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Center for the Study of Environment

RESEARCH AND EDUCATION
IN MANAGEMENT OF LARGE-SCALE
TECHNICAL PROGRAMS

NASA Grant NGL 39-004-020

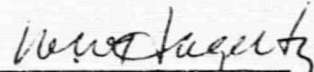Second Semiannual Progress Report
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CONTENTS

Volume I

Appendices

Volume II

Volume III

ABSTRACT

In January 1969, the National Aeronautics and Space Administration approved a grant to Drexel Institute of Technology for research and education in the management of large-scale technical programs. This report summarizes the activities of the faculty and students working on this grant. This team concentrated its efforts on three tasks: (1) development of an interdisciplinary team; (2) development of an educational baseline by and for the students; (3) investigation into the transfer and management of technology.

An educational baseline was developed by the five Research Associates to meet their needs for a program which blends factual knowledge, theory, and experience into a new approach to education. This plan includes an action research period, during which the five Research Associates will function as multidisciplinary team within some urban system. In addition, a number of new courses were developed to meet specific needs.

Because the Research Associates are to function as a single team, an initial task was the molding of the five individual students into a single group who could function efficiently as a working organization. The approach taken was to emphasize that it is the individuals who must work together and that they must develop an awareness of their personal impact on one another.

Initial investigations into the actual transfer of NASA technology are centered on simulation and gaming, and the NASA planning process and configuration management. Two games BUILD and MISPA have been developed which emphasize the decision making and negotiating processes particular to the urban environment. It is anticipated that both these areas of technology will be more deeply investigated in the next year.

1. Introduction

In January 1969, the National Aeronautics and Space Administration approved a grant to Drexel Institute of Technology for research and education in the management of large-scale technical programs. As stated in the memorandum of understanding between these two organizations, the objectives of this program were..."to establish a pilot program in graduate education and research reflecting a multidisciplinary approach to administration, management and the transfer of relevant technology." This program was to include the President of Drexel, Dr. William W. Hagerty, as the Principal Investigator, three Drexel professors as Associate Investigors and five graduate students as Research Associates. Staffing of this organization was completed September 1969, and consists of individuals whose advanced education and experience falls into three major areas: management science, engineering, and behavioral science and organizational development.

During the latter portion of 1969, the organization concentrated its efforts on three tasks.

1. The development of an interdisciplinary team which could efficiently function as a unit in multi-disciplinary research.

2. The development of an educational baseline for this pilot program, including the development of courses at Drexel to support this program.

3. Preliminary investigations into the transfer of technology and the management of technology relative to urban systems.

This document summarizes the team activities in each of the above tasks.

2 1 Education

2.1.1 Objective

As previously stated, this grant is to establish a ..."pilot program in graduate education..." leading to a Ph.D. in public administration.

A unique feature of undergraduate education at Drexel Institute of Technology is the cooperative work-study program. We propose an adaptation of this in graduate education by including supervised work as part of the educational process. A keystone of this proposal is an action research period, during which the Research Associates would study and work in an urban system. Therefore, it was necessary to develop a plan which would include this action research as an integral part of the education process.

2.1.2 Academic Baseline

The five students, in assessing their educational needs, have developed the following academic baseline as a procedure for fulfilling the intention of NASA that a new multidisciplinary approach be attempted.

2.1.2.1 Assumptions

In the education for management of large technical systems we have a number of assumptions.

The first assumption is that there are common elements and principles of management which are found in business, education, and public administration. It is proposed that the focus of attention be upon the common and basic elements, principles, and skills for management of large organizations. This requires an attempt to blend factual knowledge, theory, and experience. A necessary part of the education of a professional includes development of the ability to analyze the environment in which he is working in order to determine how best to apply the principles of management. This leads to the second assumption that a manager is a "professional" combining both theoretical understanding with skilled practice and that a manager is a generalist rather than a specialist. Therefore, our educational program should prepare us for such a generalist role.

A third assumption is that technology will continue to have an unsettling impact on our social order.

Based on these assumptions and the fact that NASA's grant to Drexel is to focus upon transfer of their management technology to urban systems, our program must include action research as a basic educational method.

2.1.2.2 Action Research

Action-research is a term which couples two basic elements. The "research" aspect means that action is based upon a planned design and methodology, a definite theoretical framework, and the testing of one or more hypotheses.

The "action" concentrates not simply on observing a particular system, but
on a change in it by actually integrating the student/manager in the system.
In this type of research the researcher is not a detached observer-reporter.
He is rather a participant-observer. As a participant-observer the effective-
ness of his functioning is one of the variables in determining the outcome
of the hoped-for change in the situation under study.

Successful action-research should produce three basic outcomes: (1)
The achievement of the planned change, (2) new knowledge, and (3) a manager
of increasing professional competence.

Since action-research is to provide the starting point for our Ph.D.
program in general management/administration, scholarly attention must be
given to the action-research design. "To design is to plan; that is, design
is the process of making decisions before the situation arises in which the
decision has to be carried out. It is a process of deliberate anticipation
directed toward bringing an expected situation under control."[1] Coupled with
the development of a research design is the need to have a clear methodolo-
gical framework. "Whereas des'gn exposes research decisions to evaluation
before they are carried out, methodology actually makes the evaluation
and exposes the method used in arriving at these design decisions so that it
too can be evaluated before hand."[2]

By its very nature action-research is difficult to conduct. In labora-
tory research there is an attempt to control the variables and only selectively
manipulate one or more of them. Action-research in the field of management/
administration does not allow for such control of the variables. Because
this is so it is critically important that the research design, the methodolo-
gical framework and a theoretical base be developed in order to provide a
systematic way to understand and keep track of the impacts of the significant
variables.

2.1.2.3 Educational Goals

Because there is no way of predicting in advance the type of action
research projects that will be undertaken, it is not possible to develop
a rigid academic program that is centered on the mastery of a specialized
body of knowledge.

For the manager/administrator we propose concentration on the develop-
ment of the following fundamental abilities:

1. Russell L. Ackoff, THE DESIGN OF SOCIAL RESEARCH, University of Chicago
   Press, Chicago, 1953, page 5.

2. Ackoff, page 6.

a. The ability to define a social system.

b. The ability to plan an appropriate action-research design.
   The ability to define the relationships within a system.

c. The analytical ability to define a problem.

d. The ability to understand the interpersonal dynamics and to function effectively.

e. The ability to understand the process of learning so that one can acquire new knowledge as needed.

f. The ability to analyze the organizational dynamics of any type of an organization.

g. The ability to develop a theoretical framework for one's activities.

h. The ability to cooperate within an interdisciplinary process.

i. The ability to evaluate a total program.

   An example of such a project is one undertaken by a Master's candidate in Drexel who served for eighteen months as a consultant to a community center in a Black neighborhood. He worked with community people to help solve some of their problems, he developed social diagnostic skills, and planned strategies of intervention. The community center was reorganized, a new informal communications network was developed, and individuals in the community were trained to increase their interpersonal skills.

2.1.2.4 An Academic Program for the Individual

Because the needs of each particular action-research project will be different and because the Ph.D. candidates have varying degrees of competence in terms of the above abilities, each student will have an academic program responsive to his needs and the research with which he is involved. The student-researcher together with his academic advisor will develop an appropriate educational strategy.

This approach calls for flexibility. It means that course requirements and the credit-amassing process will no longer serve as a framework. The basic reason for such a shift is that the emphasis within the action-research framework is not upon acquiring a high degree of knowledge about a specialized subject, but upon developing a high degree of competence in the above mentioned abilities.

2.1.2.5 Advisory Committee

The Advisory Committee would have several roles to perform. The first would be to review with the Ph.D. candidate the eduational design that he has worked out in consultation with his advisor. The Advisory Committee would make recommendations that would have to be acceptable to all parties. Once the design has been agreed upon the candidate and his advisor would work on establishing an academic plan that would serve to guide the candidate in his studies and as a standard by which he would be measured during the qualifying process. The Advisory Committee would have to concur on this academic baseline.

2.1.2.6 Qualifying Examinations

The function of the qualifying process would shift from an examination of the candidate's mental inventory of prescribed knowledge to a performance appraisal. One part of the evaluation would consist of reviewing the work of the candidate to date in light of his educational baseline. The second aspect would concern his developing competence in terms of the abilities outlined above. Since the Advisory Committee members may have limited knowledge of the candidate in these areas, additional persons of competence familiar with the candidate's work on the action-research should be invited to sit as temporary members of this examining committee.

The qualifying process would be the university's way of maintaining excellence among its candidates and the candidate's way of gaining a realistic appraisal of his ability to function effectively as a professional in his chosen field.

2.1.2.7 The Dissertation

The dissertation represents an intellectually disciplined sharing of the new knowledge developed through the action-research. An integral part of the dissertation process will be the performance of the candidate as a responsible member of the action-research team. This will insure a balance between the demands of the traditional type disseration and accountability for a professional level of performance.

2.1.2.8 Summary

The use of action-research as a vital core for the new Ph.D. program at Drexel bridges the gap between the academic community and the general society. The action-research will allow the university to bring to bear its intellectual resources to solve real problems of concern to those outside of the university. It will provide the NASA Ph.D. candidates with the opportunity to develop simultaneously both a theoretical understanding and professional competence. Since the problems will usually require an interdisciplinary effort,

both faculty and students will be required to develop the interpersonal and intellectual skills needed to work in a context involving several disciplines. It is our hypothesis that action-research will permit the development of an alternative educational strategy which concentrates on developing abilities rather than the acquisition of specialized knowledge. It will serve as a bridge between the present and the uncharted future by allowing Drexel the opportunity to participate in actually shaping at least a small portion or that future.

2.1.3 New Courses

During the past year, Drexel has developed a number of new courses to meet the needs of a curriculum in public administration. In addition to this a number of existing courses were also modified to better support this program. These courses will continue to be offered at Drexel.

A list of new courses and a brief description of each is given below.

Technology & Society - Examination of technology as a cause and symptom of the economic and social order. Psychological and philosophic bases for technological activity. Possibilities for predicting and shaping the role of technology in ther service of man. Lectures and small group case studies.

Required Reading:

1. Ellul, J., The Technological Society, Vintage, 1964 (orig. 1954)

2. Fromm, E., The Revolution of Hope, Bantam, 1968

3. Galbraith, J. K., The New Industrial State, Signet, 1967

4. Roszak, T., The Making of A Counter Culture, Anchor, 1969

Urban Systems Design I, II - Participation in design of a large-scale, socially-oriented system. Emphasis on integration of philosophic, political, economic, social, and technological elements. Final report will be oriented toward producing an action program.

Plans for Winter-Spring Quarters, 1970 - It is anticipated that the first offering of the course will be devoted to a study of the possibilities for large-scale industrialized housing projects in Philadelphia. Interaction with other major elements of community development in this area during the years 1970-2000 will be emphasized. A variety of information sources will be utilized including direct contacts with federal and local officials and with individuals in industry.

Organization Behavior Seminar - this course aimed at developing techniques to study organizations via their communication patterns.

Fundamentals of Public Administration - this course is to provide a broad view of the theory of public administration.

Seminar in General Systems Theory - an intensive three day seminar
was held to study the applicability of General Systems Theory
to the social and behavioral sciences. Additional seminars
on this theme are projected for the future.

2.2 The Multidisciplinary Approach

2.2.1 Objectives

A primary goal of this grant is the "... multidisciplinary approach to
administration, management and the transfer of relevant technology." The
approach taken at Drexel was to build a multidisciplinary team of individuals
with various and diverse specialities and personalities. An initial task
for the faculty was to integrate the five research associates into a single
group which would function as a unit in the action-research phase of the
program. Let it be said in all candor that while integration of the students
into a single group was eased by their commitment to such a venture, it has
not been a simple task. It has often been assumed that multidisciplinary
research is difficult due to the nature of the disciplines above. Our approach
has emphasized that individuals must consider their personal impact upon one
another if they are to work together; that is, multidisciplinary research
may run into difficulty because of the researchers themselves. We chose not
to overlook this factor, but to deal explicitly with it.

2.2.2 Team Development

A number of activities contributed toward the interdisciplinary team
development. The Research Associates and faculty consultants participated
in many weekly, monthly and quarterly planning and review meetings; attended
several professional meetings and made several visits to NASA Headquarters;
collaborated in the development of MISPA and BUILD (simulation games); served
as consultants to the Dean of the College of Business on the development of
a Ph.D. Program; and spent considerable time objectifying their own educational,
organizational, and interpersonal processes. Each of the Research Associates
also had exposure to teaching in human relations training in the Management
Development Laboratory at Drexel. Again, if these candidates are to partici-
pate in action research they must have action research skills prior to entry
into an urban systems. Therefore, the group of candidates primarily focused
upon their own system and sub-systems as a method of developing these skills.
These first months were not only productive in terms of the educational
process but in defining relationships, establishing trust formation, and
opening lines of communication. The NASA Drexel Team utilized these constructs
in examining themselves and this resulted in a jointly sponsored seminar with
two additional groups in the Management Development Lab in General Systems
Theory.

Every effort was made by the faculty to encourage the Research Associates to initiate and participate in the decisions that effect their education, time, and goals. There was a conscious attempt by the faculty to establish this program on the basis of Douglas MacGregor's concepts. MacGregor asserted that there are assumptions about human nature which he labelled Theory X and Theory Y. Theory X holds that man is by nature lazy, does not like work, and will attempt to shirk responsibility. Theory Y holds that man does like meaningful work, will organize his own work, and enjoys meaningful responsibility. The faculty has proceeded on the basis of Theory Y. For instance, one of the research associates was encouraged to invite Isaac Asimov, the noted scientist and science fiction writer, to a short seminar in managing the future. This encounter with Asimov was held and it proved to be a meaningful engagement for him and the research associates. As a result of these kinds of activities, processes, and reflective thinking, the classical lines between faculty and students have been modified and both faculty and students are negotiating a participative management style where all enter into decision-making and planning.

Another unique feature of the Drexel Ph.D. program under this grant was the decision to shape the educational experience to meet personal needs and goals, within certain constraints, of all of the candidates. The candidates and faculty have engaged in appraising the personal career goals of each and through a capability analysis of each candidate, have tried to mobilize and total human resources available within the team.

Through greater interpersonal sensitivity, organizational diagnostic skill, confrontation, and feedback, what appears now is a synergistic effect among the NASA Research Associates. For example, the candidates are practically managing the development of the educational baselines and the research planning and influencing the University to accept the innovativeness of what is emerging out of the four months of being engaged in the NASA Program. In addition, the students and faculty have agreed that by September 1970 their transfer (or action research) will begin in some urban system. By common agreement, the most likely management transfer immediately useful to urban systems will be NASA's planning process and configuration management. It has been agreed that the five research associates will work together within the same urban system engaging in integrative action research.

2.3 Technology

2.3.1 Objective

The purpose of this program is to investigate the application of both management science and technology to urban systems. As stated in the Memorandum of Understanding "...it is believed that NASA's organization and management experience over the past decade suggests that similar techniques might be used to realize other national goals for a large scale and technology-based nature."

Preliminary investigations have been concentrated in two areas.

1. Simulation and Gaming

2. The Planning Process and Configuration Management

2.3.2 Simulation and Gaming

2.3.2.1 Development of a conceptual basis for urban simulation and gaming activities

The fundamental purpose of this Grant has been stated in a variety of ways. The reference point has been the Space Act of 1958 which "...declares that it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind..." (Sec. 102 (a)), and that NASA shall "...provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof." (Sec. 203 (a) (3)). One important element in carrying out the intent of Congress in this regard is the development of methods which can mediate between the worlds of NASA's technological and managerial expertise in space activities and direct human needs such as housing, transportation, environmental control, etc. In our work we have put more emphasis on these mediating devices than on the further elaboration of technology, or on the analytic study of society. In particular, we have pursued the subject of urban simulation gaming because of its potentially great value in establishing some of the necessary linkages between the world of technology and the world of human need. The paper, "Uses and Misues of Computers in Urban Affairs", (Appendix A) (which was actually written and presented during the first six months of the Grant, but not included in our First Semiannual Report) extends this argument in the context of computer-based simulation gaming. The commissioned paper by Professor A. B. Shostak, "Urban Simulation and Gaming: Preliminary Experience and Perspectives," included here as Appendix C offers some valuable insights on non-computer games from a social science perspective.

2.3.2.2 Development of the urban simulation game, BUILD

BUILD is a large-scale, computer-based game oriented toward the problem of community development within the city. It became semi-operational in the fall, and is now undergoing extensive testing and evolution through usage by a variety of audiences. The paper, "BUILD -- A Community Development Simulation Game" Appendix B, provides a conceptual introduction to this work. It is important to note, however, that what we have been able to present is merely a glimpse of the method employed in BUILD, i.e. the conversational computer input/output mode of interaction between the participants and the model. No claim is made for the factual accuracy or the particular figures used, or for the structural features of the present model (essentially linear, constant-co-efficient input/output relationships). The most interesting thing about the game at this stage, and probably in the future as well, is the interaction which takes place among the participants.

2.3.2.3 MISPA

MISPA is a simplified linear simulation model of group decision-making with respect to the allocations of resources such as information time and money. It was originally developed to elicit data from NASA Managers about their implied values in allocation of resources and personal styles of management. It will also serve as a teaching and learning model for both internal NASA personnel and members of Public Administration offices at all levels of government. To date, it is being debugged by it's play and evaluation in various management courses in the College of Business Administration. Appendix E is the MISPA Game.

The environment that confronts executives participating in MISPA is a random medium sized city. A typical role assigned to the participants is that of city manager. The menu of project-objectives include the problem areas of pollution, housing, recreation and efficiency of intra-governmental systems. Priorities must be assigned and decisions taken to assign limited available resources to pursue objectives.

The objectives of the game are many fold including: a) the development and training of career governmental (mainly city) personnel, b) assessment of the transferability of the NASA management system to solution of typical urban problems and c) comparative evaluation of management (decision-making) types found in federal governmental, city and industrial organizations.

The game is so designed that any group which maximizes its profits or savings is operating at a high efficiency in terms of resource allocation. From the theoretical standpoint managers of large-scale programs are concerned with the need to develop the skill to efficiently utilize all available

resources including people. Group decision-making, although perhaps not as
efficient with respect to the time variable as individual decision-making, does
unquestionably offer for synergism via the utilization of several inputs from
the varied backgrounds of the group members. MISPA provides a vehicle for
the understanding of this process. It is expected (and borne out by initial
tests) that the performance of most groups playing the game will show a learning
curve similar to that below. This is not unusual in any way and merely says
that the more you play the better you become!
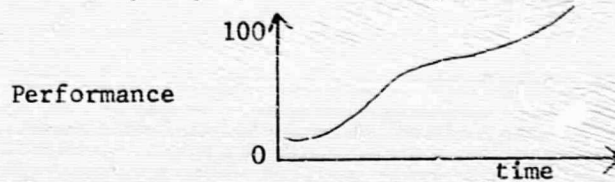
What is of importance, however, is the process the group goes through
during this time period. Some groups will progress at increased performance
levels and others will never make more than a 50% level. The development
of a theoretical framework for diagnosing group processes based on the game
performance would be most worthwhile. The potential for diagnosing and
training seems quite good. A questionnaire is being developed which formally
records basic data on each of the individuals within a group. It will capture
the conscious methodology of each group in reaching its decision points. This
will allow us to study information flow and see how each individual responds
to information as a function of any chosen variable such as position of hier-
archy, nature of work, etc. Work is also underway to develop a diagnostic
tool which will translate the individual behavior patterns onto a measurable
scale. These patterns will then be compared with performance level to
determine relationships which have bearing on group output.

2.3.3 Study of public attitudes toward large-scale technology programs.

Professor A. B. Shostak was also commissioned to write a major essay
on the above topic. The result is included here as Appendix D. We look
forward to building on the base of knowledge and understanding established
in this work through continued collaboration with Professor Shostak and
others in the social/psychological sciences.

2.3.4 The Planning Process and Configuration Management

The above subject areas still remain in the forefront as management
techniques for transfer from NASA to the urban environment. Initial studies
had previously looked at these two management tools as separate items each
providing a unique function for the overall organization. Most recently
after indepth review with responsible NASA officials and Drexel Staff, a

coalition concept is germinating in which planning and configuration management operate within the same sub-system. Specifically, planning is looked upon as a system of insuring or increasing the probability that a deserved outcome will occur. In some cases the planning process actually defines the outcome. Configuration management on the other hand provides the control function and acts as the nexus for making sure the plan or program is in fact being followed.

The above is a very simplified version of a complex process but nevertheless serves to illustrate a point. Extending this analysis one step further it is possible to identify a pattern of synergism in which an organization functions at an overall level of effectiveness far greater than would be expected considering the effectiveness of each individual sub-system.

It is our goal to apply the above model and other research results to a specific urban systems problem, and we are now actively evaluating a number of possible alternatives for this "action research" phase of our study.