Brown, presented at the 16th Annual Radar Symposium, Colorado Springs, Colorado, June 1970; published in 16th Annual Radar Symposium Record, pp. 747-765, September 1970 (SECRET)

PORCELLO, LEONARD J. DIRECTOR, RADAR AND OPTICS DIVISION

PUBLICATIONS (continued)

Papers Presented at Technical Society Meetings

"Data Processing by Optical Techniques," L. J. Cutrona, E. N. Leith, and L. J. Porcello, presented at the Third National Convention on Military Electronics, IRE, June 1959 and published in conference proceedings

"Coherent Optical Data Processing," L. J. Cutrona, E. N. Leith, and L. J. Porcello, presented at IRE WESCON, San Francisco, California, August 1959, published in 1959 WESCON Convention Record, Part 4, p. 141

"Filtering Operations Using Coherent Optics," L. J. Cutrona, E. N. Leith, and L. J. Porcello, National Electronics Conference, Chicago, Illinois, October 12-14, 1959; published in Proceedings NEC, Vol. XV, pp. 262-275

"High Frequency Phase Fluctuations in Transionospheric Propagation," L. J. Porcello and L. R. Hughes, talk presented at the Spring 1964 URSI Meeting, Washington, D.C.

"Fine-Scale Electron Distribution as Deduced from Transionospheric VHF Propagation," L. R. Hughes and L. J. Porcello, presented at the Fourth Western National Meeting of the American Geophysical Union, Seattle, Washington, December 29, 1964; Abstract, AGU Trans., Vol. 45, p. 598, 1964

"On the Application of Modern Optical Techniques to Radar Data Processing," L. J. Cutrona, E. N. Leith, L. J. Porcello, and W. E. Vivian, presented at the Ninth Symposium of the AGARD (NATO) Avionics Panel on Opto-Electronic Components and Devices, Paris, September 1965

"Coherent Optical Techniques for Radar Data Processing," E. N. Leith, L. J. Cutrona, and L. J. Porcello, invited paper presented at 1966 Annual Meeting of the Optical Society of America, San Francisco, October 1966

"Microwave Holography and Side-Looking Radar," L. J. Porcello, paper presented at Conference on Photogrammetry, Lasers, and Holography, American Society of Photogrammetry, December 1969

PORCELLO, LEONARD J. DIRECTOR, RADAR AND OPTICS DIVISION

PUBLICATIONS (continued)

Papers Presented at Technical Society Meetings (continued)

"Lake Ice Surveillance via Airborne Radar: Some Experimental Results," B. T. Larrowe, R. B. Innes, R. A. Rendleman, and L. J. Porcello, presented at Seventh International Symposium on Remote Sensing of Environment, Ann Arbor, Michigan, May 1971; published in the symposium proceedings, Vol. I, pp. 511-521

"Differential-Phase Measurements of Fine-Scale Ionospheric Irregularities," J. L. Auterman and L. J. Porcello, presented at the 1972 USNC-URSI Spring Meeting, April 1972, Washington, D.C.

Has also been major author of or contributor to approximately 40 published technical and progress reports in areas of radar, optics, and atmospheric propagation

DIGIOVANNI, ROBERT B.

Personal

Date and Place of Birth: April 6, 1941; Ardmore, Pennsylvania
Marital Status: Wife, Jacqueline; three children
Military Status: IIIA
Address and Telephone: 810 Henry, Ann Arbor, Michigan 48104
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Education and Honors Received

Cornell University, BA (1963); University of Michigan, MA (1965) and PhD (1971)
Dean's List; Cornell Undergraduate Scholarships; E.H. Snow Memorial Scholarship; G.C. Boldt Memorial Scholarship

Major Livelihood Experience

Teacher, St. James High School, 1963-64
Teaching Assistant, University of Michigan, 1964-65
Assistant Professor, Bay de Noc Community College, 1965-66
Lecturer, Eastern Michigan University, 1966-68
Instructor, Eastern Michigan University, 1968-date

Editing, Reviewing, and Writing Experience

Editor, University of Michigan Institute of Science and Technology, 1967-69--including publication of a book, Frontiers in Manufacturing Technology, III (Ann Arbor, 1968)
Editor, University of Michigan Highway Safety Research Institute, 1969
Editor, University of Michigan Bureau of Business Research, 1969-1970
Judge, Detroit News, writing contest, 1973
Reviewing Consultant, Choice, 1972-date--including an article soon to be published
Teacher of Writing, see MLE above, 1963-date--including courses in freshman composition, advanced expository writing, and creative writing
Seminar Leader (for business managers in methods of communication), University of Michigan Bureau of Industrial Relations, 1971
Wide experience with information, news, and publicity for the following:
University of Michigan Lacrosse Team, 1965-69
Wolverine Lacrosse Club, 1970-date
Eastern Michigan University Dramatic Scenes Program, 1970-date
Eastern Michigan University Dialogue Series, 1972-date