AD 711389

OAR 70-005

THE OAR PROBLEM-ORIENTED COUPLING EXPERIMENT

By

Robert J. Massey Ph.D.

Prepared by

PROGRESS MANAGEMENT SERVICES
3701 36th Rd. North
Arlington, Va. 22207
(703) 525-5262

February 1970

Technical Report of the Experiment

Prepared for

Headquarters Office of Aerospace Research
Under Contract F44620-68-C-0065

46

ACKNOWLEDGMENTS

This note is to acknowledge contributions to the effort described in this report. Contributors included:

Mr. Kenneth R. Cramer, of the Aerospace Research Laboratories, who served as Team Leader. As a research scientists, Cramer's primary motivation was to help the Air Force maintain a viable option in MHD technology. Nevertheless, he made major contributions to the development and test of problem research methodology.

Dr. John B. Dicks, Mr. Richard V. Shanklin and Mr. Ewe Zitzow of J. B. Dicks Associates of Tullahoma, Tennessee who served as consultants in MHD technology.

Mr. A. G. Hoshovsky of Headquarters OAR, technical task monitor of the Progress Management Services contract and "entrepreneur" of problem documentation in OAR.

COL Ernest P. Luke, DCS Plans and Programs, Headquarters OAR, Chairman of the project steering group.

COL Currie S. Downie, Headquarters OAR, immediate superior of Hoshovsky who provided him the backing and degrees of freedom without which little could have been accomplished.

Mr. R. R. Barthelemy and Mr. R. F. Cooper of Air Force Propulsion Laboratory, leaders in the development and promotion of MHD technology in the Air Force.

Mr. Kenton W. Zahrt, of the Aeronautical Systems Division of AFSC who served as a sounding board and informal consultant on real world technology flow in the Air Force system.

CAPT Howard A. MacEwen, Space and Missile Systems Office, AFSC, a primary promoter of the AFSC Applications Study.

Mr. Jacob Adams of the Aeronautic Systems Division, AFSC, principal technical performer of the AFSC MHD Applications Study.

Robert J. Massey Ph.D.
Principal Investigator
Arlington, Virginia
February 14, 1970

TABLE OF CONTENTS

THE OAR PROBLEM-ORIENTED COUPLING EXPERIMENT

By

Robert J. Massey Ph.D.

This report describes the activities and results of the Problem-Oriented Coupling Experiment of the Air Force Office of Aerospace Research. The Problem-Oriented Coupling Experiment consists of those portions of the OAR Technological Barriers Documentation Project subsequent to 15 February 1969. This phase involved analysis of problems in making feasible the development of a competitive, flight-weight magnetohydrodynamic (MHD) power generator, and certain experiments using the resulting technological problems.

I. REPORT SUMMARY

The objectives, activities, conclusions and recommendations of the experiment are summarized in this introductory section of the report. Details can be found in later sections and in appendices.

A. Objectives Summarized

The objectives of the activities covered by this report can be summarized as follows:

1. Experimentally test the problem identification procedures developed by Progress Management Services in earlier phases of the OAR Technological Barriers Documentation Project.

2. Experimentally test the hypothesis that selective dissemination of Problem Resumes documenting specific technological problems would contribute to more effective coupling of Air Force Research with Air Force Technology. These Problem Resumes can be considered as a "want ad" from the individual listed as "Problem Monitor" asking any scientists who believes he can contribute to its solution to contact him. Figure 1 is an example of a completed Problem Resume from the experiment.

3. Contribute to the advancement of magnetohydrodynamic (MHD) power generating technology. This objective was primary for Mr. Kenneth R. Cramer, Aerospace Research Engineer of Air Force Aerospace Research Laboratories, technical director of the effort. This objective, while an important consideration in the conduct of the experiment, is beyond the scope of this report.

PROBLEM RESUME

UNCLASSIFIED
Security Classification

1 Problem Title

High Temperature Tolerance Electric Insulators

2 Abstract

Materials having dialectric breakdown strength of 60,000 to 90,000 volts per meter and resistant to oxidation and reduction at temperatures up to 3400 K are desired for insulation between electrodes of magnetohydrodynamic (MHD) electrical generators of advanced design for airborne or space applications.

Electrical conductivities at operating temperatures should not exceed 10^{-3} to 10^{-4} mho/cm. Ceramic materials should withstand thermal shock at operating temperature with high heating rates and temperature gradients, be resistant to corrosion by cesium or potassium carbonate vapors, and mechanical corrosion by flowing gases up to Mach 2 for 24 hours. Thermal expansion, material strength and geometry limitations will be accomodated by design flexibility.

The availability of suitable insulating material, when coupled with other advances, will permit design of MHD generators with much higher channel wall operating temperatures, thus contributing to increased generator efficiency and lower specific fuel consumption.

3 References

Kenneth R. Cramer and Robert J. Massey, Technological Barriers to the Development of a Competitive, Flight-Weight MHD Power Generator, OAR 69-0020, Office of Aerospace Research, August 1969
AD 859-947

5 Key words

High-temperature electrical insulators
MHD
Flight-weight MHD generators
Problem research
Technological problems

4 Problem Monitor - To provide (or obtain) information concerning this problem contact

Kenneth R. Cramer
Aerospace Research Engineer
Aerospace Research Laboratories (ARN)
Wright-Patterson AFB, Ohio 45433

Telephone: (513) 255-5892; Autovon 78-55892

6 ATO # 1X	7 PD # 1X-10	8 Function(s) 2.2.1.1	9 Date 8-18-69

FIG 1

B. Activities Summarized

The activities covered in this report can be most concisely summarized by reference to Appendix 1, a fold-out chart depicting the role of problem research in making feasible the attainment of an advanced technological objective. Appendix 1 is from the manual, produced at the conclusion of the project, which documents problem research procedures. It is recommended that the reader leave Appendix 1 extended throughout his study of this report since frequent reference will be made to it.

Activities analogous to the first three blocks of Appendix 1 were accomplished for the objective of a competitive, flight-weight MHD power generator for airborne or space application. This process resulted in 14 technological problems. Results to this point were documented in a report, Technological Barriers to the Development of a Competitive, Flight-Weight MHD Power Generator, (OAR 69-0020) of August 1969.[1]

Resumes of individual technological problems were forwarded to 30 OAR scientists (Block 4) to stimulate technical dialogue between relevant scientists and the Team Leader, Mr. Kenneth R. Cramer of ARL (Block 5). While the technical dialogues conducted up to the time of this report were dissapointingly few, three problems were carried through the Block 7 process.

C. Summary of Conclusions

The scale of problem dissemination, and the extent of responses, did not provide a basis of statistically significant data to support firm conclusions. The evidence which is available, however, leads us to the following tentative conclusions.

CONCLUSION #1. The methodology for problem identification and documentation, developed in earlier phases of this project and depicted in Appendix 1, is feasible and relatively inexpensive.

CONCLUSION #2. Scientists receiving Problem Resumes will scan the titles to identify problems falling in their area of interest and will read the full resumes of such problems.

CONCLUSION #3. Air Force scientists will voluntarily contact monitors for specific Air Force problems falling within their area of special competence.

CONCLUSION #4. Exposure of its scientists to documented statements of specific problems, both Technology Needs and Research Needs, serves Air Force interests.

CONCLUSION #5. Personal referral is still the most efficient available strategy for bringing technology need problems to the attention of the best qualified inhouse scientists.

---

[1] Subsequently revised and republished as Problems of Conceptual Flight-Weight MHD Generator, OAR 70-1.

D. Summary of Recommendations

RECOMMENDATION #1. That the Air Force intensify implementation of the policy of documenting specific Technology Needs and Research Needs.

RECOMMENDATION #2. That the Air Force require documentation, on Problem Resume forms, of Technology Needs and Research Needs identified in the course of Air Force supported studies and analyses.

RECOMMENDATION #3. That the scientific content of Air Force problems be systematically defined and the resulting Research Needs assigned to individual OAR scientists as Problem Monitors, documented on Problem Resumes, and appropriately disseminated.

RECOMMENDATION #4. That Air Force Research Needs, to which research work units are relevant, be listed on the DD1498 "Research and Technology Resume" for such work units.

RECOMMENDATION #5. That the Air Force establish a limited number of advanced Technological Objectives and pursue the development of the base of knowledge and technology required to make such objectives attainable through implementation of the full process depicted in Appendix 1 of this report.

RECOMMENDATION #6. That the Air Force establish the objective of providing means for faster and more efficient identification of inhouse scientists best qualified to advise on particular problems.

RECOMMENDATION #7. That improvement in the Air Force's ability to identify, define and document its needs for new knowledge and technology, and to harness Research and Technology Development to meeting those needs, be systematically and continuously pursued.

II. TEST OF PROBLEM IDENTIFICATION METHODOLOGY

A. Test Objectives

The objectives of the test of problem-identification procedures were twofold, to test the procedures which had been developed in earlier phases of the project and to produce the supply of technological problems, documented on Problem Resume forms, required for the test of problem-driven coupling. The test was to produce answers for these questions:

- Will the procedures set forth in the Problem Analyst's Guide of January 1969 work?
- How can these procedures be improved?

B. Procedures to be Tested

The problem identification procedures to be tested were documented in the Problem Analyst's Guide of January 1969. This Guide was organized around a fold-chart (see Appendix 2) depicting four phases and a total of 36 events.

In essence, the problem identification procedures is an orderly approach to breaking a macro-problem into a structure of "bite-size" micro-problems. The advanced technological objective (ATO) subjected to analysis constitutes the macro-problem.

The problem identification process is carried out by a team consisting of a Team Leader expert in the ATO technology, several ATO Consultants expert in the ATO technology, and a Problem Analyst. Mr. Kenneth R. Cramer, Aerospace Research Engineer of the Aerospace Research Laboratories of the Office of Aerospace Research served as Team Leader. The ATO Consultants were Dr. John B. Dicks, President of J. B. Dicks Associates of Tullahoma, Tennessee, and Mr. Richard V. Shanklin and Mr. Ewe Zitzow, also of J. B. Dicks Associates. Dr. Robert J. Massey, President of Progress Management Services, and the developer of the procedures to be tested, served as Problem Analyst.

A central aspect of the methodology as defined in the Problem Analyst Guide is the division of labor between the Problem Analyst and the other members of the team. In general, the Problem Analyst performs those functions which do not require the expertise of the technical team members. He relieves the technical members of "paper work" by drafting or editing all documentation. He also is the team's expert on the problem identification methodology.

Additional information of the duties of performers of problem research can be found in Appendix 1.

The activities reported in this section of the report encompass those functions depicted by Blocks 1, 2, and 3 of Appendix 1. The process begins after a decision has been made to analyze an advanced technological objective in order to identify the problems in its attainment, then solve them through research and technology development effort, and thus develop the base of knowledge and technology required to make attainment of the objective feasible.

The Team Leader and the Problem Analyst then define the objective to be analysed in terms of explicit and quantitative specifications.

Next, the Team Leader, the ATO Consultants and the Problem Analyst perform a functional analysis and sensitivity analysis to identify those functions where improvements will have the highest-leverage impact on attainment of the objective.

They then identify specific hypothetical technological attainments which, if available, would improve performance in a high-leverage parameter. These hypothetical technological advances are then documented on Problem Resume forms. These problems are "Technology Needs." In the later stages of the process, qualified inhouse scientists, with the aid of the Team Leader and Problem Analyst, will analyze these Technology Need problems to identify and define their scientific content.

C. Selection of Objective to be Analyzed

As originally conceived, the Problem-Oriented Coupling Experiment was to be conducted jointly by the Office of Aerospace Research and the Aeronautical Systems Division of the Air Force Systems Command. The Technological Barriers Documentation Project of OAR was to collaborate with a projected 100-technical-manmonth study of potential applications for MHD power to be conducted by SAMSO, ESD, and ASD, under the leadership of ASD.

AFSC technical personnel agreed to apply OAR problem research methodology to the analysis of at least one advanced MHD system concept in each of the three participating Product Divisions. OAR was then invited to conduct a study of problems in improving the state of the art of MHD power generation sufficiently to make MHD competitive with turbo-alternators for general airborne applications.

D. Definition of the objective

The Team Leader analyzed projected performance figures for the turbo-alternator, principal rival for MHD for airborne power applications, to derive a quantitative definition of "competitive," for an MHD system. These requirements, expressed as specifications, (Page 1-3 of OAR 70-1) called for a system with power per total weight of 1.43 $\frac{kwh}{\#}$ for a ten hour mission, 1000 KW capacity, fixed weight not to exceed 1,000 pounds, and specific fuel consumption of $\frac{.6\#}{kwh}$. Preliminary calculations indicated these specifications were potentially feasible, or more precisely, they failed to reveal any fundamental laws which would preclude eventual attainment of these performance objectives.

Analysis of the tentative objective specifications by the ATO Consultants indicated the defined objective was suited to the purpose of the test, i.e. potentially feasible but sufficiently ambitious as to probably require new technology for its attainment.

The objective was narrowed to specify a combustion-fired, open-cycle system. The essential functions of such a system were documented on functional flow block diagrams (FFBD's) which appear in Part 1 of OAR 70-1. These activities accomplished the functions depicted by Block 1 of Appendix 1 and produced the products listed under "Product #1" on the leader to that chart.

E. Identification of High-Leverage Functions

The ATO Consultants, in collaboration with the Problem Analyst, defined a structure of functions and sub-functions where technological advances would have the greatest impact on attainment of target performance capabilities, i.e., "high-leverage" functions. The results of this process are documented on the set of functional flow block diagrams (FFBD's) in Part II of OAR 70-1. These FFBD's evolved through several generations of draft, review, redraft,etc

While this documentation naturally evolved to reflect the evolving analysis, a reciprocal relationship also existed. That is, the evolution of the documentation stimulated and catalyzed the evolving analysis.

The analysis of high-leverage functions was actually accomplished in parallel with the definition and documentation of technology need problems. The definition of problems also had some influence on the functional analysis.

Ideally, the functional analysis process is output-oriented, that is, it is to define the results which must be accomplished rather than suggest particular means of providing the results. This ideal has not been completely achieved in the FFBD's documenting the analysis of high-leverage functions. However, as the FFBD's evolved, each generation came closer to the ideal.

F. Definition and Documentation of Technology Needs

The MHD Consultants identified problems and provided preliminary definitions. For the most part these problems were previously known to the consultants but had never been reduced to writing. Thus the process was more one of providing documentation, in a form likely to be widely understood, than it was of identifying the problems.

The system of joint authorship of problems with the technical person and the Problem Analyst as coauthors, worked very effectively. The value realized here was not merely relieving the technical person of paperwork drudgery, it also enhanced substantive statement of the problem as an instrument for conveying the problem to some ultimate reader. Joint authorship necessarily involves communicating the substance of the problem from the technical expert to the Problem Analyst. Much of the information essential for understanding of the problem by the Problem Analyst was so familiar to the technical person and his direct associates that he made the unconscious assumption that "everyone knows that." Discussion of drafts prepared by the Problem Analyst resulted in eliciting this essential information from the technical person and getting it expressed in language familiar to the wider technical community.

Early drafts of most of the problems were developed by the Problem Analyst and the ATO Consultants. The Team Leader was directly involved in the final draft of all problems and in the initial definition of several. This involvement of the Team Leader in the final definition of problems, and the associated technical discussions with the consultants, provided for the assimilation by the Team Leader of the problem as understood by the senior author of the problem, i.e., the consultant. Here it is important to distinguish between the assimilation of the problem, and the abstract of the problem which appears in the Problem Resumes.

The understanding of the problem in all its complexities and contingencies is a difficult, time-consuming, and never completely finished task. Assimilating the abstract, which merely conveys the information that a problem exists and describes its general nature, is relatively easy.

G. Results of the Test

1. Feasibility. The test demonstrated both the feasibility of analyzing an objective to identify technological problems in its attainment, and the basic soundness of the division of labor of the team approach.

It would probably be dangerous to extrapolate these results to cases involving totally new objectives, for which there does not exist any cadre of well qualified experts. The objective analyzed involved reaching hitherto-unattainable levels of performance for a device whose nature was well understood. The majority of advanced technological objectives will be of this nature.

2. Cost. The cost of accomplishing this protion of the effort, including printing of 200 copies of the report, Technological Barriers to the Development of a Competitive, Flight-Weight MHD Power Generator (OAR 69-0020), was suprisingly modest. Total costs, even including an allowance of 90% overhead on the time of the Team Leader, the only inhouse participant, came to $6,195.00. Costs would be much higher for less familiar objectives and where experts are not available.

3. Non-product benefits. The Team Leader believes his participation in this joint ASD-OAR effort will have long-range benefits growing from the effective working relationships now established with personnel of the ASD Directorate of Advanced Systems Concepts (ASBX) who were involved in the ASD MHD.

One tangible results of the OAR-ASD collaboration was a chapter in the detailed ASD study report on problems in advancing the state of the MHD art.

III. TEST OF PROBLEM-DRIVEN COUPLING

A. Scope of the Test

The test of problem-driven coupling corresponds to experimental test of the functions depicted by Blocks 4, 5, and 7 of Appendix 1.

These functions are:

Block 4, circulation of resumes of the technological problems to appropriate inhouse scientists. Ideally, the problems should reach those scientists best qualified to provide consulting services on each individual problem.

Block 5, discussions between the Team Leader and Inhouse Scientists. Through these discussions it was hoped the Team Leader could learn:

o What technology is already available and what must be developed to make solution of the problem feasible.

o The people and organizations who are leaders in relevant research.

o Inhouse scientists who are potential Problem Monitors for "Research Need" problems to be defined in the Block 7 function.

o Relevant research work units planned or in process.

Block 7, analysis of the technological problems documented on the Problem Resumes to identify their scientific content. Such scientific content will be defined in terms of "Research Need" problems and documented on Problem Resumes. For these problems, an appropriate inhouse scientist will be listed on the resume as Problem Monitor.

B. Test Objectives

Through selective dissemination of the technological problems produced through test of problem identification procedures, it was hoped to illuminate these questions:

o How effective is the Application's Officer organization as a channel for selective dissemination of problems to those OAR inhouse scientists best qualified to provide consultation concerning them?

o If resumes of problems -- "want ads" for scientific and technological knowledge -- actually reach relevant scientists, will they read them? Put another way, will Problem Resumes be placed far enough up on the priority list of all things the receiving scientist "ought to read" to be included within that limited sub-set that he actually can and does read?

o Will the information on the one-page Problem Resume adequately convey to the reader the essential nature of the problem? the requirement here is only understanding sufficient for the receiving scientist to recognize the probability that his expertise is relevant to the problem.

o If the receiving scientist does read the problem, and does recognize that his expertise is probably relevant to it, will he actually take the trouble to contact the focal individual listed as Problem Monitor on the resume?

o What is the nature, extent and effect of technical communications resulting from selective dissemination of problems?

o What effect, if any, will selective dissemination of problems have on research planning and execution?

C. Circulation of Technology Problems to Inhouse Scientists

Sets of resumes for all problems, plus several copies of OAR 69-0020, were forwarded to applications officers of AFOSR and the OAR laboratories on 15 October 1969. They were requested to analyze the problems and forward individual problems to individual scientists within their organization whose expertise they believed was particularly relevant to such problem(s).

The request memorandum prepared for the information of scientists receiving problems asked them to contact the Team Leader if they could help illuminate any of the following issues:

"a. Means of solving the problem without additional research
"b. Current or planned OAR work units relevant to the problem
"c. Technical approaches for developing a solution
"d. Names of the key men and organizations working in the area
"e. Performance which can probably be achieved now
"f. Predictions -- guesses, forecasts, SWAGES -- of advances in the state of the art
"g. Predictions of probable cost of a research program for significantly increasing the rate of advance."

Problem Resumes were forwarded to four individuals in AFSOR, 11 in CRL, and 15 in ARL.

D. Documentation of User-Producer Dialogues

The concept of the experiment called for oral debriefing of the inhouse scientists. They were to decide whether or not they could contribute to illumination of the problem, and to initiate contact with Cramer only if they believed they had something to offer. To minimize the demands on the "volunteer" scientists, they were to be asked only to make themselves available for oral discussion, rather than to prepare any documents.

E. Follow-up Letters and Response Sheets

Approximately two months after initial distribution of resumes to inhouse scientists, a follow-up letter, with a "response sheet" as an enclosure, was forwarded to each person receiving problems.

F. Results of the Test

1. Contacts with the Team Leader. The pattern of feedback resulting from circulation of Problem Resumes was puzzling in several respects. No direct response by scientists to who resumes were sent was made until after the follow-up letter in early January 1970. Since that time substantive interractions have occurred with two scientists and others have contacted the Team Leader to get more information or to arrange for in-depth discussions at a later date.

The two substantive direct interactions were judged to be very useful from the standpoint of MHD technology. One contact was with Dr. N. T. of ARL, the other with C.S. of CRL.

Dr. N.T. held an extensive technical discussion with the Team Leader on 16 January 1970, plus several later contacts. While N.T.'s response followed receipt of the problems by over three months, exposure to these problems had, in the meantime, influenced his ideas and actions. He had already discussed some of these problems with colleagues at technical meetings and had passed along copies of resumes.

In the dialogue N.T. stated that he was considering modification of his future program in order to increase relevance to MHD problems. He is also considering attending the next MHD symposium.

N.T. helped translate the Technology Needs problems in his area to Research Needs statements. (See Block 7 of Appendix 1).

N.T. also provided copies of technical papers directly relevant to Problem #1X-10, "High temperature tolerance electrical insulators."

Interraction with N.T. was definitely a two-way information flow. Prior to receipt of the resumes and discussions his knowledge of MHD and its problems was limited. After these events his understanding of the problems and opportunities in MHD had been greatly enhanced. He now believes that his particular field of materials can make significant contributions to MHD technology.

C.S. of CRL reports that on initial receipt of the Problem Resumes he did not respond because he did not feel he had any specific information to offer. He did, however, pass along the resume, #1X-4, "Higher temperature superconducting materials," to colleagues. Later, C.S. became aware of a major effort conducted by scientists at American Science and Engineering and MIT. He then passed a copy of the Problem Resume along to these people.

At an even later time, C.C. forwarded the Team Leader a copy of a proposal directly related to synthesis of high-temperature superconducting material, C.S. reported that the people were of high caliber and the concept excellent but that CRL was unable to fund it due to limited funds for new starts.

This very limited sample suggests that introducing resumes of specific research and technology problems into the system can catalyze specific and direct flow of relevant information and can subtly influence the research of exposed scientists: It also suggests that the time-span of the reaction to problem resumes may be rather long. The median resulting event may not occur for several months.

While the above were the only substantive contacts with problem resume recipients completed to the time of this report, they were not the first contacts triggered by the resumes. The first substantive contact was triggered evidently by tertiary (third-echelon) flow of Problem Resumes. A Dr. Bates of Batelle Northwest of Seattle,Washington visited at Wright-Patterson and conducted an extensive and productive technical dialogue on the subject of problem #1X-14, "Non-isotropic materials (conducting insulators)". Dr. Bates had been doing original work with ceramic non-isotropic materials and provided technical papers on the subject. Dr. Bates became aware of Problem #14 from an ARL staff member, who was not on the initial distribution list.

Instructions issued within one organization led the recipients to believe that the Team Leader would call them if he desired any additional information. Thus effective problem resume circulation was only to 26 people rather than to 30.

Probably the most significant inhibiter of response was the crush of activities related to paragraph 203 of the Defense Appropriation Act for 1970, the "Mansfield Amendment," which forbids support of research not directly and tangibly related to military needs. This event triggered a total review of every research task and a massive rewrite of the documentation for those tasks where Air Force relevance was not apparent in the DD 1498 write-up, even though the work actually met the test of the Mansfield Amendment. This effort, coinciding with program review, may have driven out all other activities -- including response to Problem Resumes -- not associated with firm deadlines and meaningful penalities.

2. Response sheet results. A total of 24 of the 30 response sheets were completed and returned. Appendix 8 is a response sheet filled in with summarized results. Appendix 9 is a transcript of all substantive supplementary notes.

Analysis of the results reveals several trends.

a. On the request for their views on the feasibility of a voluntary response system -- where there is no deadline or penalty and the recipient of the resume decides whether or not to contact the Problem Monitor -- seven out of eight indicated "Yes." The one who indicated that he did not think it feasible was from AFOSR, an organization in the vortex of the administrative storm resulting from the Mansfield Amendment. Thus the laboratory scientists were unanimous in holding that a voluntary response system is feasible, provided problems are specific, go to the right people, and are not in excessive quantity. These caveates are derived from supplementary notes, letters, and interview dialogues. (Limited number of responses to this question was due to unfortunate wording. The wording indicated the question was to be answered only if in a previous question the respondent had indicated that he had not contacted Cramer due to "lack of time and pressure of deadline activities." While only one respondent cited pressure of deadlines, eight did express their views on the feasibility of a voluntary response system.)

b. Recipients in general did not feel that the problems were finding their way to the right people often enough. In question 2.a. over 60% indicated "little knowledge" relevant to the problem. Question 2.a. was addressed to the absolute level of their knowledge of the problem, while 2.b. was concerned with how knowledgeable they were compared to other scientists in the same organization. On 2.b. 48% checked the lowest category, "Others are much better qualified than I am."

Several supplementary notes were concerned with inadequacies in dissemination. On suggestions for increasing the number of responses, one scientist wrote, "Resumes should be sent to scientists working in the problem area or at least that field of research."

c. Over a third of the respondents, nine out of 24, indicated that they had passed copies of resumes along to others.

d. Question 4 contained three parts dealing with the desirability of identifying problems and providing problem information services. Respondents were asked, in each case, to check one of five categories indicating their estimate of the potential benefits. These categories ranged from "very great," (+5), through "potentially harmful." (+1).

(1). On the desirability of identifying and documenting problems, 10 indicated "very great," (+5). All Marks were +3 ("Some benefit") except for one vote for "Potentially harmful."[1]

---

[1] That respondent from AFOSR, indicated that the basis of his mark was that the problems were technological problems and that what was needed was Research Needs problems. His views concerning the limitations of the problems he received are compatible with the problem research process (see Appendix 1). Under that process, feedback from people such as himself was sought to help convert the (Block 3) Technology Need problems into one or more (Block 7) Research

The median mark fell in the second from the highest category, "worthwhile" with a numerical average of 3.96 where the lowest category was assigned a weight of +1 and the highest +5.

2.) On the desirability of selective dissemination of Problem Resumes, responses were strongly favorable with a weighted average of 3.83. The same number of respondents (15) marked the top two categories, but with a shift of three from the top to the next lowest (+4).

3.) There was clearly less enthusiasm shown for the idea of establishing problem information services. While on the issues of problem documentation and problem dissemination, there was only one mark in the lowest two categories in each case, there were a total of six marks in the lowest two categories on this issue. The weighted average of the marks was 3.16, thus placing it just slightly above the middle blank of "some benefit."

IV. CONCLUSIONS

On the basis of experience to this point, which includes over two years experience in problem documentation as well as the formal aspects of the Problem-Oriented Coupling Experiment, certain tentative conclusions seem warranted. These include the following:

CONCLUSION #1. The methodology for problem identification and documentation, developed in earlier phases of this project and depicted on Appendix 1, is feasible and relatively inexpensive. Technological problems can be identified through analysis of advanced technological objectives, and the scientific content of these problems can be identified with the aid of Air Force inhouse scientists.

The cost of carrying through the process depicted on Appendix 1 should be relatively modest, at least when it involves an objective about which considerable knowledge already exists, as was the case with the MHD exercise. In particular, the time demands on participants other than the Problem Analyst and Team Leader should be expected to be modest. Future analysis of approximately the complexity of the MHD study documented in OAR 69-0020, can be accomplished within the following manhour budget:[1]

---

[1]These figures are estimates. They are based, however, on the actual experience of the people who participated in the experimental test. They are offered only because time estimates are important to any decision to implement problem research, and the subjective opinions of people who have done it once provide a better basis for judgment than does the next best available information source.

a. Phase IA (Blocks 1, 2, and 3 on Appendix 1), analysis of the ATO and derivation of 20 or less Technology Need problems.

1. ATO Consultants, two or three, 20 to 40 manhours each.

2. Problem Analyst, 60 to 120 manhours.

3. Team Leader, 40 to 80 manhours.

b. Phase IB through documentation of Research Needs Problems (Blocks 4, 5, 6, and 7 on Appendix 1). (No estimate is made for the Block 8 function since no relevant experience was gained.) This is assuming the analysis of up to 20 technological (Block 3) problems and derivation of up to 30 research need (Block 7) problems.

1. Team Leader, 150 to 300 manhours.

2. Inhourse Scientists, 50 persons, 1 manhour each for the dialogues related to briefing the Team Leader on the technology need problems (Block 5).

3. Problem Monitors, 4 to 10 hours for each research need problem (Block 7), or a total of 120 to 300 manhours.

4. Problem Analyst, 100 to 200 manhours.

CONCLUSION #2. Scientists receiving Problem Resumes will scan the titles to identify problems falling in their area of interest and will read the full resumes of such problems. This conclusion is subject to the following qualification:

That scientists are not provided valid grounds for a judgment that reading problem resumes "is a waste of time." Problems should be well drafted, with the aid of an individual highly qualified in the subject matter of the problem, and should be selectively disseminated to scientists known to have an interest or competence in the area. Note that this conclusion states only that under such conditions, receiving scientists will read the titles. They will then decide whether or not it is worth their while to read the rest of the resume, and that if in their judgment the rest of the resume is worth reading that they will read it.

CONCLUSION #3. Air Force scientists will voluntarily contact monitors for specific Air Force problems falling within their area of special competence. Owing to the limited scale of the Problem-Oriented Coupling Experiment, and the fact that it involved technological problems rather than rigorous statements of Research Needs, this conclusion is tentative and not based on substantial evidence. It is rather a hypothesis to be experimentally tested at a later date. Comments of respondents indicate that the recipients will respond if the problem is sufficiently specific and relevant to the receiver.

CONCLUSION #4. Exposure of its scientists to documented statements of specific problems, both Technology Needs and Research Needs, serves Air Force interests. The massive research of Donald Pelz and his associates of the University of Michigan[1] has rather conclusively demonstrated how exposure to real problems stimulates both the creativity and productivity of phenomenon-oriented scientists. Responses of scientists in this experiment were consistent with Pelz' contentions. Documentation of problems aids technical people to be aware of Air Force needs and thus in a better position to meet them. When problems are assigned to technically qualified Problem Monitors, who are identified on Problem Resumes, Problem documentation will significantly speed the flow of research-generated new knowledge to practical application.

CONCLUSION #5. Personal referral is still the most efficient available strategy for bringing technology need problems to the attention of the best qualified inhouse scientists. This conclusion is based not on any inadequacy of the Applications Officer channels employed in this experiment, but rather on the superiority of working through less formal channels.

In future applications of the problem research methodology tested in this experiment, Problem Resumes should be forwarded primarily to scientists either known to the Team Leader or ATO Consultants as particularly knowledgeable in the area, or recommended by these individuals. The Team Leader will normally know the technical experts in his own laboratory. These experts can, in turn, identify the best qualified inhouse people to provide in-depth consultation in relation to a particular problem. Also, it is from such people that Problem Monitors will be assigned. (See Block 6 of Appendix 1.) In the consultant identification process described above, inhouse scientists contacted would be expected to either act as consultants themselves, or recommend a better qualified inhouse scientist.

While informal, this process would not depend solely on the scientist taking the initiative to contact the Team Leader. The Team Leader would open contact with the scientists identified as best qualified and would press for a firm commitment for a visit or phone discussion.

---

[1] Donald C. Pelz and Frank M. Andrews, Scientists in Organizations (New York: John Wiley and Sons, 1966). See also Donald C. Pelz, "Organizational Factors in Creativity," Innovation, #9, 1970, Pelz and Andrews, "Diversity in Research," International Science and Technology, July 1964.

It has been the writer's experience that scientists are generally willing to make themselves available for consultation in their areas of expertise, at least for anything up to one hour. Such consultation also falls within the official mission of OAR laboratories. While the phrasing varies somewhat, this statement from the mission of Air Force Cambridge Research Laboratories is typical.[1] "Provides scientific advice and consultation to all segments of the Air Force."

V. RECOMMENDATIONS

The following recommendations are offered:

RECOMMENDATION #1. That the Air Force intensify implementation of the policy of documenting specific Technology Needs and Research Needs. Implementation of this recommendation should be pursued not only through formal Problem Research, as described in the problem research methodology manual produced under the Problem-Oriented Coupling Experiment, but also by all other promising means. One such means is described in a report, "A 'Hidden' Hand' for Harnessing Research to Mission Needs" which was prepared for the *Office of Aerospace Research*.[2]

RECOMMENDATION #2. That the Air Force require documentation, on Problem Resume forms, of Technology Needs and Research Needs identified in the course of Air Force supported studies and analyses. Specific problems are regularly identified in the course of studies -- feasibility, research applications, technology applications, concept formulation, mission analysis, etc. -- but the utility of the resulting problem information is degraded by the way it is documented. Typically problems are buried in the body of reports and neither identified in the index nor the table of contents.

The preparation of a Problem Resume on each problem identified in a study, and the inclusion of such problems as the last pages of the reports, would vastly increase the usability of this valuable information but would add little if anything to the cost of the basic study.

---

[1] Organization and Function Chartbook, Office of Aerospace Research, United States Air Force.

[2] Robert J. Massey, "A 'Hidden Hand' for Harnessing Research to Mission Needs: Methodology for Deriving and Utilizing Specific Statements of Requirements for New Knowledge and Technology," PMS-001, Progress Management Services, 3701 36th Rd., Arlington, Virginia 22207, May 1968 (AD 672-274).

RECOMMENDATION #3. That the scientific content of Air Force problems be systematically defined and the resulting Research Needs assigned to individual OAR scientists as Problem Monitors, documented on Problem Resumes, and appropriately disseminated. In effect, this recommendation calls for carrying all of the "raw" problems resulting from implementation of Recommendation #2 and other problem-defining activities, through appropriate portions of the problem research process as depicted on Appendix 1.

Implementation of this recommendation would involve the following:

3a. Assignment of "raw" Technology Needs to a technically competent individual for accomplishment of Blocks 4 and 5 functions. This would result in determining the current state of knowledge and technology concerning the problem, and specifically in identifying those Technology Need problems with significant scientific content. It would also result in identifying problems which are substantially identical to problems already "in the inventory." As more problems are documented and analyzed, an every-increasing percentage will be found to duplicate problems previously established.

3b. Assignment of technically qualified individuals to (Block 6) to define and document the Research Need problems involved in the solution of Technology Need problems with significant scientific content (Block 7).

3c. Assignment of focal point responsibility (Block 6), and the identification of this individual on the Problem Resume, for each Research Need problem emerging from the Block 7 function. These individuals are to serve as focal points for the flow of information useful in developing the capability to solve the problem.

3d. Selective dissemination of the resulting research need Problem Resumes to scientists whose current or future work might contribute to the problem's solution.

RECOMMENDATION #4. That Air Force Research Needs, to which research work units are relevant, be listed on the DD 1498 "Research and Technology Resume" for such work units. Implementation of this recommendation would give visibility to the Air Force relevance of fundamental research. From an administrative standpoint, it would provide information for distribution of reports of research to individuals best situated to exploit them. Implementation of this policy would also provide the basis for incentives for researchers to seek out problems to which their research is relevant, since in the present climate, other things being equal, the chances of funding of a proposed effort would tend to be directly related to demonstrated relevance.

This recommendation applies only to refined and verified statements of Research Need, such as would result from implementation of Recommendation #3, rather than to "raw" problems as initially identified by studies and analyses.

RECOMMENDATION #5. That the Air Force establish a limited number of Advanced Technological Objectives and pursue the development of the base of knowledge and technology required to make such objectives attainable through implementation of the full process depicted in Appendix 1 of this report. This recommendation encompasses the following sub-recommendations:

5a. That capabilities which science and technology might make attainable in 10 to 25 years be predicted and defined through a systematic technological forecast.

5b. That the "products" in the forecast be subjected to some form of "military market research" to forecast the value to the Air Force of the envisioned capabilities.

5c. That a limited set of potential attainments, characterized by very high military worth and predicted potential scientific and technological feasibility, be established as Air Force Advanced Technological Objectives.

5d. That the Air Force Advanced Technological Objectives be analyzed to identify and define specific scientific and technological advances which would make their attainment feasible.

5e. That the Air Force systematically pursue the building of the base of new knowledge and technology required to make attainment of specific ATO's feasible.

RECOMMENDATION #6. That the Air Force provide means for faster and more efficient identification of inhouse scientists best qualified to advise on particular problems. In this respect, we believe the comment of one ARL scientist in particularly appropriate:

> "If a computer storage capability for problem resumes is established, it would be relatively easy to establish simultaneously a file of scientists listed according to specialties, interests, etc. The latter could be elicited from the scientists themselves for insertion into the data bank. Computer matching of problem resumes and scientists concerned could then be accomplished. The major problem in such a scheme would be establishing categories of specialization and interest which are sufficiently descriptive and yet sufficiently broad to be practical."

Implementation of recommendations 1 and 3a -- documentation of problems and assignment of focal point responsibilities to technically competent individuals -- would provide a mechanism for "expertise retrieval" for inhouse scientists assigned as Problem Monitor for one or more problems.

The motivation for this recommendation is not to facilitate future problem research effort, even though it would do that; it is rather to provide the Air Force with the means to make more effective use of the potential represented by the knowledge of its inhouse scientists. The assignment of explicit problem monitorship responsibility would help to "package" this knowledge in a more usable form, and would provide the means for easier identification of the mind in which particular knowledge is stored.

RECOMMENDATION #7. That improvement in the Air Force's ability to identify, define and document its needs for new knowledge and technology, and to harness Research and Technology Development to meeting those needs be systematically and continuously pursued. It is these capabilities the problem research methodology developed under the Problem-Oriented Coupling Experiment is designed to provide. Problem Research methodology is today about at the stage of development analogous to aircraft technology in 1915, on the verge of becoming useful, but capable of tremendous growth. Improvement in the Air Force's ability to harness Science and Technology to the task of more efficient accomplishment of its mission as an objective for RDT&E effort fully as inherently valid as the development or better weapon systems.

THE ROLE OF PROBLEM RESEARCH IN MAKING ATTAINABLE AN ADVANCED TECHNOLOGICAL OBJECTIVE

(NOTE: Originally this figure was a long fold-out chart. For the ease of reading overlap and tape the pages together.)

PARTICIPANTS IN THE PROBLEM RESEARCH PROCESS

THE TEAM LEADER acts as "Project Manager" for the problem research effort. Later, he normally continues as the ATO Monitor during the process of building the base of knowledge and technology required to make attainment of the advanced technological objective (ATO) feasible. The Team Leader should be an inhouse staff member knowledgeable in the ATO area.

THE PROBLEM ANALYST serves as consultant to the Team on problem research methodology and is the writer/editor for all documentation, thus relieving the experts of this burden. The Problem Analyst prepares documentation in collaboration with the substantive experts by preparing multiple drafts for mark-up and criticism by the senior author. Junior inhouse staff members will normally serve as Problem Analyst.

ATO CONSULTANTS are experts in the field of the advanced technological objective. Either inhouse or contract experts may serve in this role.

INHOUSE SCIENTISTS are those scientific and technical staff members most highly qualified in the area of particular problems. They provide information and technical judgments related to particular problems through oral dialogue with the Team Leader.

MONITORS (for individual problems, the ATO, and major sub-objectives) are inhouse staff members who are assigned responsibilities related to developing the base of knowledge required for solution of individual problems or the attainment of the ATO or major sub-objectives. Monitors serve as focal points for all types of information relative to solution of the problem or attainment of the objective. The name, address and telephone number of the assigned Problem Monitor appears on the Problem Resume.

DELIVERABLE PRODUCTS OF THE PROBLEM RESEARCH PROCESS

PRODUCT #1 - Definition of the objective. This product consists of (1) a schematic diagram (if the objective involves a device), (2) a set of functional flow block diagrams (FFBD's) covering essential functions in the device's operation, and (3) target performance specifications.

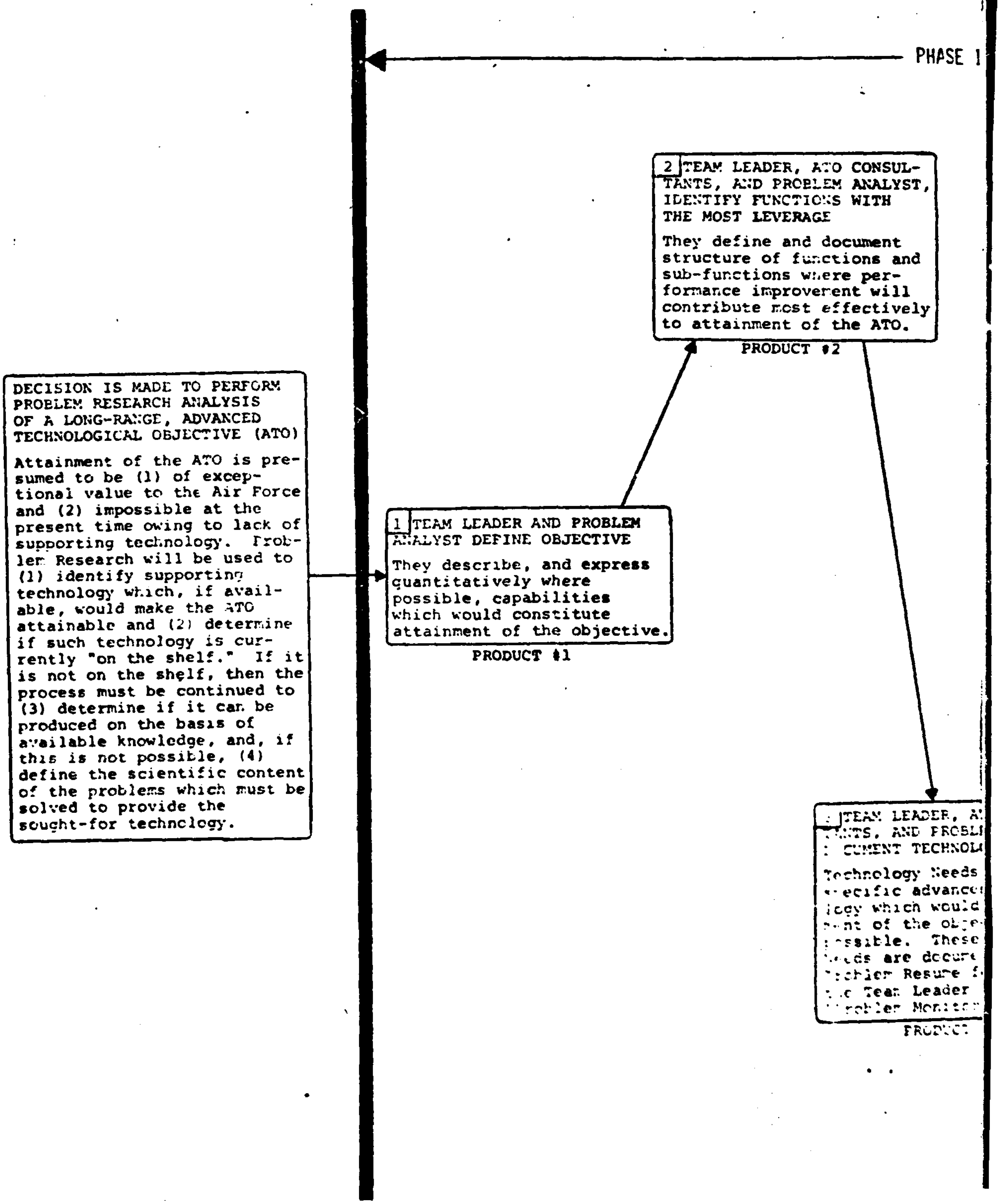
PRODUCT #2 - A set of FFBD's documenting the structure of functions and subfunctions where improved performance promises to contribute most effectively to attainment of target performance objectives.

PRODUCT #3 - Problem Resumes documenting technological problems (Technology Needs) whose solution collectively provide the technology required for attainment of performance called for in Product #1.

PRODUCT #4 - Problem Resumes documenting Research Needs, i. e., problems whose solution would provide the basis for solution of the technological problems in Product #3.

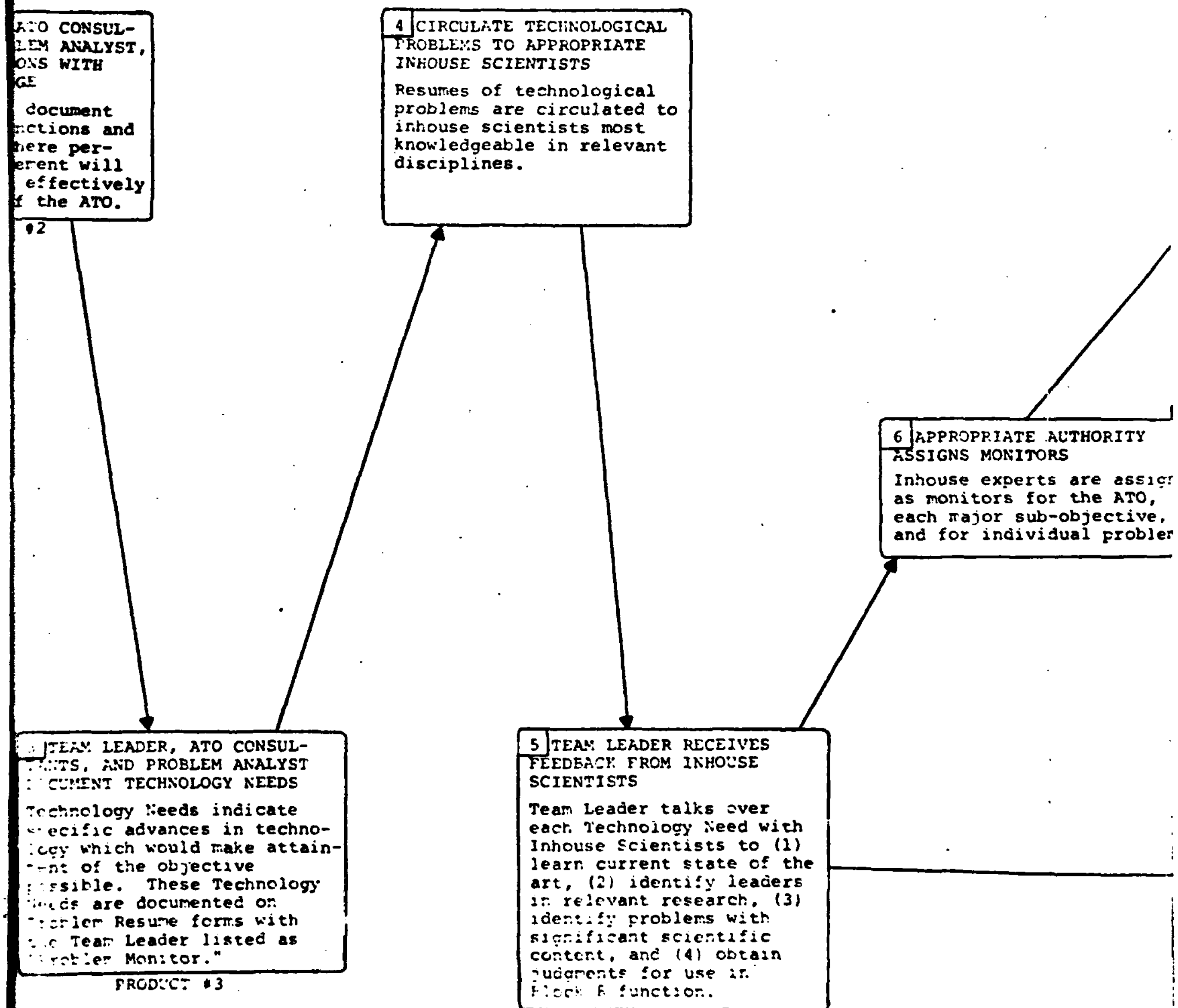
PRODUCT #5 - An analytical report which predicts the time frame in which the knowledge and technology necessary for attainment of the ATO will probably be available. This report also outlines a program of support for pacing areas of research designed to reduce the time required to make the ATO attainable.

Appendix 1

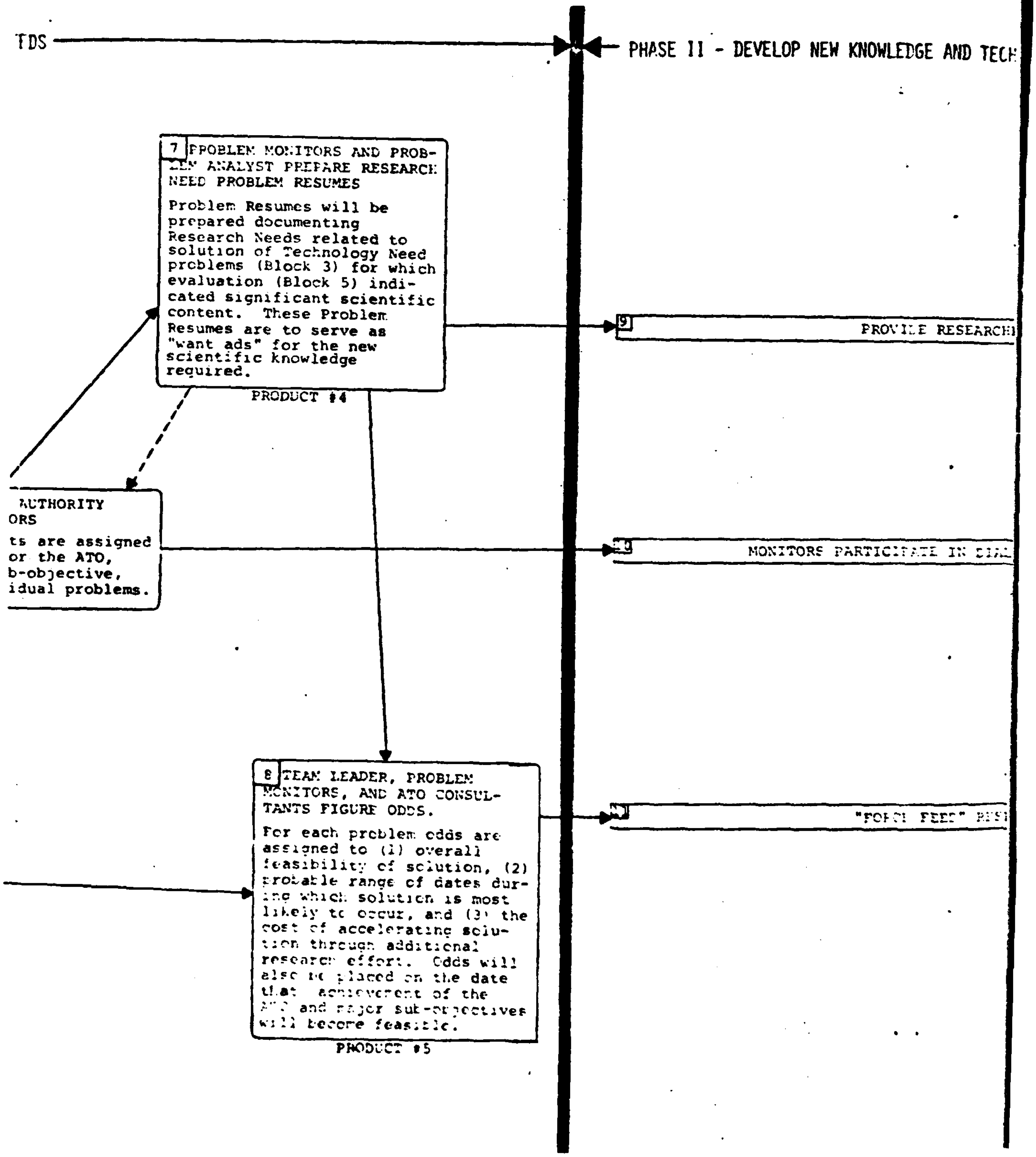

PHASE 1
DECISION IS MADE TO PERFORM PROBLEM RESEARCH ANALYSIS OF A LONG-RANGE, ADVANCED TECHNOLOGICAL OBJECTIVE (ATO)
Attainment of the ATO is presumed to be (1) of exceptional value to the Air Force and (2) impossible at the present time owing to lack of supporting technology. Problem Research will be used to (1) identify supporting technology which, if available, would make the ATO attainable and (2) determine if such technology is currently "on the shelf." If it is not on the shelf, then the process must be continued to (3) determine if it can be produced on the basis of available knowledge, and, if this is not possible, (4) define the scientific content of the problems which must be solved to provide the sought-for technology.
1 TEAM LEADER AND PROBLEM ANALYST DEFINE OBJECTIVE
They describe, and express quantitatively where possible, capabilities which would constitute attainment of the objective.
PRODUCT #1
2 TEAM LEADER, ATO CONSULTANTS, AND PROBLEM ANALYST, IDENTIFY FUNCTIONS WITH THE MOST LEVERAGE
They define and document structure of functions and sub-functions where performance improvement will contribute most effectively to attainment of the ATO.
PRODUCT #2
TEAM LEADER, A
Technology Needs
Team Leader

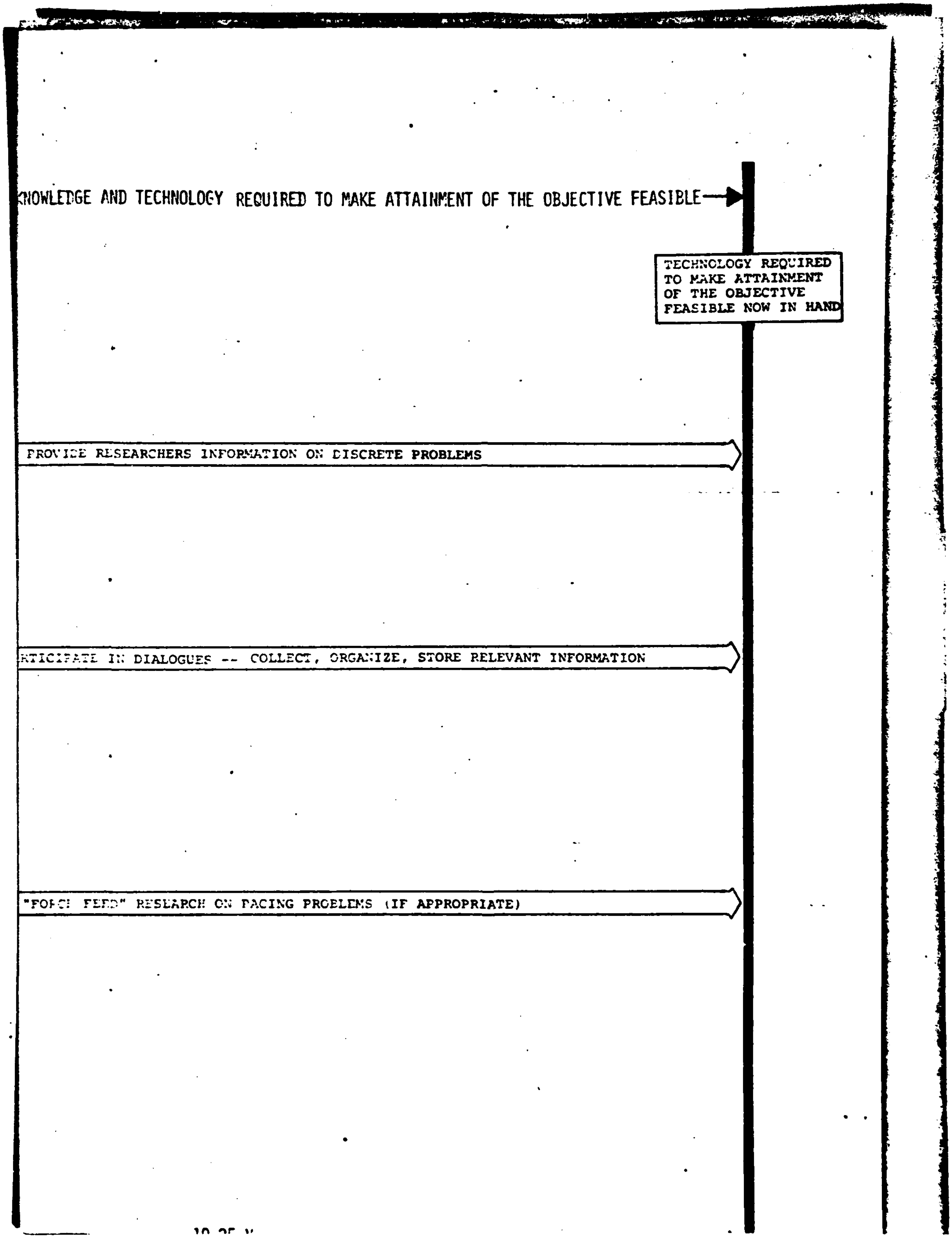
THE ROLE OF PROBLEM RESEARCH IN MAKI

PHASE I - ANALYZE OBJECTIVE -- DETERMINE TECHNOLOGY NEEDS -- DETERMINE RESEARCH NEEDS

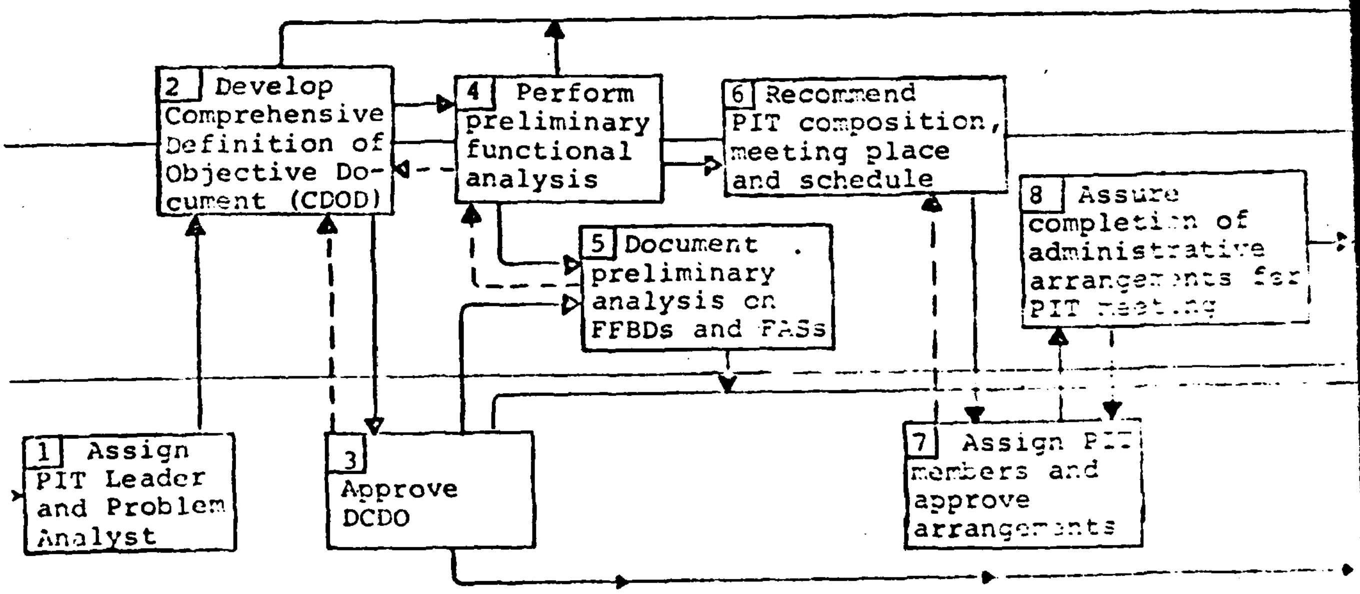


...ACH IN MAKING ATTAINABLE AN ADVANCED TECHNOLOGICAL OBJECTIVE

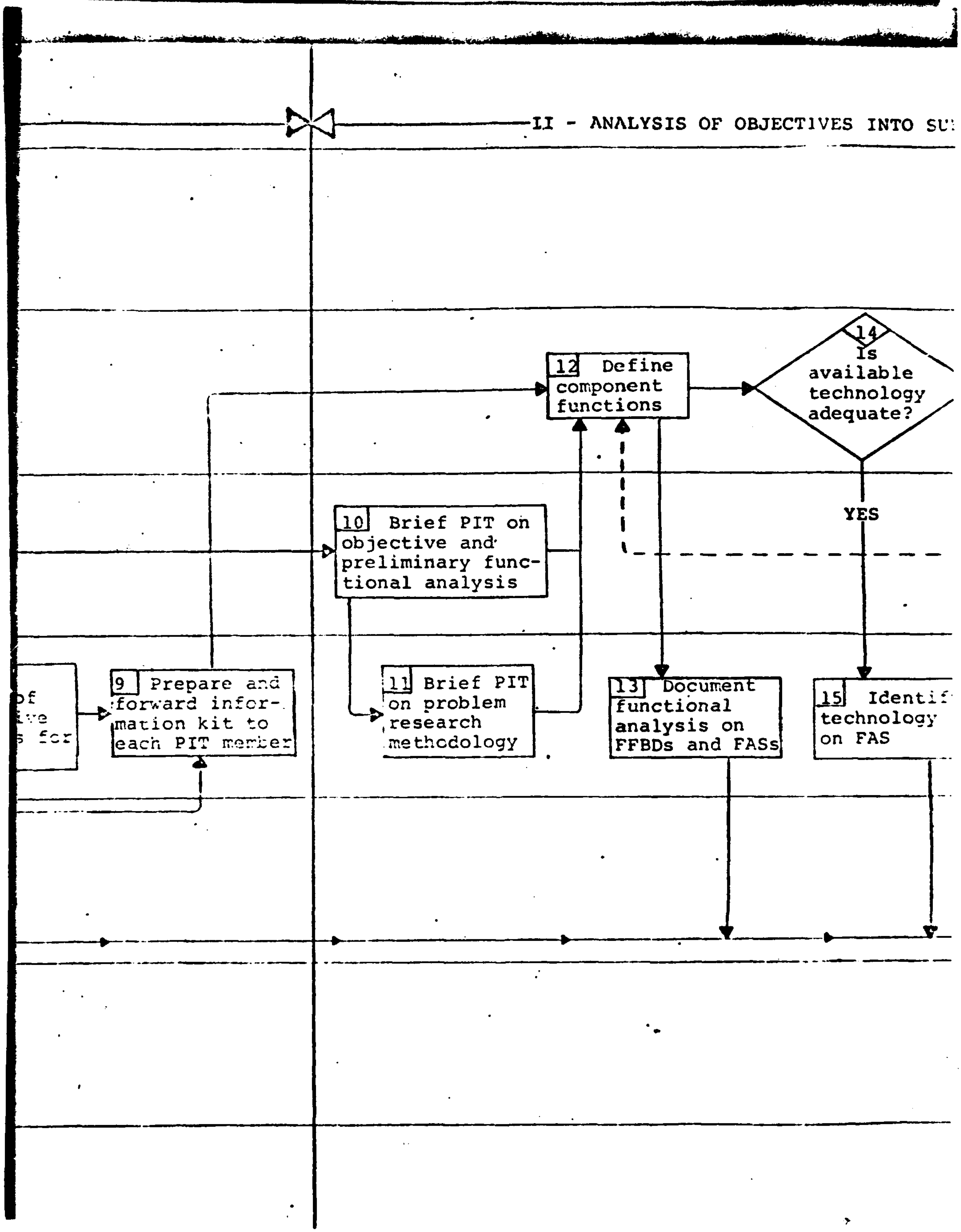



KNOWLEDGE AND TECHNOLOGY REQUIRED TO MAKE ATTAINMENT OF THE OBJECTIVE FEASIBLE
TECHNOLOGY REQUIRED TO MAKE ATTAINMENT OF THE OBJECTIVE FEASIBLE NOW IN HAND
PROVIDE RESEARCHERS INFORMATION ON DISCRETE PROBLEMS
RTICIPATE IN DIALOGUES -- COLLECT, ORGANIZE, STORE RELEVANT INFORMATION
"FORCE FEED" RESEARCH ON PACING PROBLEMS (IF APPROPRIATE)

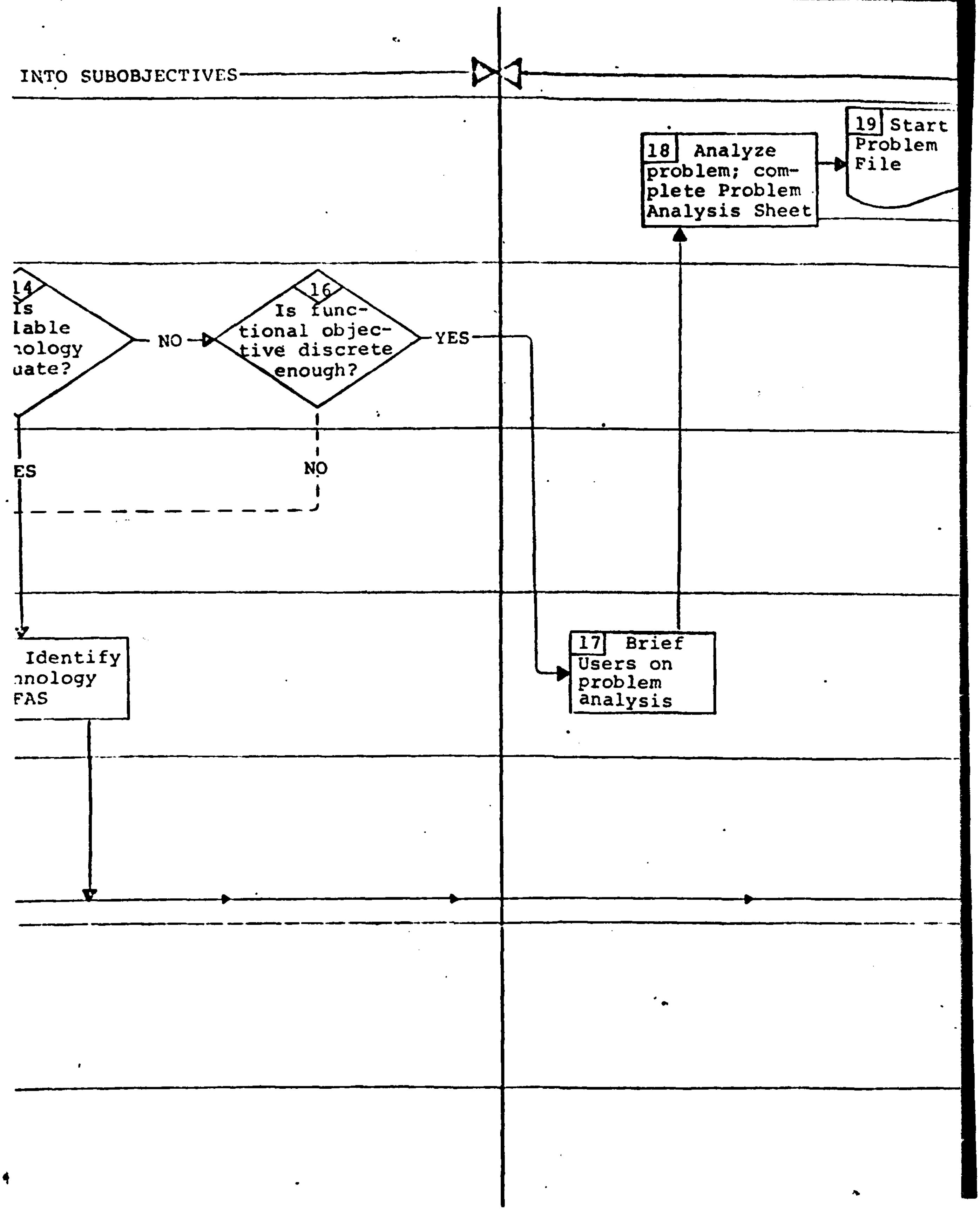
I - ORGANIZATION AND PRELIMINARY ANALYSIS

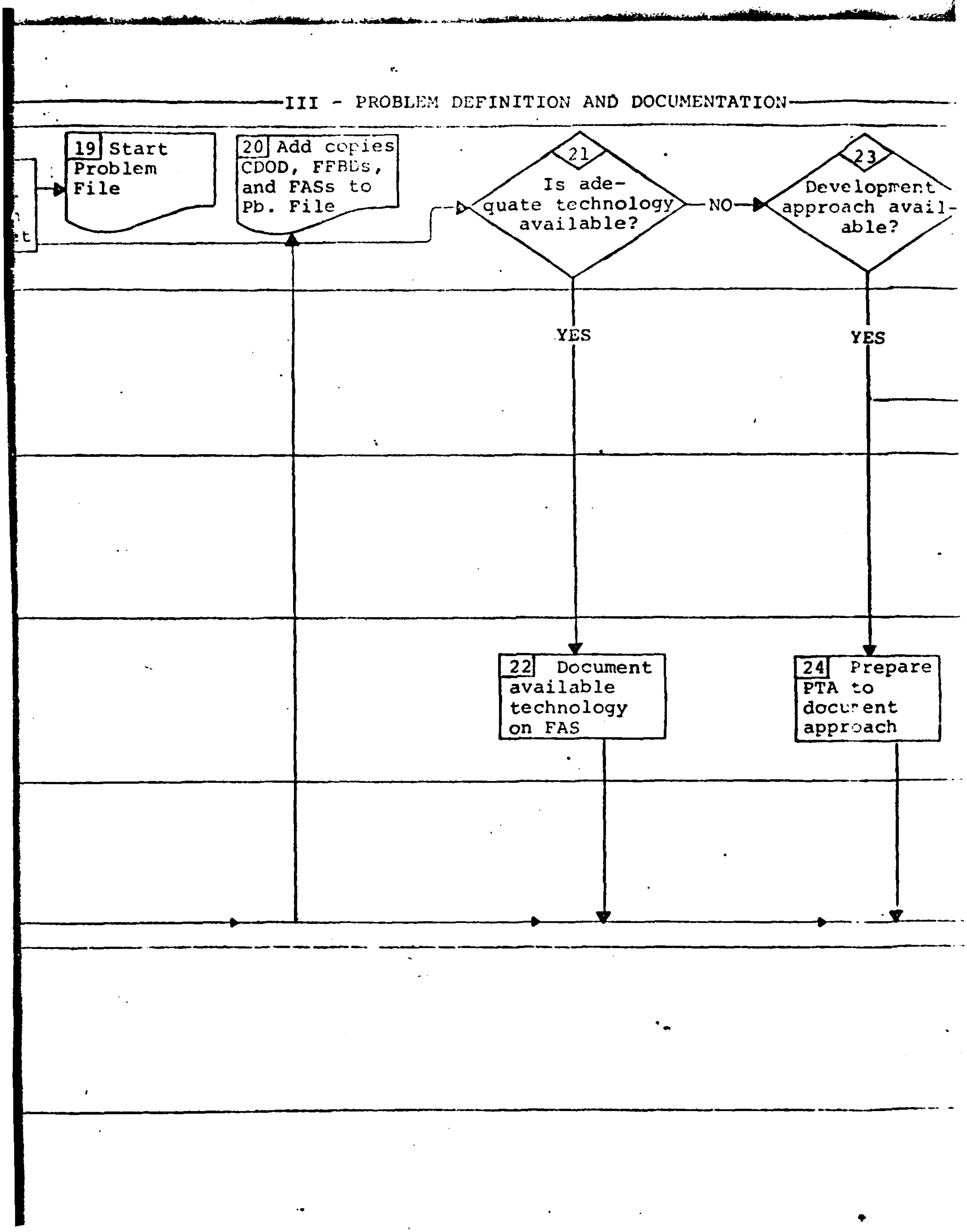


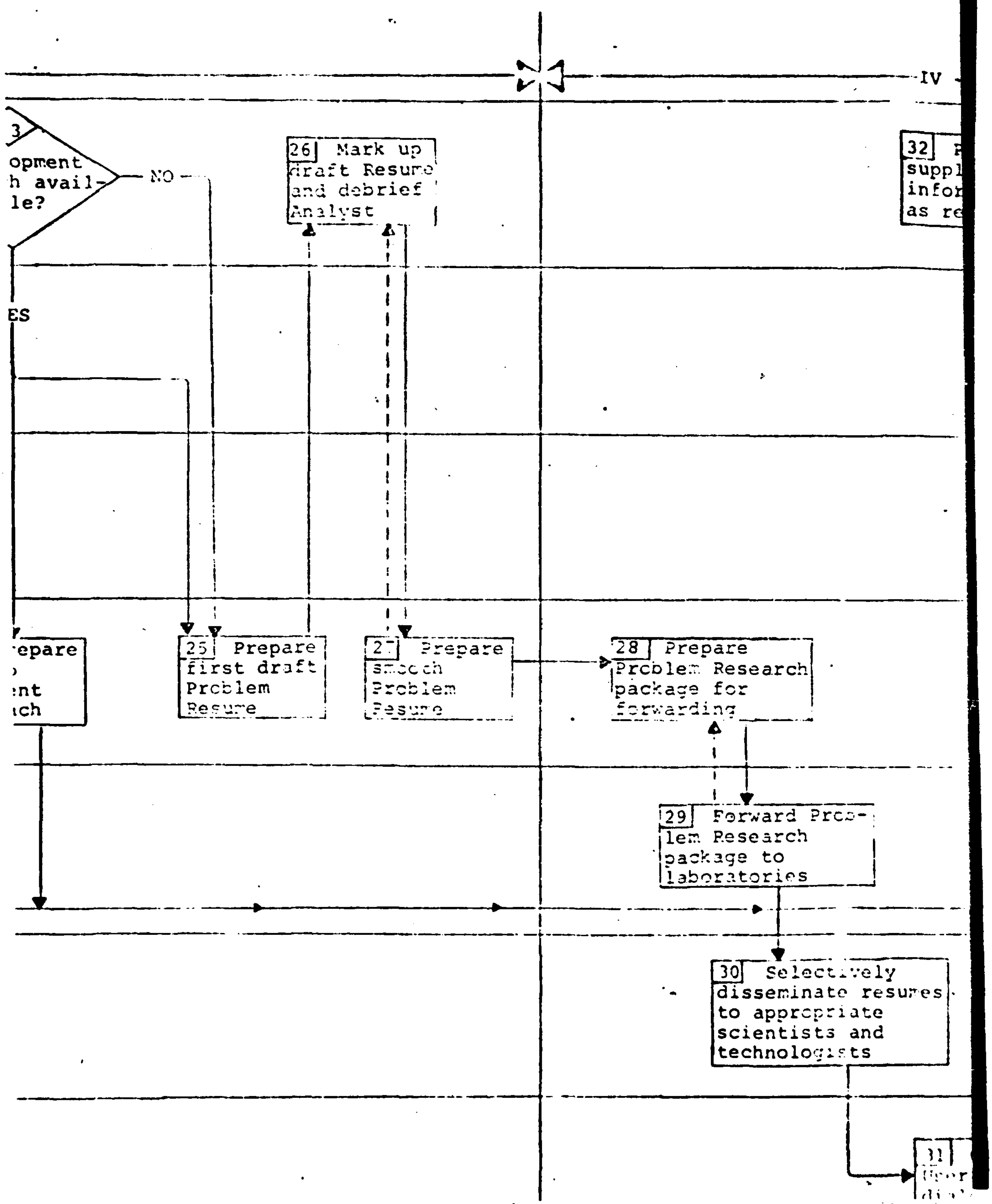
Appendix 2

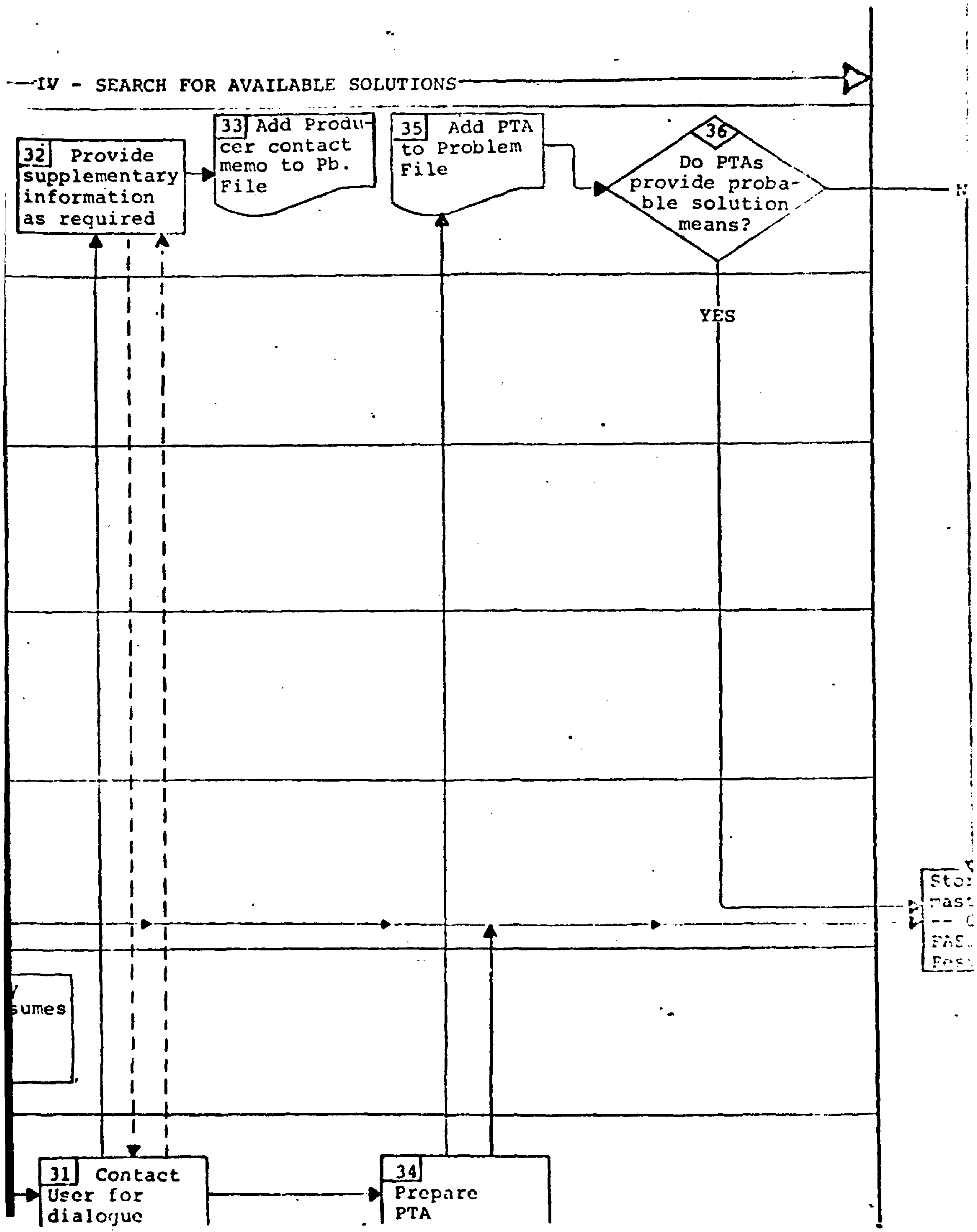


II - ANALYSIS OF OBJECTIVES INTO SU
12 Define component functions
14 Is available technology adequate?
YES
10 Brief PIT on objective and preliminary functional analysis
9 Prepare and forward information kit to each PIT member
11 Brief PIT on problem research methodology
13 Document functional analysis on FFBDs and FASs
15 Identif technology on FAS


INTO SUBOBJECTIVES
18 Analyze problem; complete Problem Analysis Sheet
19 Start Problem File
14 Is
lable
nology
uate?
NO
16 Is functional objective discrete enough?
YES
ES
NO
17 Brief Users on problem analysis
Identify
nnology
FAS


III - PROBLEM DEFINITION AND DOCUMENTATION
19 Start Problem File
20 Add copies CDOD, FFBDs, and FASs to Pb. File
21 Is adequate technology available?
NO
23 Development approach available?
YES
YES
22 Document available technology on FAS
24 Prepare PTA to document approach


IV
opment
h avail-
le?
NO
ES
26 Mark up draft Resume and debrief Analyst
32
suppl
infor
as re
epare
nt
ich
25 Prepare first draft Problem Resume
27 Prepare smooth Problem Resume
28 Prepare Problem Research package for forwarding
29 Forward Problem Research package to laboratories
30 Selectively disseminate resumes to appropriate scientists and technologists
31



IV - SEARCH FOR AVAILABLE SOLUTIONS
32 Provide supplementary information as required
33 Add Producer contact memo to Pb. File
35 Add PTA to Problem File
36 Do PTAs provide probable solution means?
YES
umes
31 Contact User for dialogue
34 Prepare PTA

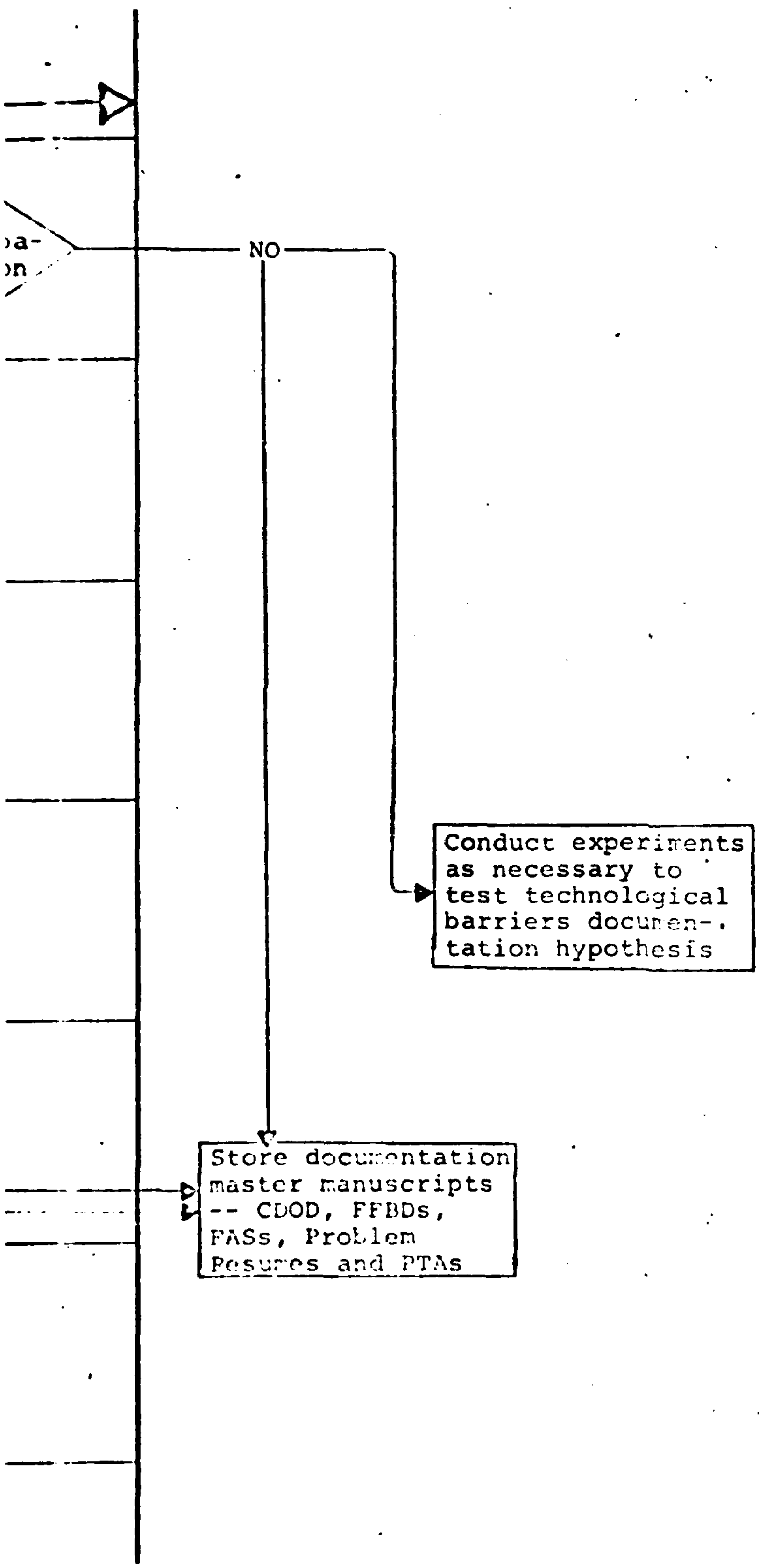


FIGURE IV - PROBLEM RESEARCH PROCESS

RESPONSE SHEET FOR RECIPIENTS OF PROBLEM RESUMES
SUMMARY OF THE RESPONSES

____
Name of recipient

____
Recipient's organization

1. These questions are to determine the practicality of the policy of purely voluntary response to Problem Resumes:

a. Did you receive copies of the enclosed resumes? 22 YES 2 NO

b. Have you contacted Mr. Cramer in the last few days? 7 YES 17 NO

c. If you did not respond, was it mainly because of:

(1) Lack of time and pressure of deadline activities? 0

(2) Belief you had very little to contribute? 15

(3) Other (please explain)? 3

d. If you did not respond, and the reason was -- too little time; too much pressure; do you think this is a temporary condition? In other words, do you think a voluntary response system is feasible in normal times? 7 YES 1 NO

2. This series of questions is concerned with the effectiveness of selective dissemination of problems within your organization. The questions below are an attempt to get at two aspects of this issue: (1) the absolute extent of your expertise in the problem area, and (2) the relative degree of your expertise compared to that of other people in your organization.

a. How knowledgeable do you consider yourself to be in the areas related to these problems? (or conversely, How close is the problem to the heart of your field?)

	Much Knowledge	Some Knowledge	Little Knowledge
FFBD#	8	22	48
FFBD#			
FFBD#			
FFBD#			
FFBD#			
FFBD#			
FFBD#			

APPENDIX 3

b. How do your qualifications for responding to these problems compare to the qualifications of others within your organization?

	I am the most knowledgeable	Several of us about equally well qualified	Others are much better qualified than I am
FFBD#	16	22	35
FFBD#			
FFBD#			
FFBD#			
FFBD#			
FFBD#			
FFBD#			
FFBD#			
FFBD#			
FFBD#			

3. Did you pass any of the resumes, or copies of them, along to colleagues you thought might be interested in them? 9 YES 15 NO

4. This series of questions is concerned with your views on the desirability of identifying, documenting, and disseminating information on technological problems.

a. On identifying, defining, and documenting problems, assuming that valid Air Force technological problems can be identified, at modest cost, what are your views concerning the potential benefit of the Air Force from such activity?

10 Very great (+5)

5 Worthwhile (+4)

8 Some benefit (+3)

___ No value (+2)

1 Potentially harmful (please amplify if you check this one)(+1)

10 x 5 = 50
5 x 4 = 20
8 x 3 = 24
1 x 1 = 1
24

$\frac{95}{24} = 3.96$

b. On selective dissemination of Problem Resume. Assuming that resumes of valid technological problems are available, what is your view of the desirability of selective dissemination of these resumes as a means of triggering direct person-to-person contact between producers and users of scientific knowledge?

7	Very great	(+5)	7 x 5 = 35
8	Worthwhile	(+4)	8 x 4 = 32
8	Some benefit	(+3)	8 x 3 = 24
			1 x 1 = 1
			24 92
	No value	(+2)	92/24 = 3.83
1	Potentially harmful (please amplify if you check this one)	(+1)	

c. On providing problem information services. Assuming that resumes of valid technological problems are available in considerable numbers, what are your views on the desirabiltiy of establishing a computer storage and search capability and providing information services on problem information analogous to services now available on work unit information through the DD 1498 system?

3	Very great	(+5)	3 x 5 = 15
5	Worthwhile	(+4)	5 x 4 = 20
10	Some benefit	(+3)	10 x 3 = 30
			5 x 2 = 10
			1 x 1 = 1
			24 76
5	No value	(+2)	76/24 = 3.16
1	Potentially harmful (please amplify if you check this one)	(+1)	

5. Do you have any suggestions for measures to increase the probability that relevant scientists will (1) read resumes, and (2) contact the individual listed on them? 7 YES 17 NO. If "YES," please elaborate.

When completed, please return to the Principal Investigator in the enclosed envelope. His address is

Dr. Robert J. Massey
3701 36th Rd. North
Arlington, Va. 22207

TRANSCRIPT OF SUPPLEMENTARY REMARKS ON RESPONSE SHEETS

M.L., CRL

I think the definition of the problem and request for information is helpful beyond the immediate goal of soliciting a prompt response. It helps define the state-of-the-art and Air Force needs and it stimulates thought and research goals to 1. meet needs as defined 2. develop alternate approaches which might overcome present roadblocks. A great idea - hope you continue and broaden it.

M.S., CRL

The problem posed by Mr. Cramer is too difficult to be "solved" by person-to-person contact. Whole research laboratories are attempting to solve this problem, and not by direct attack either - by doing research in the whole field of superconductivity. We are not doing any superconductivity research at our particular lab within CRL. Maybe within the next decade someone, somewhere, will make a (lucky?) breakthrough and discover a new alloy which will push the superconducting transition up to room temperature - I don't know!

C.S., CRL

5. Do you have any suggestions for measures to increase the probability that relevant scientists will (1) read resumes, and (2) contact the individual listed on them? YES

Make the compilation of resumes compulsory reading for all scientific branch chiefs, laboratory chiefs, program leaders, etc. in OAR. Have the establishment officially support this procedure, particularly by rewarding (promotion, QSI) scientists who respond to identified AF problem and who succeed in providing a solution.

When I received the problem resume entitled "High-Temperature Superconducting Materials" last fall, I did not contact the "focal individual" because of my less-than-direct interest and lack of a contribution.

Since that time I became aware of an enormous study conducted by scientists at American Science & Engineering (Cambridge, Mass.) and at MIT directly on the subject. I therefore advised this group to contact Mr. Cramer at ARL, who was listed on the resume as the "focal individual."

I think this is an example of indirect benefits accruing from this mechanism of continually identifying AF technological problems. As a senior scientist in OAR, I should definitely be aware of all AF problems existing in my field, and, to some extent, should be reasonably aware of major technological problems not in my field. In this way I will be in a position to, on the one hand, optimize our research, and secondly to assist work going on elsewhere. Good luck.

Appendix 4

D.F., CRL

1.c.(3) These questions are to determine the practicality of the policy of purely voluntary response to Problem Resume:

Having reviewed it with all of the Electronic and Mechanical Engineers in my Branch, we had nothing to contribute. This is a problem for a Metalurgist, the instructions were: "If you know how to solve it, or an approach for developing means to solve it, please contact the "user." Since we were in neither category, contact with the "user" seemed useless.

1.d. If you did not respond, and the reason was -- too little time; too much pressure; do you think this is a temporary condition? In other words, do you think a voluntary response system is feasible in normal time?

Happy to contribute to some other problem nearer my field.

D.C.R., ARL

5. Do you have any suggestions for measures to increase the probability that relevant scientists will (1) read resumes, and (2) contact the individual listed on them? YES

Resumes should be sent to scientists that are working in the problem area or at least that field of research.

H.A.L., ARL

5. (same as question above)

Don't expect many scientists to go looking for engineering problems - some forcing mechanism or triggering device (such as these resumes) must be used.

Problem Resume 2.2.1.2 - High temperature thermal insulator/ electrical conductors .....in an environment characterized by temperatures up to 3400°K or more, ... not only the ultimate goal should be stated (operating at 3400°K) but the present state of the art. This goal is by far too far off. What is the present operating temperature? Would 3000°K or even 2000°K already be an advancement? I might try to think if you want anything around 2000°K, but I refuse to think even if 3400 or 3000°K is really required.

Problem Resume 2.2.1.1 - High temperature tolerance electrical insulators ....What is the present state of art. How long operates the present seal before deterioration (milliseconds, hours?).

S.I.F., ARL

5. (same question as above)

In addition to identifying problem areas, identify capability areas of scientists to be contacted. Then match a few resumes that have a high likelihood of stimulating the interest of the contact. Further, ask scientists to let you know of other problem areas that might be of interest to them.

K.S., ARL

It may be useful to prepare a listing of problem resumes by title and circulate these to research organizations for response, if individuals are interested.

D.W.T.L., ARL

4.a. On identifying, defining, and documenting problems, assuming that valid Air Force technological problems can be identified, at modest cost, what are your views concerning the potential benefit of the Air Force from such activity? VERY GREAT

If problems are reasonable and distributed to the right people. If a person receives too many unreasonable requests or such outside his area, he will soon stop reading all of the Problem Resumes.

4.c. On providing problem information services. Assuming that resumes of valid technological problems are available in considerable numbers, what are your views on the desirability of establishing a computer storage and search capability and providing information services on problem information analogous to services now available on work unit information through the DD 1498 system? NO VALUE

"Solutions" should be stored i.e. technological advances with name of originator.

I think that "problem storage" is of no value, because who would dig through all problems and who can foresee all possible applications of some new advancement (unless it is made in pursuit of a particular problem).

However, of possible greater value would be a catalog of new advancements for 1) the man who has the problem can better judge those groups of subject which have an impact on the solution of his problem, and 2) it helps to identify expertise of researchers working in a given area. The work unit information certainly does not reflect correctly all past and present expertise of individuals.

I have some specific ideas for such a set-up which I would be glad to discuss with you if you want to follow it up.

T.O.T., ARL

5. (Same as question 5 on page 2)

If a computer storage capability for problem resumes is established, it would be relatively easy to establish simultaneously a file of scientists listed according to specialties, interests, etc. The latter could be elicited from the scientists themselves for insertion into the data bank. Computer matching of problem resumes and scientists concerned could then be accomplished. The major problem in such a scheme would be establishing categories of specialization and interest which are sufficiently descriptive and yet sufficiently broad to be practical.

H.W.J., AFOSR

1.b. (Have you contacted Mr. Cramer in the last few days?)

Original instructions stated Mr. Cramer would contact me if further info desired.

1.c. (3) (On reason for not contacting Mr. Cramer)

Response not requested in original input! Simply asked to be "aware of problem."

1.d. (On feasibility of a voluntary response system, to which H.W.J. checked "No.")

THERE ARE NO "NORMAL" TIMES IN RESEARCH TODAY! A simple "response requested" wherein interest/potential can be shown by checking a block, is far better than a "zero priority" voluntary response system!

4.a. (On the desirability of identifying, defining, and documenting problems, where he checked "potentially harmful.")

What is needed is identification of scientific (knowledge) barriers, not technological barriers! (Problems forwarded to this person were definitely technological -- Block 3 -- problems.) This requires cooperative, often face-to-face communication between scientists and technologists to identify what knowledge is lacking that science might supply. Your "Problem Resume" is therefore misoriented if it is an intra-research form. What is needed is an OAR (Program Element Monitor) screening/interpretation of tech barriers to derive scientific barriers which can then be passed to the proper project scientist.

M.S., AFOSR

1.c.(3) (On reason for not contact Mr. Cramer)

I thought Cramer was to call me.

UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) PROGRESS MANAGEMENT SERVICES 3701 36th Rd. North Arlington, Va. 22207	2a. REPORT SECURITY CLASSIFICATION ~~N/A~~ Unclassified 2b. GROUP N/A

3. REPORT TITLE

THE OAR PROBLEM-ORIENTED COUPLING EXPERIMENT

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Technical report

5. AUTHOR(S) (First name, middle initial, last name)

Robert J. Massey

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
14 February 1970	40	

8a. CONTRACT OR GRANT NO. F44620-68-C-0065 b. PROJECT NO c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) OAR 70-005

10. DISTRIBUTION STATEMENT

Distribution of this Document is Unlimited

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
Tech. other	Office of Aerospace Research 1400 Wilson Blvd. Arlington, Va. 22209

13. ABSTRACT

The objectives of the experiment were (1) to test problem research methodology developed in previous phases of the OAR Technological Barriers Documentation Project, and (2) to test the hypothesis that exposing Air Force scientists to specific technological problems would aid in coupling research to practical purposes.

An advanced technological objective of a competitive, flight-weight magnetrohydrodynamic (MHD) electrical generator was analyzed to define specific technological problems whose solution would make development of the envisioned device feasible. These problems were documented on single-page Problem Resumes and selectively disseminated to scientists in OAR laboratories with a request to contact a given individual if they could contribute to illumination of the problems.

Dissemination of problems and resulting technical feedback were not sufficient to be statistically significant. Results indicated, however, that specific Research Needs can be identified and documented at modest cost and that their selective dissemination to Air Force scientists is in the Air Force's interests. The report includes specific recommendations on exploitation of problem documentation and Problem Research.

DD FORM 1 NOV 65 1473

UNCLASSIFIED
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Research program administration						
Coupling						
Technological objectives						
Research objectives						
Technology Needs						
Research Needs						
Technological problems						
Problem Research						