COAL - ISSUES FOR THE EIGHTIES

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Report of the Inaugural Meeting for
an IIASA Collaborative Industry Study

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PREFACE

This paper summarises the proceedings of the inaugural meeting to establish a new international collaborative project for the coal industry--the first IIASA Industry Study to be carried out under the generic title of "Issues for the Eighties". The purpose of this paper is to provide information for those who may be interested in the project to understand what has so far been done, and what the value may be of cooperation.

It may be worth saying something about the general concept lying behind the IIASA Industry Studies. The purpose of these is to bring together representatives of the same industry from many countries, to identify the key issues which the industry faces over the next ten years, to identify the way in which systems analysis can assist in the major policy and investment decisions, and to engage in a collaborative program of information exchange and research. IIASA's role is essentially catalytic. It is our task to identify needs, and seek to create the conditions in which they can be satisfied. Its unique international--but non-governmental--position in the systems analysis field, and the fact that it works in so many fields of concern to industry (Energy, Resources, Environment, Manpower and Health, Management, Technology, etc.,) makes it an ideal base for a creative exchange of information methods and ideas. Funding limitations restrict the amount of research that it can undertake but, in any case, the knowledge and research skills lie within the industry itself. The fact that the work will be collaborative is fundamental to its success, which we hope will result in better information and an improved methodology for those involved in policy decisions.

Up to the present, two such industry studies have been set in motion, one in coal and another in the forestry/forest product industry. The reasons for selecting the coal industry, and the

general background to the study, are set out in Appendix A which was sent out in advance to participants at the inaugural meeting held at IIASA in March 1979. A brief report of that meeting, together with recommendations for future action follow. Various supporting documents are set out in the Appendices.

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INTRODUCTION

We should emphasize that if systems analysis were simply the application of mathematical techniques or computer programs to well defined problems, there would be no need for such a study. But it is much more than that. Decision-making and systems analysis (or operational research as the British call it) are interacting processes, and the problems to be tackled are ill-defined and changing with time. Progress can only be made by practical research in the industry itself, and the exchange of ideas must take place between those involved, both researchers and managers. It was noted at the March meeting that no such dialogue takes place as it does in the more technical field. Since these studies can yield major returns to the companies concerned there is clearly a gap to be filled. This gap provides an opportunity, but there is also a danger that expectations may be raised too high. There are simply too many topics to explore all at once, whether for information exchange, or for collaborative research. Inevitably therefore this first meeting focused on certain issues where interest is lively and research already in progress, since these are topics on which progress can be made quickly. They are not the only topics that need to be studied nor necessarily the most important ones. Other issues will be identified and explored as the work goes on, and the individual studies will be examined within the content of the overall problems of the industry. That is what the decision-makers have to do, and that is the only way that the systems analyst can help.

ORGANIZATION OF MEETING

This inaugural Task Force meeting was attended by participants from Canada, FRG, Hungary, Poland, UK, USA, and IIASA staff. An attendance list is given as Attachment B. An important feature was the seniority, practical experience and range of backgrounds of those who attended. Several other countries have shown an interest but were unable to attend this meeting. A desire to participate in this project was expressed by FRG, Czechoslovakia, GDR, and the USSR.

Keeping in mind that the objective of this project is to provide assistance to those responsible for investment and policy decisions in the coal industry throughout the world, the Task Force meeting consisted of listening to presentations by some of the participants and holding discussions on selected topics.

There were three presentations from industry representatives from Hungary, Poland and the UK, one of the WELMM (Water, Energy, Land, Manpower, Material) project being undertaken at IIASA, and a presentation of a joint project on environmental issues being planned by IIASA and Argonne Research Laboratories of the US Department of Energy. These helped to focus the discussions which were centered on the five topic areas set out in the Appendix of Attachment A namely:

- -- Exploration and Characterization
- -- Mine Planning and Organization Problems
- -- Operations Planning and Production
- -- Distribution and Utilization
- -- Corporate Requirements (Externalities, Environmental and Institutional).

Three main issues for joint study evolved from these discussions and it was agreed that these would form the main basis for work in the immediate future.

PRESENTATIONS

At this meeting, presentations were made by Mr. George Mitchell--UK, Dr. Jan Stachowicz--Poland, Dr. Laszlo Lengyel--Hungary, Dr. Loren Habegger--USA, and Dr. Nikolai Vorontsov and Mr. Arnulf Gruebler from IIASA. Since this document is meant to be only a brief summary of the main points discussed at the meeting and not a set of minutes, and since the presentations were usually meant only to give an overview of the participants' areas of recent work or interest in order to solicit responses from the other participants, we are only supplying a brief synopsis of each presentation.

Mr. George Mitchell--UK

Mr. Mitchell started his presentation by pointing out that the UK has a plentiful supply of coal for the future and is devoted to increasing coal output. This commitment, however,

follows twenty years of decline in the industry so that all the questions concerning the planning of new mines are having to be thought out again in the new circumstances. It is important to realize that the political, social, and institutional problems are perhaps even more important than the engineering design problems in planning a new mine and that Operational Research (as it is called in the UK) and Systems Analysis have a substantial part to play in both. Although his team studied the problem from the point of view of the coal industry, it is necessary to analyze the national situation and, indeed, the position of special interest parties, if the negotiation process is to be satisfactorily completed.

So far as the "engineering aspects of planning" are concerned, there are a number of roles which the OR/Systems Analysis team could undertake. Some of the work is genuine "research", a search for the 'best' answer to the problem. Such research could be devoted either to systems economics or to management and organization. The UK has looked at such subjects as the scale of operation, choice of mining methods, ventilation and the underground environment along with the questions of computer technology and control. A second function that the OR/SA man can undertake is 'belief analysis' in which he can explore the consequences of various design assumptions. Traditional modelling techniques are of value in this connection. Although some of these are a once-off nature, they have a large number of standard programs that could be used to look at problems of exploration, transport, manpower allocation, etc. An important role for the OR/SA man here is in checking the consistency of assumptions. Finally, a third type of study is in the exploration and analysis of new ideas, a kind of extended technology assessment. The use of computers as an aid to planning is one such new idea which is still relatively unexplored. The value of integrated planning needs deep analysis. Little thought has been given to the design of a planning process that would keep options open as long as possible. Perhaps one of the main ways in which IIASA could help the industry is in guiding and coordinating new thinking about "the planning of planning".

Dr. Jan Stachowicz--Poland

Dr. Stachowicz began his presentation by giving some salient facts concerning the Polish mining industry. For example, during the period 1970-1977, coal output has increased from 140 million tons to 186 million tons. Coal output is forecasted to increase to over 210 million tons in 1980 and 240 million tons by 1985. At present, 380 thousand people are employed in the mining industry, and production comes from about 65 mines. With this background, Dr. Stachowicz then proceeded to elaborate several premises which they feel will form the future of the mining industry. These include:

-- the world economy will shape the trends in coal demand

-- it will be necessary to integrate coal exploitation and utilization on a global scale

-- mining-geological conditions will continually degrade
-- fewer people willing to work in the mines
-- increasing competition from other materials (fuels)
-- increasing legal and formal restrictions (environmental, etc.).

Some important practical problems of interest to the Poles include the following:

-- how to design management systems for planned new mining basins
-- how to modernize the management systems in existing organizations
-- how to create conditions to encourage effective use of computers in the mining industry
-- how to improve the process of decision-making.

Dr. Stachowicz, being aware of the basic differences between capitalistic and socialistic economic systems along with the associated differences between organization and management theory, does not expect this project to define and develop a compact organization theory. However, the results of our work could contribute to the recognition of general rules of organizational development.

At present, Poland as conducted two pilot studies in two areas and in several mines as well as in other economic units working for the mining industry. This work is briefly described in the section "MAIN DISCUSSION TOPICS" in topic I, Management and Organization.

We have included copies of the viewgraphs used by Dr. Stachowicz in Attachment C. The last viewgraph lists the main topics of interest to Poland. A full paper will be issued later by IIASA as a working paper.

Dr. Laszlo Lengyel--Hungary

Dr. Lengyel discussed a number of models, some still at the theoretical stage and others at the operating stage, which Hungary is using in their planning. The models are linked together and to data bases to give a very comprehensive coverage of the problem. These models cover the areas of exploration, mining, and processing.

One model group is used to determine how to fulfill the final demands for product under constraints on labor and capital. That is, to select the best way of exploration, the best mining technology, etc., based on data in data bases. These data bases have geological, ecological, and technical data. Questions they have concern how to express tradeoffs in the ability to decrease capital at the expense of the environment? What technological

changes will occur? They are also curious about what information others have on the influences on infrastructure, for example railroads.

Mr. Arnulf Gruebler--IIASA

Mr. Gruebler discussed the WELMM approach to analyzing energy strategies. This approach, developed at IIASA in the Resources and Environment Area, takes into account Water, Energy, Land, Materials, and Manpower. One can use the WELMM Facility Data Base to assess the impacts of certain strategies, large scale coal mining for example, on the environment. The Resources Group has launched just such a study. The objective of this study is to collect and analyze the WELMM data of a large number of coal mines in various countries. The process of data collection is currently being actively pursued. A partial set of data has already been computerized for analysis. The full study should be completed this year.

Parallel to this, they are in the process of developing, from various existing data bases, a WELMM Resource Data Base by basins and for major fields. During this year, the combination of data bases along with the WELMM coal mining study will allow them to better understand the potential constraints of a large world coal option.

Dr. Loren Habegger--USA
Dr. Nikolai Vorontsov--IIASA

This presentation set out the background to a proposed study on Integration of Regional Environmental Goals into Coal Production and Utilization Strategies. This proposal is set out in detail in Appendix D.

MAIN DISCUSSION TOPICS

Management and Organization

This topic, which had been introduced by Dr. Stachowicz in his paper, generated the most discussion, partly because the Polish, UK and FRG coal industries were all engaged on active research in this connection. The issues raised were very wide involving problems at colliery and group (Area, Combinat, Company) level.

One fundamental issue arose from the introduction of computers and automatic information recording of mining operations and environment. This was producing an information explosion which no-one quite knew how to handle. The question of how it should be summarized and analyzed gave rise to further major questions of managerial authority and organization.

Another major question was to explore the benefits of different methods of introducing computers into the mine. Should they be done by reflection and research before the event or is the best way to provide managers with computers and see what they do with them? Britain is adopting this second strategy, giving the managers assistance and support so they understand the capabilities of the computer, and then observing (in a scientific sense) what they do with it. They should have at least some preliminary results on this strategy by the end of the year.

It was suggested that it would be helpful to analyze what has happened in other industries. For example, the British and Japanese steel industry experience. The British tended to start with some on-line process control and worked up unit by unit and at every successive stage met problems of coordination and having to scrap something in one place and make it fit somewhere else. The Japanese, however, had a very strong top down approach. The top management gave very strong commitments to computerization from an early stage and forced it down from there. In the long term this has paid off well but probably raised considerable difficulties in the short term.

This discussion raised issues which are already being studied within the Management and Technology Area at IIASA. The first is in the Innovation task, which is specifically concerned with the problems of introducing innovation into the industry. The work on the impact of small scale computer systems on management and organization is also relevant.

Poland is working on two Pilot studies in which they are gathering statistical information which describe geological mining conditions, technological conditions, and organizational conditions in the collieries. These collieries are then divided into homogeneous groups based on the Wroclaw taxonomy method. Thirty-one coefficients have been defined for describing a mine as a whole. While collecting statistical data that describe the technique, technology and organization levels of a mine, a supplementary study, called Pilot Study I, was initiated. This study looked at the problems concerned with decision processes at the mine and area levels, the type of information used in the decision-making process, the function of the information (computer) system, etc. Poland should finish Pilot Study I by the end of the year. They have all the statistical material but must yet complete their analysis.

It was pointed out that in the United Kingdom there have been studies on the effect of certain factors on methods of management and organization and geological uncertainty turns out to be a very important factor. Where geological uncertainty exists, the organization must be one that allows rapid response and decentralized decision-making compared with the colliery where geological fault is rare and the emphasis can and must be on the central management. Interestingly, geological conditions is one of the statistics collected by the Poles in their study.

Planning for Planning

This discussion developed from the suggestion made at the end of George Mitchell's presentation. It was considered a major topic for future consideration, bringing together both institutional and engineering aspects, but in the absence of a full preparatory paper the discussion was inevitably rather fragmented. Equally there was a good deal of experience available, and this could ensure that a workshop on the topic would provide a useful information exchange.

Some of the topics proposed concerned the problems of information collection, information storage and retrieval, and data bank definition. As an example, during the planning process one might discover he needs some piece of mining data. How do you evaluate it? How do you make maximum use of it? Furthermore, the data you see represents some average data of the past. How do you update it? How do you transform it into reliable variables for planning the future? The FRG and Poland have done some work in this area and will report on their efforts at our next meeting.

As was pointed out by the participants, there is an important link between the information system and the management organization. Thus there must, of necessity, be an overlap between this proposal and the previous one. This is, of course, not surprising since when one takes a systems analysis view of a problem, the interdependencies and interrelations are what make the problem what it is.

Another topic concerns the prediction of likely technological effects on productivity, machine performance and recovery factors. Again this raises questions of what is the best way of introducing innovation. Although this is not in the direction that IIASA's planning to take in their research on innovation, it is close to it. Thus a link could be formed to IIASA's research. In this proposal, this link would be the only area of research for IIASA. IIASA's main input would be to structure the problem and then organize the workshop. Some careful analysis must be done on how to split the problem up and then relate each piece to the other.

Environmental Goals

The main thrust of this effort will be to perform case studies aimed at answering the following question: given that certain environmental consequences can occur with coal, what strategies or options are available to us? These strategies include both technological options and the optimal use of coal while still satisfying certain environmental criteria. The important point is that one must look at the mitigating consequences. The usefulness of this work will be to give to the coal industry some indication as to the viability of coal demand growth and should also contribute toward better defining the environmental issues.

It was stated that a workshop on the above might not draw the same participants as topics I and II. However, there is obviously a relationship between the topics. Also, REN (Resources

and Environment, an area in IIASA) was planning on holding such a workshop near the end of the year. Since many of the participants at this meeting showed an interest, it was thought to be worthwhile to make the two meetings adjacent so that those interested could attend both. As an example of the interest, the UK said they were willing to contribute a case study and Poland said they were willing to have their current methodology compared to REN's.

Although this work is part of the coal project and thus under the direction of Mr. Rolfe Tomlinson, the major impetus and research will come from REN. Mr. Tomlinson will only help in coordinating the activities. As part of that responsibility, we are enclosing a copy of a draft proposal from REN which gives more detail to this topic. It is Attachment E. Those wishing to comment on this document may contact Dr. Vorontsov directly.

WHERE DO WE GO FROM HERE

It was envisaged that the next meeting would be held in a participating country at the beginning of November. Poland agreed to explore the possibility of the meeting being held in Katowice. The main topics for discussion would be 'Management and Organization', 'Planning for Planning' and 'Environmental Issues'. Although the environmental regional study might attract a substantially different group of attendees than the other topics, it was felt that there were advantages in keeping all the topics together. The purpose of that meeting will be to exchange information on the selected topics, and to plan some future research. In order to do this effectively, papers concerned both with past results and future research should be available for examination in advance of the meeting. IIASA will be in contact with all participant countries during the summer to ensure this. In particular, a number of informal meetings will take place at IIASA in July to prepare detailed plans and draft some of the papers.

We are anxious that the papers presented should be as concise and factual as possible (the problems of translation must always be remembered).

Papers are welcomed on the following topics:

-- Management and Organization
-- Planning for Planning
-- Other relevant topics listed in the Appendix of Attachment A.

In each case it would be helpful to have

-- Statements of present procedures
-- Evidence on which these are based, or experiences of their effectiveness
-- Statements of recent or on-going research.

This work will be coordinated at IIASA by Jack Eddington, in close cooperation with Jan Stachowicz (Poland).

Attachment A

COAL-ISSUES FOR THE EIGHTIES

A proposed international cooperative study
to assist the coal industry.

January 1979

International Institute for Applied Systems Analysis
Schloss Laxenburg, Austria

COAL-ISSUES FOR THE EIGHTIES

An International Cooperative Study
to Assist the Coal Industry

Almost every major study of energy demand suggests that sometime between 1985-2010 there will be a sudden upsurge in coal demand on a world-wide basis. This will be caused by a leveling off of liquid fuel supply combined with increasing energy demand. This increase in coal demand is likely to occur over a shorter period of time than the industry would normally be able to respond to; and this response time, due to legislative and technical factors, is becoming longer. Moreover, the uncertainties underlying the major investment decisions that will have to be made in the '80s are becoming larger. Legislative change, technological development, the availability of manpower with the right skills--all these will combine to make the major investment and planning decisions more difficult and complex than ever before. All possible means of reducing and understanding that complexity must be explored.

A number of major studies have been undertaken directed towards a clarification of the background issues. Examples are to be found in the Energy program at IIASA, and in the work of Professor Carroll Wilson at MIT, first through his Workshop on Alternative Energy Strategies and then through the current World Coal Study. These studies are of crucial importance in identifying the issues--but when the issues have been identified the decisions still have to be made. It is towards those decisions that future cooperative research programs need to be directed.

This memorandum proposes a collaborative research venture to be centered at the International Institute for Applied Systems Analysis with the participation of coal companies, universities, and governments from many nations. Its purpose will be to provide

assistance to those in many countries who will be facing the major questions of policy and investment in the coal industry from 1980 onwards--questions such as:

- What is the likely impact of different environmental policies on coal production and use?
- How can the planning process--from exploration to production--be sped up?
- How is the 'best' size of operation for a new mine or complex determined?
- How much should be paid for flexibility in operation and supply?
- How are alternative technology options to be evaluated?

The intention of such a study would be to review the critical areas of decision making facing the industry in the next ten years, to identify methods already available to assist in their solution, and to engage in necessary further research on a collaborative basis towards closing some of the major gaps that are found.

Such research cannot be done in isolation within a university or a research institute. It has to be done by, or with the close involvement of, the industry itself. The problems are not unique to any one company or country--they are common to all. Indeed, many groups in different countries are already working on them. Unfortunately, however, there is not in this area of planning and organization the same exchange of ideas and cooperation that exists in the technical field, despite the fact that the advantages to be obtained are at least as great. The exchange of ideas, the avoidance of duplication, the common identification of policy issues--all of these make a coordinated program a sound proposition, provided of course it is carefully directed towards practical application.

The Role of Systems Analysis

Many names have been given to the kind of research that leads to guidance on practical planning and policy issues facing the coal industry in the '80s. We describe it as systems analysis. It involves looking at the problem whole, cutting across traditional boundaries of profession and discipline, and above all expressing results in such a way that the analysis can be quickly repeated as new information comes in. This can enable decision makers to respond to sudden unexpected changes with rapidity. It is also a complement, indeed a necessary complement, to the general background studies already done or in progress, since it is directed towards the real decision making procedures. The systems analyst helps by clarifying issues, comparing alternatives and quantifying outcomes; he does not tell the decision maker what to do--that is neither possible nor desirable.

The International Institute for Applied Systems Analysis

IIASA is the only international institute specifically devoted to systems analysis and its application. For five years it has been undertaking a major program into Energy Systems, but its fields of concern also include Food and Agriculture, Resources and Environment, and Human Settlements. Central to this proposed study would be the work of the Institute's Management and Technology Area. This Area is concerned directly with problems arising in organizations and is led by someone with 25 years experience in the coal industry in the United Kingdom.

The advantages that IIASA would bring to this study arise from:

1. Its international character, with staff drawn from more than 17 countries and with support at the highest scientific level for its work.
2. Its unique position as a center of expertise in systems analysis.

IIASA is involved in many applications, but the role that it plays is determined by certain constraints. In the first place, it cannot play a direct consulting role to individual industries, partly because of the problems of geographical distance and partly because of the way in which its staff are recruited. A second constraint lies in its funding--IIASA simply does not have the resources to mount on its own account the research effort that a study such as this requires. Even if it could, the work would not be particularly effective since such research, if it is to be applied, needs to be carried out in close cooperation with management in the coal industry. In any case, IIASA could only tackle it by recruiting a team of people who were experienced in the industry. Since most of the companies will be tackling these problems on their own behalf, it makes better sense for them to continue this work and, if necessary, expand it. On the other hand, if suitable staff are not available, then a particular organization could find it desirable to provide funds so that appropriate staff could be recruited to IIASA.

To summarize, IIASA is ideally suited to be a center for cooperative research; it can aid in identifying the state of the art, act as a meeting place for discussion of ongoing research, provide specific expertise, coordinate and identify research, and undertake individual research projects.

The First Step

A first meeting of technical experts took place in October 1978 to identify the main issues that such a cooperative program should study, and these are discussed in the Appendix. Clearly all the problems listed would constitute altogether too large a program to tackle at one time, and thus the first step in launching the project is to decide which items have general support as topics of research. We propose therefore to hold a working meeting at IIASA from March 27-30, 1979, at which time these issues can be discussed and a plan developed. We are thinking of spending half a day on each of the five main topics: Exploration, Mine Planning and Organization, Operations, Distribution/Utilization,

and Corporate Problems. It would save time and help preparations if we could have a brief statement from those attending, stating what work has been done in each of these areas and what interest there is in the problem. On the final day, we would try to pull all this together in a concerted research plan.

At present we envisage that such a plan might involve effort on the part of the cooperating organization of about one man, either directly through in-house research, or by funding similar work here at IIASA. Two general approaches might be adopted. We might identify major projects for study over a period, or simply plan to hold conferences on each of the main topics in turn on, say, an annual basis.

Whilst we would not necessarily ask for a final commitment on the part of individual representatives at the end of the working meeting, we hope that they may be able to give a firm indication of the part that they might play. We cannot stress too strongly that an essential part of this project is the involvement of interested, knowledgeable parties. We know this project would not benefit from an "ivory tower" approach. If it is to succeed, a wide spectrum of those with a stake in the future of coal must be involved.

Queries

Any questions or comments on this proposal should be addressed to Rolfe Tomlinson, Leader, Management and Technology Area, IIASA, Schloss Laxenburg, Austria.

/snh

APPENDIX

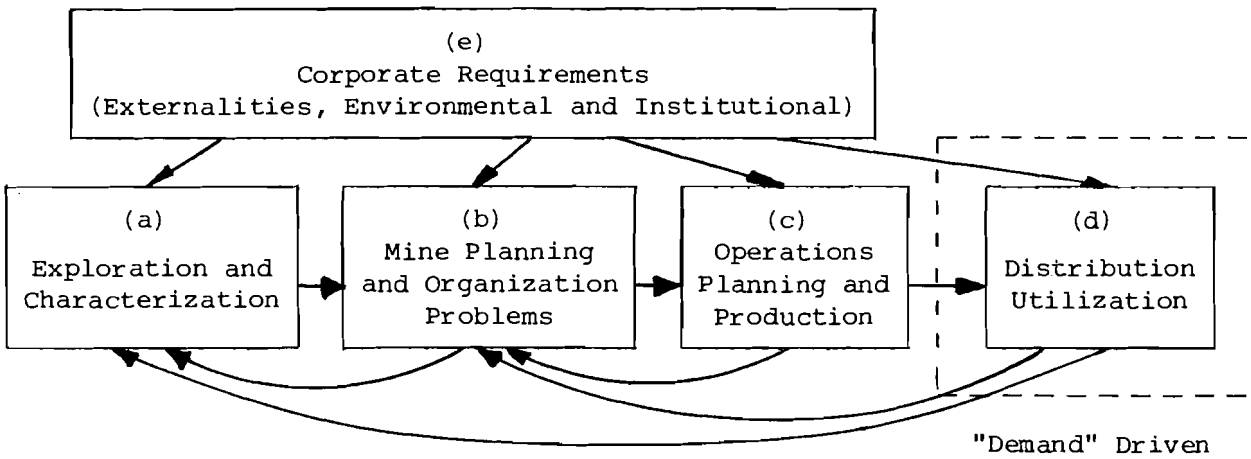
A REVIEW OF RESEARCH REQUIREMENTS*

General Structure

The general planning and organizational process of Coal Industries can be simplified for the purpose of our discussion to five groups:

(a) Exploration and Coal Characterization
(b) Mine Planning and Organization Problems
(c) Operations Planning and Production
(d) Distribution and Utilization
(e) Corporate requirements, mostly concerned with externalities.

Schematically this could be described as shown below:



It will be seen that the groups of problems cannot be kept totally distinct, and that there is some feedback between groups through time.

The extent to which utilization may change over time will affect the robustness of decisions in the first two stages, independent of whether utilization changes due to market forces (as

* Draft based on the report of an international group of experts meeting at IIASA in the period October 16-27, 1978.

is possible in Western countries) or government planning (as is possible in both Western and Socialist countries). Utilization factors will also influence economy of scale considerations in the second stage, and changes in utilization may lead to inflexibilities of scale. Pressures to decentralize electric utilities and different technologies of power generation are examples that could be quoted here.

The research requirements of each group will be considered separately.

(a) Exploration and Coal Characterization

The oil crisis of 1973 gave new impetus to exploration for, and characterization of, coal reserves. This led to a number of new physical technologies, some adapted from oil industry practice. This was coupled with a greater degree of involvement by systems analysts in the evaluation of uncertainty associated with these methods, and the economic trade-offs between cost and knowledge. One example of the former was seismic surveying where techniques applicable to coal exploration were adapted from the oil industry. As with any new technology, there is uncertainty as to its applicability in specific situations. Certainly the expense of seismic surveys, and in general, the cost for any new information can only be justified if the information gained leads to reduced mining costs or increased value of output.

Whether or not such a pay-off is to be expected can only be investigated in the context of where the information is most useful, and thus where quite different external constraints may act. If the information will reduce mining costs, then its value must be investigated in the context of mine planning and strategy. Within existing mine complexes, such further exploration data can be used as input to simulation or operational gaming methods with the mine management or planners. However, with completely new mines, methods appropriate to an existing operational mine may not be widely useful. One particular point of concern is whether the whole process of exploration strategy and the mechanisms for data evaluation can be used to contract the time scale for planning

as currently experienced. It may be both necessary and possible to effect a greater linkage, using standardized data banks, between the exploration and mine planning stages. Have improvements in methods of data analysis increased the reliability associated with exploration data, and can these improve utilization assessment, for example? One problem that systems analysts have recently been attempting to resolve is the large degree of discrepancy between what are defined as resources and reserves in the major coal producing countries. Before any standardized methodologies of linking exploration processes to detailed mine planning can occur, such differences must be fully resolved.

Possible Research Topics

- The standardization and systemization of world coal resources and reserves taking into account changing technologies of mining on reserves assessment.
- The methods by which exploration strategy is decided and methods of data analysis developed.
- The methods of evaluating costs and benefits of increasing coal reserve characterization.
- The linkages between data required for exploration and mine planning in order to shorten the timescale of planning and improve strategy development.

(b) Mine Planning and Organization Problems

The problems of geological risk and uncertainty associated with coal characterization still remain. However, with completely new mines, additional dimensions to the problem are added when the location and the rate of output are themselves factors to be decided. The proper size of a mine is a factor which is particularly complex to analyze, relating as it does to all other factors. There seems to be no unanimity of view and indeed there may be no absolute solution outside of an individual context. In a virgin area, problems of interaction with the physical environment, problems of attracting and housing increasingly skilled manpower and

problems of providing transport infrastructure will all occur. The last factor is one that will have a direct link to decisions on choice of utilization. There will also be problems associated with the time horizon of an investment program. New mine planning inevitably deals with incomplete information, particularly on cost structures. Thus, even more than in existing mines, the planning process must be able to cope with changes of estimate. Two possible solutions exist; first, the development of models covering as wide a data-base as possible so that changing assumptions can be rapidly reflected in changing estimates; and second the decision making must be organized so that options can be left open as long as possible. These two solutions are complementary. However, the differing framework of institutional pressures in various countries will, to a large extent, determine how practical these approaches might be. There are also distinct differences in the levels of detail such models take on. Simple models which interface with other stages and externalities by fixed assumptions are somewhat easier to develop and cost less to run, if computerized. However, much of the dynamics of the situation are omitted. Complex and elaborate computer models, which take in more of the dynamics of the relationships between other stages, take longer to develop and longer to run.

There are also substantial differences in the levels at which major mine planning is done in various countries; centralized mine planning may be less sensitive to localized environmental and social pressures whereas localized planning may not always gain the benefit from standardization of evaluation techniques and the best diffusion of technological developments.

The planning process must obviously take into account the possibility of new technological developments and the risks associated therewith. We feel that the relationship of new extraction technologies to the mine planning process and the spread of computerized control technology within new and existing mines may well have a much greater impact over the next ten years than any one factor over the last ten years. These may also affect the time horizons over which new mines are brought to fruition and

thus the risks associated with individual developments. An important consideration here is the role that systems analysis can and should play in assessing technology development options. This affects research and development with likely results both at the mine planning and operations planning stages. The procedure for evaluating where best to put resources for research is not a problem unique to the coal industry, but the industry currently may have greater need of it than others.

The impact of computer developments has been substantial over the last few years in the coal industry, particularly in assisting the building of large data banks for planning purposes. However, the experiences of using these in coordinated organization and control of mine planning and management have probably been more mixed than in manufacturing and process industries. The growth of mini and micro-computers, particularly in underground environmental control, may change markedly the way that managers understand how they can use such technology in other aspects of their work.

Possible Research Topics

- The economy of scale as it relates to mine size; its relationship to type of mine, manpower strategies and changing technologies of extraction.
- The relationship of scale to flexibility of output including marginal reserves, and the need to compress time scales of development once strategy has been fixed.
- Procedures for evaluating technology development options; R&D strategies for mining research.
- The relative benefits in large coal industry data bases for planning purposes.
- The procedures for evaluating organization and management strategies in the coal mining industry.

(c) Operations Planning and Production

This stage is probably the one that has to date received the most attention from systems analysts. This may be due as much to the fact that external pressures will be less here than in other stages than to the fact that more systems analysis has been taken because certain processes are inherently more susceptible to modeling. Many modeling approaches have been undertaken and described in the literature both for open and deep mines. These vary from production optimizing models (e.g., the Zimmerman Coal Model and others) which will choose the best mining technique given seam thickness and coal characteristics, to operational gaming and simulation approaches where analytical models are less appropriate. Substantial success has been achieved in most companies in modeling coal clearance problems associated with variable production rates and shaft or drift capacity. The fact that there have been substantially different approaches to essentially similar problems of production planning, argues a good case for a "state of the art" review of the various modeling approaches.

The use of computers, both large and mini/micro systems, is likely to make a growing substantial impact in this stage in the near future. The monitoring and control of routine (e.g., underground environment) and complex functions (e.g., coal clearance) with the consequential creation of a far more detailed mine information system will have major effects on labour productivity and the range of skills required.

Although direct external pressures may be less during this stage, there are still linkages to the other stages; one particular area of current concern is the extent to which changing production methods can in certain circumstances leave increasing proportions of proved reserves unextracted and thus diminish the inherent value of them.

In deep mined operations some recent systems analysis work has shown interesting but inconclusive results from a study of historical coal face productivity and its relationship to factors

such as coal type, depth and seam thickness. This has left a large measure of productivity at present unexplained by other factors. However, there is large scope for the pooling of models used for the determination of productivity and therefore profitability under substantially varying conditions.

Possible Research Topics

- A state of the art review of current modeling approaches in coal mining operations planning, including both production control and productivity forecasting.
- The impact that changing computer technology, and in particular control technology, will have on all aspects of mine planning and operations.

(d) Distribution and Utilization

A wide range of options are possible for the distribution and utilization of coal. In addition to being a combustion fuel for electric utilities and for providing process steam in industry, coal in the form of coke, is a process requirement for steel making. Furthermore, liquid and gaseous fuels markets are developing for coal derived products.

Various internal and external factors will influence the market for coal and its utilization pattern. The success of technology R&D, cost of specific technologies, and comparative cost of coal versus oil and gas, are examples of important technical and economic factors. Moreover, government policies such as price controls can be of major influence here; also the factors determining utilization may be quite different between market and planned economies. Noting this and because of the emphasis being placed on utilization by other studies, such as the MIT World Coal Study, the focus here will be on understanding utilization to the extent that it influences the managerial and technical aspects of coal production. As an example, development of fluidized bed combustion will influence mine planning and strategy by permitting higher levels of high sulfur coal mining.

Possible Research Topics

- The effect of alternative environmental strategies on coal production and use.
- The effect of coal combustion and conversion technology R&D on coal production.

(e) Corporate Requirements

In some areas externalities are having an increasing effect on both the outcome and methods by which mine planning and strategy are carried out. Systems analysts are being increasingly employed to clarify the chain of consequences between those responsible for setting environmental standards, be they on pollution or other matters, and the managers responsible for delivering the coal for whatever use. In some countries there is an increasing feeling that the gaps between legislators and producers are growing, and that the systems approach is the only way of ensuring that decisions are made with a better understanding of the outcomes. Some regulatory legislation has proved both a stimulus and created uncertainty.

Social legislation on health and safety is another area not peculiar to the coal industry where the impact, particularly in deep mines, will be significant. The influence that this will have on the type of manpower required, and the relative levels of payment to other industries, may make significant differences to marginal investment decisions.

It may be helpful to itemize some of the more important externalities as they would appear to the coal industry:

(a) General environment--pollution (emission and visual), land reclamation, water availability.

(b) Social legislation.

(c) Government policy or mandates.

(d) Public opinion and image of industry; attractiveness to manpower.

(e) Existing and changing social and economic infrastructures.

(f) Technological changes in other sectors.

(g) Risk.

Not all corporate problems can be considered as externalities. Capital limitations may have a drastic effect on investment policy at a mine, and the integration of a whole range of company activities will obviously be of major importance. However, these are likely to be local rather than universal problems.

Possible Research Topics

- The effect of alternative environmental and social policies on coal production and use.
- Corporate information and control systems, with particular reference to modern developments in small scale computer system technology.

/snh

Attachment B

ATTENDANCE LIST

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Attachment C

PRESENTATION VIEWGRAPHS

Dr. Jan Stachowicz

SCIENTIFIC RESEARCH ACTIVITIES OF THE POLISH MINING INDUSTRY FROM 1916 TO 1985

1. PROBLEMS CONNECTED WITH FUEL AND ENERGY BALANCING AND WITH PROGRAMMING THE PROGRESS OF THE POLISH MINING INDUSTRY IN A 25 YEAR TIME HORIZON.

2. PROBLEMS INCLUDING THE TECHNICAL PROGRESS IN TECHNOLOGICAL PROCESSES IN MINES, PARTICULARLY IN CONNECTION WITH MINERS PROTECTION AGAINST HAZARDS.

3. RESEARCH CONNECTED WITH MANAGEMENT ORGANIZATION AND MINING ECONOMICS.

4. TECHNICAL PROGRESS IN MINING MACHINE CONSTRUCTION, INVESTMENT EXECUTION AND MINING CONSTRUCTION ASSEMBLY.

5. PROBLEMS CONNECTED WITH COAL UTILIZATION AND ITS EFFECTIVE USUAGE.

6. NATURAL ENVIRONMENT PROTECTION, PARTICULARLY IN THE UTILIZATION OF SOLID MINERALS, MINE WASTE-MATERIALS, MINE WATER DISPOSAL.

SYSTEM INTEGRATED ORGANIZED TECHNOLOGY - SIOT

COMPONENTS OF THE ECONOMIC SYSTEM

SOFTWARE -- OF THE WHOLE CONCEPT, METHOD AND TECHNIQUE THAT FORM THE TECHNOLOGICAL ASPECT OF WORK PROCESSES.

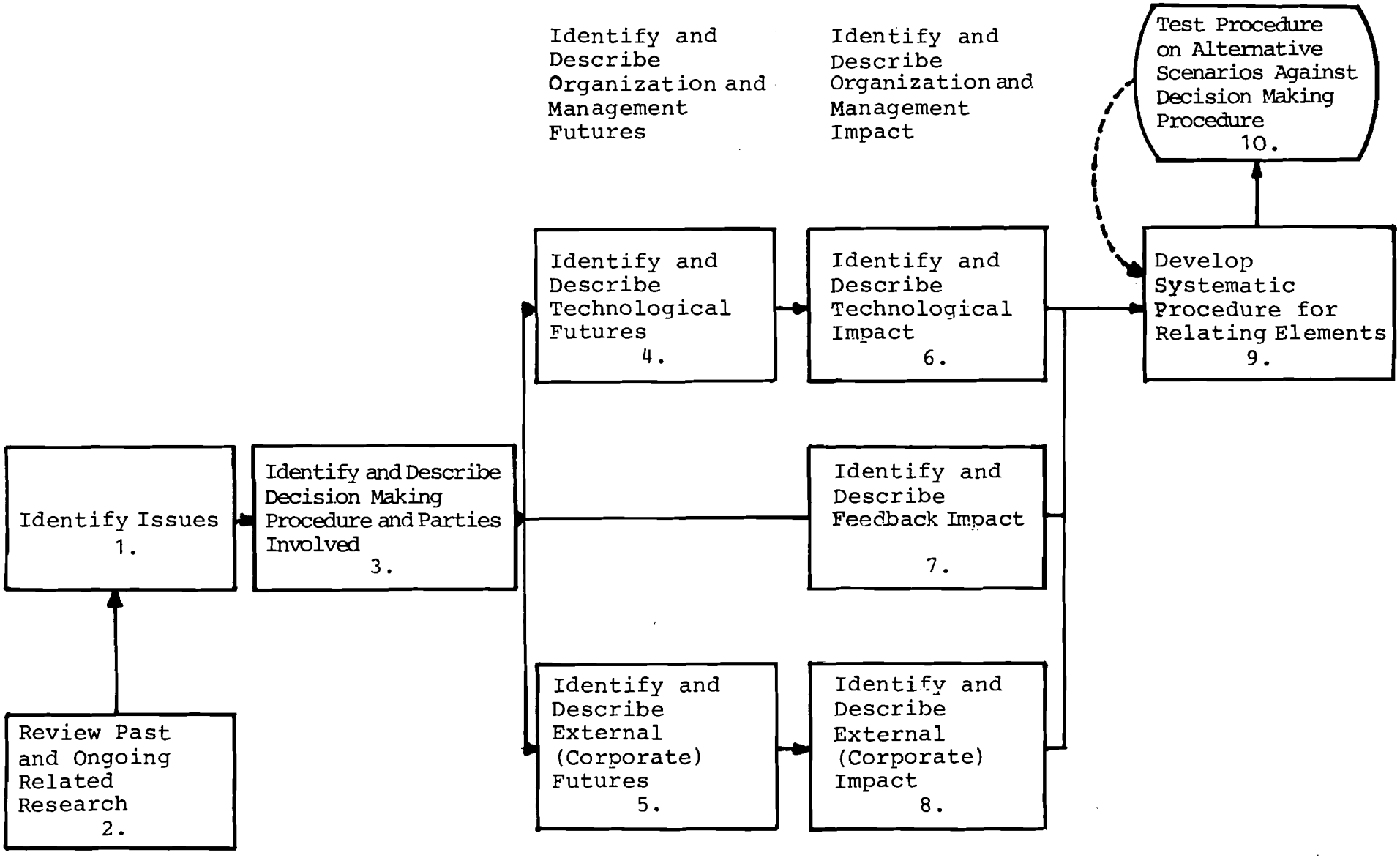
HARDWARE -- OF THE WHOLE TECHNICAL FACTORS OF THE WORK PROCESSES.

ORGWARE -- OF THE ORGANIZATIONAL ASPECTS OF WORK PROCESSES, THEIR FORMAL AND LEGAL REGULATIONS, ORGANIZATIONAL ASPECTS OF MANAGEMENT AND INFORMATION SYSTEMS AND DECISION-MAKERS QUALIFICATIONS AS WELL AS THE ORGANIZATIONAL CLIMATE.

A BRIEF STATEMENT OF THE CURRENT STATE-OF-THE-ART OF COMPUTER MANAGEMENT SYSTEMS IN THE MINING INDUSTRY

1. SYSTEMS OF COMPREHENSIVE EVALUATIONS FOR TECHNIQUE AND TECHNOLOGY
2. BASIC ANALYTICAL ACCOUNTING SYSTEMS
3. A GROUP OF SPECIAL SYSTEMS
4. PRODUCTION AND INVESTMENT SYSTEMS
5. THE AUXILIARY ACTIVITY PLANNING SYSTEMS
6. SERVICE ACTIVITY PLANNING SYSTEMS

THESIS: THE PURPOSE AND METHODS OF PROPOSED RESEARCH



THE RESEARCH AND DESIGNING BASE OF THE POLISH MINING INDUSTRY

-- THE CENTRAL MINING INSTITUTE (GJG)

-- THE COMPUTER INSTITUTE OF THE MINING INDUSTRY (COJG)

-- THE CHIEF MINING STUDIES AND DESIGN OFFICE (GBSIPG)

-- THE RESEARCH AND DESIGN CENTRE FOR MINERALS PROCESSING AND UTILIZATION (SEPARATOR)

-- THE CENTRAL DESIGNING - TECHNOLOGICAL CENTRE FOR THE MINING MACHINERY INDUSTRY (ORTEM)

-- THE CENTRAL DESIGNING - CONSTRUCTIONAL CENTRE FOR MINING (KOMAG)

-- THE RESEARCH CENTRE FOR MINING CONSTRUCTION (OBRPW)

THE COAL MINING INDUSTRY IS PARTICULARLY APPROPRIATE FOR PROGNOSTIC AND RETROSPECTIVE RESEARCH

THIS IS ILLUSTRATED BY:

- -- THE LONG HISTORY OF COAL MINING IN VARIOUS CONDITIONS
- -- THE DIFFERENT ROLES OF THE COAL INDUSTRY IN DIFFERENT COUNTRIES
- -- THE DIFFERENT CONDITIONS FORMING BOTH THE TECHNIQUE AND TECHNOLOGY OF MINING PROCESSES
- -- THE DIFFERENT ENVIRONMENTAL CONDITIONS IN DIFFERENT COUNTRIES
- -- THE VARYING POSSIBILITIES OF MANPOWER IN-FLOW TO THE MINING INDUSTRY
- -- THE DIFFERENT SOCIAL, CULTURAL CONDITIONS ETC.

THE DIFFERENTIATION OF CONDITIONS FORMING DEVELOPMENT OF THE MINING INDUSTRY IN THE WORLD AND THE COMPLEXITY OF THIS INDUSTRIAL BRANCH JUSTIFY THE USE OF SYSTEMS ANALYSIS IN RESEARCH.

THE PRESENT STATE OF OUR RESEARCH, DESIGNING AND IMPLEMENTATION ON POINTS 1.1.1, 1.1.2, 1.1.3, 1.1.4, AND 1.2.

1.1.1. RECOGNITION OF POSSIBILITIES OF USING MODERN ORGANIZATIONAL STRUCTURE SOLUTIONS IN COAL MINING CONDITIONS

1.1.2. RESEARCH IN THE SCOPE OF NEW SOLUTIONS IN CREATING COMPUTER SYSTEMS BASED ON A DATA BASE

1.1.3. EVALUATION OF ADVANTAGES GAINED BY USING LARGE DATA BASES FOR PLANNING PURPOSES

1.1.4. DEFINING THE TENDENCIES OF CHANGES IN ORGANIZATIONAL PROCESSES AND PLANNING IN THE MINING INDUSTRY IN ASPECTS OF COMPUTER TECHNIQUE DEVELOPMENT

1.2. THE STUDY OF INTERDEPENDENCIES BETWEEN THE SIZE OF THE ECONOMIC UNIT AND ITS PRODUCTION EFFECTIVENESS

RESEARCH GOALS

1. COMPARATIVE ANALYSIS OF COAL MINING UNITS AND ALSO THE OTHER ECONOMIC UNITS WORKING FOR MINING INDUSTRY ON DIFFERENT MANAGEMENT LEVELS ACCORDING TO THE UNIFORM RESEARCH METHOD.

2. FORECASTING WORKS CONNECTED WITH THE ELABORATION OF RATIONAL FUNCTIONING STANDARDS AND THE DEVELOPMENT OF OBJECTS GROUPED IN HOMOGENEOUS CLASSES.

3. THE SYNTHESIS OF ANALYTICAL AND PROGNOSTIC RESULTS CONTRIBUTE TO SYSTEM STUDIES NECESSARY FOR DEVELOPMENT OF THE FOLLOWING DISCIPLINES:

   -- ORGANIZATION AND ECONOMICS OF THE MINING INDUSTRY

   -- MANAGEMENT ORGANIZATION

THE RESEARCH METHOD

1. STUDY WORKS NECESSARY FOR LISTING THE ACTUAL TENDENCIES AND PROPOSITIONS IN THE SCOPE OF MODELLING THE DEVELOPMENT AND FUNCTIONING OF INDUSTRIAL ECONOMIC ORGANIZATIONS.

2. COLLECTING THE STATISTICAL MATERIALS COMPRISING DIFFERENT COEFFICIENTS THAT DESCRIBE THE TECHNIQUE, TECHNOLOGICAL AND ORGANIZATION LEVELS OF A MINE.

3. SYNTHESIS OF COLLECTED INFORMATION AND RESEARCH RESULTS.

4. DETERMINING THE DEVELOPMENT TRENDS OF INDIVIDUAL TYPOLOGICAL HOMOGENEOUS MINE GROUPS.

PILOT STUDY I

A SUPPLIMENTARY INVESTIGATION TO POINT 2 OF THE RESEARCH METHOD

NUMBER OF INVESTIGATED OBJECTS - 10

NUMBER OF INVESTIGATED DECISION-MAKING CENTRES - 250

PROBLEMS:

- LISTING THE PRODUCTION PROCESSES AND INFORMATION
- DECISION PROCESSES ON MINE AND UNION LEVELS - THEIR CONNECTIONS AND STRUCTURE
- TYPE OF INFORMATION USED IN THE PROCESS OF DECISION MAKING
- CONTENT EVALUATION AND THE FUNCTION OF THE INFORMATION COMPUTER SYSTEM

PILOT STUDY II

TYPOLOGICAL DIVISION OF PRODUCTIVE MINES

COEFFICIENTS:

- X_1 - CAPITAL INVESTMENT AS A WHOLE
- X_2 - THE ANNUAL OUTPUT
- X_3 - PRODUCTIVITY OF LABOUR
- X_4 - AVERAGE TEMPERATURE IN THE FACES
- X_5 - AVERAGE SEAM INCLINATION
- X_6 - AVERAGE FACE THICKNESS
- X_7 - AVERAGE LENGTH OF THE WORKING FACE
- X_8 - WATER INFLOW TO THE MINE
- X_9 - AVERAGE MINING DEPTH
- X_{10} - AVERAGE DAILY WALL ADVANCE
- X_{11} - AVERAGE DAILY FACE ADVANCE WITH HYDRAULIC FILLING
- X_{12} - AVERAGE DAILY ADVANCE OF THE LONG-WALL WITH CAVING
- X_{13} - PROPORTIONAL OUTPUT FROM MECHANIZED LONGWALL FACES
- X_{14} - NUMBER OF SHIFTS PER DAY
- X_{15} - TIME OF WORKING AT THE FACE
- X_{16} - LABOUR COSTS
- X_{17} - MATERIAL COSTS
- X_{18} - AMORTIZATION CHARGES
- X_{19} - COSTS OF ENERGY
- X_{20} - PREPARATORY WORK INTENSITY
- X_{21} - AVERAGE DAILY ADVANCE OF THE ROCK GANGWAYS
- X_{22} - AVERAGE DAILY ADVANCE OF THE ROCK-COAL GANGWAYS
- X_{23} - AVERAGE DAILY ADVANCE OF THE COAL GANGWAYS
- X_{24} - EMPLOYMENT IN THE INDUSTRIAL GROUP WORKERS
- X_{25} - EMPLOYMENT IN THE INDUSTRIAL GROUP ADMINISTRATION STAFF
- X_{26} - EMPLOYMENT IN THE INDUSTRIAL GROUP - ENGINEERS, TECHNICIANS
- X_{27} - EMPLOYMENT IN THE NON-INDUSTRIAL GROUP
- X_{28} - ABSENTEEISM OF WORKERS IN THE INDUSTRIAL GROUP
- X_{29} - DEGREE OF WORK BY THE JOB
- X_{30} - AVERAGE WAGE
- X_{31} - VALUE OF GROSS FIXED ASSETS

THESIS OF THE STUDY (POINT 1)

THERE IS A NECESSITY FOR ELABORATION OF SCIENTIFICALLY PROVED AND PRACTICABLE PRINCIPLE OF MANAGEMENT CAPABILITY FOR THE FUTURE OF THE MINING INDUSTRY CONCERNING:

- -- MANAGEMENT SYSTEMS
- -- ORGANIZATIONAL STRUCTURES
- -- INFORMATION SYSTEMS
- -- PROBLEM SOLVING
- -- ATTITUDE TO CHANGE
- -- ORGANIZATIONAL CLIMATE

AND A NEED TO ANSWER THE FOLLOWING QUESTIONS:

- -- HOW TO DESIGN MANAGEMENT SYSTEMS FOR PLANNED NEW MINING BASINS
- -- WHAT DIRECTIONS TO TAKE IN MODERNIZING THE MANAGEMENT SYSTEMS IN THE EXISTING ORGANIZATIONS
- -- HOW TO CREATE CONDITIONS IN THE SCOPE OF COMPUTER SERVICE FOR EFFECTIVE USE IN THE MINING INDUSTRY
- -- HOW TO IMPROVE IN A PRACTICAL WAY PROCESSES OF DECISION-MAKING IN THE MINING INDUSTRY
- -- HOW TO CREATE AN ORGANIZATIONAL CLIMATE AND CULTURE FOR RAISING PROFITABILITY OF THE MINING INDUSTRY
- -- HOW TO STIMULATE DEPOSIT EXPLOITATION PROFITABILITY

4. DETERMINING THE DEVELOPMENT TRENDS OF INDIVIDUAL HOMOGENEOUS MINE GROUPS

IN THIS STUDY WE WILL PROCEED IN THE FOLLOWING WAY:

4.1 FOR INDIVIDUAL TYPOLOGICAL HOMOGENEOUS GROUPS WE WILL DEFINE THE THE PROGNOSTIC STANDARD VARIANTS OF A MINE

4.2 USING THE PROGNOSTIC APPROACH BASED ON THE PROGNOSTIC STUDIES AND HEURISTIC METHOD WE WILL DEFINE INDIRECT VARIANTS OF DEVELOPMENT BETWEEN THE ANALYSED MINES AND THE PROGNOSTIC STANDARD VARIANTS

4.3. DETERMINATION OF THE COLLECTION STRATEGY

4.4. ANALYSIS OF THE DEVELOPMENT COLLECTION STRATEGY

SUBJECT 2

ORGANISATION AND TECHNOLOGICAL FACTORS STIMULATING DEPOSIT EXPLOITATION PROFITABILITY

RESEARCH GOALS

1. LISTING OF THE VARIOUS METHODS CONCERNED WITH THE FOLLOWING:
   - -- ECONOMIC EVALUATION OF MINERAL RAW MATERIALS RESOURCES
   - -- THE VALUE OF USEFUL MINERALS IN A DEPOSIT
   - -- GEOLOGICAL MINING AND ECONOMIC CRITERIA OF RESOURCE BALANCING
   - -- EVALUATION CRITERIA OF DEPOSIT LOSS WITHIN THE DESIGN, DEVELOPMENT AND EXPLOITATION OF THE DEPOSIT

2. COMPARING THESE METHODS IN ACCORD WITH A UNIFORM METHOD

3. ELABORATING THE GENERAL LINES OF UNIVERSAL COEFFICIENTS

MAIN TOPICS OF INTEREST TO POLISH INSTITUTES

1. THE THEORETICAL AND METHODOLOGICAL ASPECTS OF PROGRAMMING THE MINING INDUSTRY DEVELOPMENT WITH PARTICULAR STRESS ON THE PROGRESS AND ADAPTATION OF THE SYSTEMS APPROACH TO WHICH STATEMENTS HAVE BEEN DEVELOPED AT IIASA.

1.1 METHODOLOGICAL ASPECTS OF MODERNIZATION AND DESIGNING THE MANAGEMENT SYSTEMS IN THE MINING INDUSTRY.

1.1.1. RECOGNITION OF THE POSSIBILITY OF USING, IN COAL MINING CONDITIONS, MODERN ORGANISATIONAL STRUCTURE SOLUTIONS.

1.1.2. RESEARCH IN THE SCOPE OF NEW SOLUTIONS IN CREATING COMPUTER SYSTEMS BASED ON DATA BASES.

1.1.3. EVALUATION OF ADVANTAGES GAINED BY USING LARGE DATA BASES IN THE MINING INDUSTRY FOR PLANNING PURPOSES.

1.1.4. DEFINING THE TENDENCIES OF CHANGE IN ORGANIZATIONAL PROCESSES AND PLANNING OF COMPUTER TECHNICAL DEVELOPMENT.

1.2. INTERDEPENDENCE STUDY CONCERNING THE SIZE OF THE ECONOMIC UNIT AND ITS PRODUCTION EFFECTIVENESS.

2. ORGANISATION AND TECHNOLOGICAL FACTORS STIMULATING THE DEPOSIT EXPLOITATION PROFITABILITY.

Attachment D

ENVIRONMENTAL PROJECT PROPOSAL

ISSUES FOR THE 80's: COAL

Integration of Regional Environmental Goals Into Coal Production and Utilization Strategies

A Collaborative Study by
The International Institute for Applied Systems Analysis (IIASA)
and
Participating National Member Organizations (NMO's)

Draft Study Outline
April 1979

ISSUES FOR THE 80's: COAL

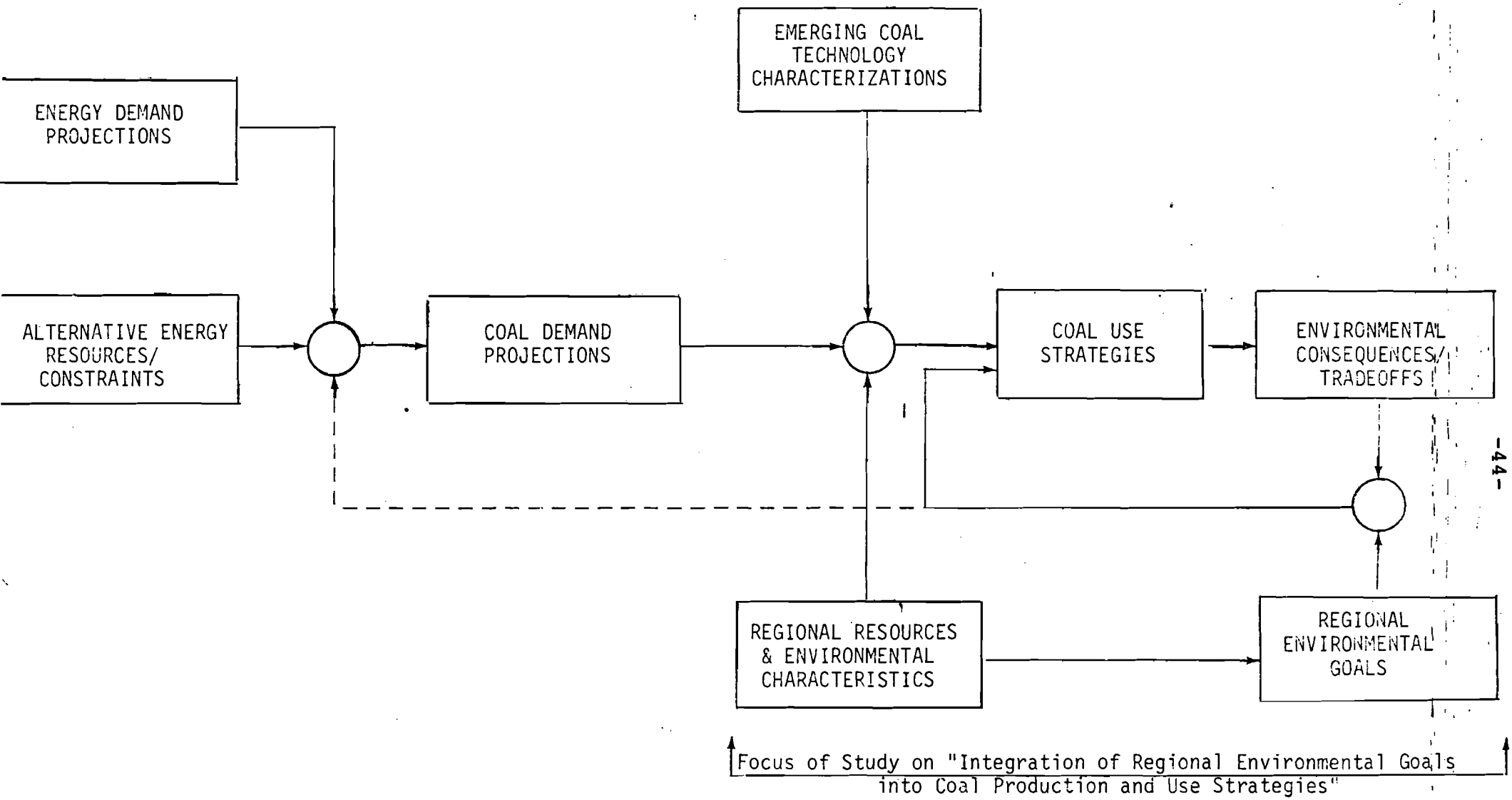
PURPOSE: To aid energy policy makers and the coal industry in planning for anticipated increases in coal demand in the next 10-20 years.

STUDY COMPONENTS:

A. IIASA Resources and Environment Area. Integration of Regional Environmental Goals into Coal Production and Utilization Strategies.

B. IIASA Management and Technology Area. Development and application of Procedures for Planning, Organization, Management, and Introduction of Innovative Technology in the Coal Extraction Industry (Not included in this outline).

STUDY PERIOD: 1979-1980



Generalized Analysis Procedure for Regional Coal Development and Environmental Assessment

STUDY OBJECTIVES:

- Exchange of information on existing IIASA and NMO methods for integrating alternative environmental goals into coal development strategies.

- Extension and application of IIASA and NMO methods in representative regional case studies.

- Exchange of IIASA and NMO data on characterization and timing of emerging coal technologies.

- Comparison of approaches to defining NMO regional environmental goals

- Evaluation and development of approaches to estimating environmental consequences and goal tradeoffs.

STUDY APPROACH:

Coal Task Force Meeting - March 27-29, 1979. Definition of critical issues by potential NMO participants

Coal: Issues for the 80's Working Session - November 1979. Information exchange on

- o Selection of representative regional case studies
- o Available IIASA and NMO methodologies for case studies
- o Emerging technology timing and characterizations
- o Definition of regional environmental goals
- o Available IIASA and NMO methods for estimation of environmental consequences and goal tradeoffs.

Case Study Analysis - 1980

Coal: Issues for the 80's Symposium - December 1980

- o Presentations on representative case study results by collaborating NMO's.
- o Discussion of possible future related studies by IIASA and NMO's.

Study Organization

IIASA PARTICIPATION:

- Conduct Task Force Meeting
- Conduct Working Session
- As necessary, facilitate case studies through:
    - o Case study definition
    - o Coordination of data and methodology exchanges
    - o Assisting in application of IIASA methodologies
- Conduct Symposium
- Publish Symposium Proceedings

NMO PARTICIPATION:

- Contribute to Task Force Meeting, Working Session, and Symposium
- Develop case study methodology as required
- Conduct case study

CASE STUDY SELECTION:

Participating NMO's will be encouraged to select differing individual regional case studies which will provide to the overall study a representation of a broad range of regional characteristics, e.g.,

1) Alternative environmental issues or goals:

- o Reduction of air emissions
- o Water conservation, or
- o Coal waste disposal and land use

2) Differences in existing development:

- o Industrialized, urban area, or
- o Rural area

3) Various coal cycle components:

- o Extraction
- o Transportation
- o Electrical generation
- o Conversion to liquids or gases
- o District heating and cogeneration

PARTIAL LISTING OF AVAILABLE IIASA INFORMATION AND METHODS:

- Results of "Research Program on Management of Regional Energy/Environment Systems"
- Results of "Energy/Systems Program"
- WELMM Resource Accounting approach (Water, Energy, Land, Materials, and Manpower)
- Analytical Methodologies from IIASA System and Decision Sciences Area

CASE STUDY EXAMPLE (Tentative) - U.S./CANADA

Strategies and Tradeoffs for Coal Utilization in the U.S. and Canadian Great Lakes Basin

BASIC ISSUES:

- The Great Lakes Basin is a net energy importer (~80%)
- What are the economic and physical impediments for use of coal as a major future energy source?
- What are the environmental constraints to use of coal? Focus on SO_2, emission control
- What coal technologies will be available to overcome economic, physical, and environmental constraints to coal use?
- What are the tradeoffs resulting from emphasis on SO_2 control?

APPROACH:

Regional Characterization

- Existing energy supply
    - o Domestic and imported oil
    - o Natural gas from U.S. and Canadian resources outside region
    - o Nuclear
    - o Coal
- Environmental Conditions
    - o Acidification occurring in small lakes
    - o SO_2 emissions from utilities
    - o Air quality problems in U.S. related to industry
    - o Emissions from Sudbury metals industry

Regional Demand Projections

- Department of Energy Scenarios for U.S.: increased dependence on coal
- Ontario Min. of Energy Scenarios for Canada: continued dependence on nuclear, oil, gas
- Alternative Canadian Scenario: increased dependence on coal to sustain economic growth, reducing oil imports
- Energy end-use requirements as determinant of viable energy forms
- Available coal resources
    - o U.S. - Great Plains, Western, Interior, Eastern
    - o Canada - Alberta, U.S. imports

Evaluation of Coal Technology Options (FBC, FGD, Combined Cycle, Direct Heating, etc.)

- Cost
- Environmental residuals
- Compatibility with end-use requirements
- Compatibility with physical constraints (transportation, retrofit, water needs, etc.)

Evaluation of Environmental Impacts

- SO_2 control as primary environmental control focus
    - o Regulatory limitations
    - o Limitations based on prevention of further acidification in Basin and Eastern U.S. and Canada
- Tradeoffs for Alternative SO_2 Control
    - o Solid Waste Disposal
    - o SO_2 emissions at mine-mouth conversion outside of Basin
    - o Water requirements
    - o NO_x emissions, which also contribute to acid rain

EVALUATION OF THE TRADEOFFS FROM COAL-RELATED ENVIRONMENTAL GOALS

- A Preliminary Proposal -

Draft No. 2
November 1978

TABLE OF CONTENTS

1.0 Introduction

Recognition of the limitations of present energy use patterns that rely heavily on increasingly scarce supplies of natural gas and oil, has led to extensive assessments of the potential for the utilization of alternative more abundant energy resources. Coal has been identified in a number of studies and in several government policy statements as a resource that could provide an increasing proportion of energy requirements for specific countries. Specific regulatory policies have been developed to stimulate substituting coal in the industrial and utility sectors for dwindling supplies of natural gas. At the same time, significant increases in coal-related research and development efforts have occurred to provide the technological basis for increased coal use. Furthermore, policy analysts are evaluating the potential for a world coal market, including both raw coal and coal derived products, such as methanol.

Concomitant with the interest in increased coal use, coal related environmental policies and standards have been getting stricter. In addition to tighter air quality emission standards, new solid waste, resource recovery and reclamation programs have been implemented or are being proposed. Both the nature and the full ramifications of these programs are unknown. From an industry standpoint, the uncertainties in the coal policy framework make production and use decisions difficult. Moreover, there may be inconsistencies or conflicts between these increased coal production and use policies and the environmental quality policies.

The traditional approach to coal-related assessments has been to define and then analyze scenarios for energy supply and demand based on various factors such as fuel costs, resource limitations, demographic and economic projections, historic trends, and technology assumptions. Environmental considerations are typically included through added technology costs for pollution control measures and then through estimation of the environmental impacts of the defined energy demand scenarios. If the estimated environmental impacts are judged unacceptable according to certain standards, appropriate adjustments in energy scenarios may be included.

These energy-demand-driven assessments, with their emphasis on identifying energy resource impacts and limitations, have not fully analyzed the tradeoffs associated with alternative regional goals for environmental protection or natural resource conservation. For example, a stringent

regional policy to reduce atmospheric sulfate levels and related acid precipitation could force use of alternate coal technologies that have significant implications for waste disposal problems. Alternatively, a regional siting pattern and coal technology mix that emphasizes water conservation in water shortage areas will also affect the level and distribution of atmospheric emissions and solid wastes generation.

The study outlined here will evaluate these tradeoffs for alternative coal technology implementation strategies that are primarily driven by environmental considerations. A specific level of coal utilization will be specified before the analysis. The evaluations will be conducted for specific regions and comparisons conducted to identify interregional differences and similarities.

2.0 Objectives of the Study

This study will evaluate the environmental, resource and energy trade-off associated with regional environmental goals. Specific environmental objectives identified for separate evaluation are:

1) Reduction of air emissions so as to eliminate unacceptable health and environmental impacts,

2) Reduction of energy related water consumption in subregions with limited water resources, and

3) Reduction of coal solid waste problems.

In addition, the implication of regional siting and technological mix patterns will be evaluated by considering

- o minemouth versus load center siting (export of coal or product),
- o alternative levels of coal development.

The time frame of focus will be the next 15 - 20 so that the study can provide information useful in near term policy considerations. Consideration will be given to the complete coal fuel cycle-extraction, transport, combustion and conversion.

3. Approach

The study outlined here will evaluate the environmental, resource and energy tradeoffs associated with alternative coal utilization strategies designed to satisfy specific regional environmental goals. In its most simple form, the approach entails:

1) Specification of regional environmental goals, including two or more levels of control for air, water and solid waste effluents,

2) Development of plausible regional technology mix and siting patterns,

3) Tradeoff analysis and synthesis.

To the extent possible, this study will be coordinate with and make use of existing results, data bases, and methodologies developed by IIASA, Argonne, and others, in related energy assessments. For example, regional energy demand scenarios have been developed as part of USDOE-sponsored coal assessments and as part of the IIASA Energy Systems study. The IIASA WELMM approach provides useful information on energy system resource requirements. The IIASA Energy Systems study has also developed regional characterizations in selected areas that may provide input to this proposed study.

Details on the specific tasks are presented below:

Task 1: Development of Criteria for Tradeoffs

An initial required task is the development of systematic criteria for evaluating tradeoffs for competing coal fuel cycles on a unit and regional basis. Emphasis will be placed on defining tradeoff parameters such as loss of efficiency through intermediate fuel processing, water consumption, atmospheric and aqueous effluents, waste disposal problems associated with increased effluent control, implication of spatial distribution of fuel cycle components (e.g. minemouth vs. load center siting), transportation and transmission requirements, and technology costs, including environmental control system costs.

Task 2: Definition of Regional Environmental Goals

A set of regional environmental goals will be specified and subsequently analyzed. Specific environmental objectives that have been identified for potential separate evaluation are:

1) Reduction of air emissions so as to eliminate unacceptable health and environmental impacts,

2) Reduction of energy-related water consumption in subregions with limited water resources, and

3) Reduction of coal waste disposal problems.

To clearly illustrate the tradeoffs associated with these objectives, two or more alternate levels of control will be developed for each objective.

Task 3: Regional Study Area Selection and Characterization

Study areas will be chosen, as discussed in Section 4, primarily on the basis of (1) range of environmental issues, (2) potential for coal development and utilization, and (3) availability of regional characterization. For selected coal demand scenarios, regional technology mix and siting strategies will be defined so as to satisfy the alternative environmental goals that are prescribed.

Task 4: Characterization of Fuel Cycle Components

The definition of tradeoff parameters in Task 1 will provide direction to the necessary characterization of alternate technologies utilized in each phase of the coal fuel cycle. Technologies now in use and technologies anticipated to be demonstrated by the year 2000 are to be considered, depending on their potential usefulness in meeting the prescribed environmental objectives. Potential technologies include:

1) Direct combustion with flue gas desulfurization using either regenerable or throw-away sorbent,

2) Fluidized bed combustion,

3) Gas turbine/steam combined cycles,

4) Coal gasification or liquefaction,

5) Physical or chemical coal preprocessing,

6) MHD, and

7) Advanced extraction and reclamation procedures.

Task 5: Tradeoff Analysis

Using the regional technology mix and siting patterns and the technology characterizations as a basis, the tradeoffs associated with alternate levels of control for specific environmental media or objectives will be evaluated. Here the emphasis will be on compatibility between "media" objectives. An example of the type of question to be addressed is, "Will tightening air quality regulations impede achievement of solid waste disposal goals?". Finally, tradeoffs between alternative environmental goals will be identified and analyzed.

4.0 Regional Study Area Selection

Numerous studies have identified the factors necessitating regional analysis of coal environment issues. Some of these include regional unique features such as

- o coal availability and cost,
- o nature and type of resource (e.g. deep or surface mining),
- o characteristics of the resource (sulfur content, BTU content, % ash, etc.),
- o economic and industrial development,
- o energy supply/demand system.

While the study relies on a case study approach, care must be exercised so that the case study results can be generalized to provide input into a broader national and international policy debate on coal, particularly environmental and coal use issues.

Therefore, the criteria to be used in selecting case study areas include:

- o potential for coal development,
- o range of environmental issues,
- o range of coal utilization (market potential for coal in electric utility, industry and other sectors),
- o availability of regional characterization and other information,
- o capability of generalizing potential study results.

It is recommended that case studies be undertaken in Eastern and Western countries with potential for increased coal development. Possible countries for study area selection include Bulgaria, Canada, FRG, GDR, Poland, USA and USSR. In addition, consideration should be given to the potentially unique problems faced by a developing country such as India or a South American country.

To validate the study's analytic approach, it is recommended that analysis proceed for one or two countries at most. When substantive results are obtained, analysis can be initiated in other areas.

Four U.S.A. areas are suggested for initial consideration:

1) Powder River Coal Basin in northwestern Wyoming and southwestern Montana,

2) Texas Lignite Coal Fields and nearby markets,

3) The Southwestern Indiana coalfields and the Evansville area,

4) The Ohio River basin with potential for industrial coal use.

5. Products of the Study

A set of technical reports will be the written products of the study. In addition, meetings and conferences are planned as a mechanism for establishing collaboration, for user inputs and to transfer study results.

Reports

- o A Framework for Evaluating the Tradeoffs of Alternative Coal Related Environmental Goals.
- o Tradeoffs between Alternative Environmental Goals.
- o Implication of Environmental Goals for Coal Production and Uses.

Meeting/Conference

- o A technical meeting for review and comment on the tradeoff structure.
- o Regional conference discussing the case study results.
- o An international conference comparing regional results and delineating policy implications of the study.*

*Tentative-depends on level of funding.

Attachment E

OTHER PROPOSALS

The following two proposals received some support and are thus included here for completeness. They are currently not part of the coal project research plan, but this could change in the future.

Targets for Technical Research

This relates to applying a systems analysis approach to defining areas or targets for technical research. One might apply a bottleneck type of approach to determine where the biggest payoff would occur if a technological improvement could be made. However, it is most important that when looking at certain specific technical problems, one does not omit all of the interdependencies to the total mining process, for example, the impacts on downstream operations. It is this broad coverage of the problem that is meant by saying a systems analysis approach. It was intended that this work would initially be done through workshops and case studies. It was also thought that conditions in countries are sufficiently different that the same procedure would not apply. But knowing the general approaches used in other countries, the exchange of such information, would be very beneficial.

Although there was no opposition to this proposal, the three proposals in the body of this report were given higher priority. It was mentioned that this proposal was a subpoint of the "Planning for Planning" proposal. However, it was generally felt that this was a large enough project to be considered by itself.

Trend Indicator

The second proposal was to develop a "trend indicator" for coal demand that was market oriented with something like a twenty year time horizon. By market oriented, we mean looking at the coal market to see how it actually operates. One possible trend indicator, for example, could be the capacity of current and projected coal fired power plants. It was put forth that this might be a reasonable indicator of future coal demand. And this type of indicator would be valid in both an East and West setting.

There were, of course, opposing opinions. It was pointed out that there were already many case studies about coal demand - the just published OECD study on steam coal demand, the Stanford Research Institute study on coking coal, and others. Furthermore, there are many energy studies recently completed or still in progress looking at this subject. The rejoinder to this was that in

actuality, when you come back five years later, you find things have not behaved as projected. It was thought that the application of the scientific method and the systems analysis approach would lead to greater insights than the straight forward application of simple economics.