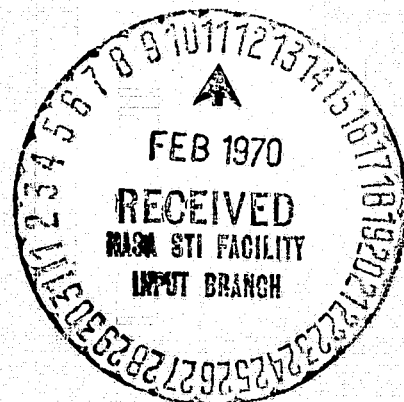**NASA**

National Aeronautics and
Space Administration

Syracuse University

Reflections on Interdisciplinary Research

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THE PROJECT MANAGEMENT RESEARCH SERIES

Studies of Project Management
and Management Systems

The studies incorporated in the project management research series are supported by a grant from the National Aeronautics and Space Administration to Syracuse University. They are prepared by professors and graduate students from the following fields: business administration, engineering, political science, and sociology. The studies are related to an investigation of project management and management systems associated with the Apollo program.

The series includes four types of documents:

1. Working papers which are developed as interim reports of concepts associated with project management and management systems. These papers are exploratory in nature and serve as a focus for discussion and are subject to further refinement as the research program progresses.

2. Occasional papers which are developed in areas not directly related to project management and management systems but which cover topics of interest to the investigators which are generated through participation in the research project.

3. Reports which are unpublished documents submitted to NASA and other interested parties which represent the final results in particular areas of inquiry in the research project.

4. Theses and dissertations which are the unpublished results of the research efforts of graduate students associated with the project and which represent the writing requirements of their degree programs.

5. Publications which are articles, books, and monographs published by professional journals, commercial publishers, or the university.

REFLECTIONS ON INTERDISCIPLINARY RESEARCH

Our objective is to explore both the problems and prospects of meaningful interdisciplinary research within the university structure. Most of what we will discuss is based on our current experience with a grant from NASA to investigate the role of the project manager and management systems within NASA. Additionally, some of our thoughts are derived from our own "ideal construct" of what interdisciplinary research should encompass. It may be questionable whether our recommendations can truly be reached; however, we strongly believe that pursuit of them is a worthwhile and challenging objective.

Before proceeding, allow me to briefly explain the nature of our present research program. Hopefully, my explanation will provide some background for the forthcoming discussions. Our project was established one and one-half years ago. We have a rather large group of professors and graduate students involved in our research. Ideally, each discipline represented on the research team would bring certain kinds of expertise to the problem. Our team consists of the following principal investigators:

1. Two Business Administration Professors.

2. One Sociology Professor.

3. One Political Science Professor.

4. Four College of Engineering Professors.

Additionally, the team includes the following graduate students-:

1. College of Business Administration - Two doctoral candidates.

2. The Maxwell School - Two doctoral candidates.

3. College of Engineering - One graduate student.

Our research team uses the phrase, role of the project manager, rather loosely to mean the following:

1. The Organizational Environment of the Project Manager

   Environment includes the project manager's social interaction patterns within the NASA organization. Specifically, the project manager's interactions with others in the programmatic organization, the functional organization, and the institutional structure of NASA. One of the primary objectives for this phase of the research is to define the "organizational set" of the project manager.

2. The External Environment of the Project Manager

   One other rather obvious factor regarding the project manager's role is his interface and coordination with contractors and sub-contractors. Part of our research group is examining closely these interaction patterns between project managers and the contractors.

3. Historical Development of NASA Project Management

   Another phase of the research is examining the question of: "Why project management as a managerial mechanism for NASA?" It is tracing the historical evolution of project management within NASA, the organizational modifications necessary to accommodate it, and the dynamics of the perceptions of NASA management regarding project management.

4. Managerial Styles of Project Managers

   This phase entails a close examination of the methods or managerial styles used by project managers to operate within their organi-

zational and external environment. The authority/influence
mechanisms employed by project managers both vertically and
horizontally within the organization also are being researched.
And the effects of various systems on managerial behavior are
being investigated.

5. Analyses of Project Management Systems

The final focus entails rather intensive investigations of the
various management systems used in a programmatic organization.
In addition to the analysis of the project management systems
the impact of systems on the organization is being examined.
Evolution of their usefulness to both functional and program
management is being assessed.

This overview of our current project will give an idea of the
scope of the research we are undertaking at Syracuse. For each of the
five major research areas at least one professor and one graduate
student is responsible for the completion of the topic. However, for
almost all of the areas other team members are making useful contribu-
tions.

The Rationale of Interdisciplinary Research

The Syracuse/NASA relationship from the outset has been character-
ized by two considerations both of which are actively promoted by NASA.
First that the research conducted by Syracuse faculty members
and graduate students should not be directed to solving NASA problems
primarily but rather directed to utilize NASA as a sort of management
laboratory. It was proposed by NASA that the investigations would lead
to a clearer understanding of concepts developed by NASA which are more

advanced than those being promulgated within the university. Our investigations thus far indicate that this assumption has some validity. Indeed [NASA as a relatively young organization has developed some unique management concepts which may be of significant value. These concepts are being explored) and our group's intent is to disseminate the findings as widely as possible.

The second consideration initially proposed by NASA was the encouragement of interdisciplinary research which is characteristic of NASA's internal management operations. Consequently, they justifiably believed that interdisciplinary research should be encouraged. We believe that the NASA position on interdisciplinary research is fundamentally sound and that in the long run the complete acceptance of this research methodology within the university is inevitable. In medicine and the hard sciences, such interdisciplinary efforts have led to new hybrid disciplines. Even in the soft sciences such an approach is yielding fruitful results. For example, the new field of organization behavior is a unique mix of business administration, public administration, sociology, anthropology, and psychology. While we are in agreement on the fundamental desirability of interdisciplinary research, we do have some basic questions about it which we want to explore with you today.

We should now probe the question- what is the purpose of interdisciplinary research within the university? Depending upon who is asked, one may receive a variety of responses. Consider the following as examples:

1. Interdisciplinary is a research methodology for solving complex, multi-disciplined problems.

2. Interdisciplinary research is a mechanism utilized to foster greater cooperation between faculty people who are often parochial in their outlook and overly protective of their own disciplines. In essence, interdisciplinary research is a guise for breaking the "organization barrier" existing in far too many universities.

We are of the opinion that in its ideal state interdisciplinary research accomplishes both of the above points. However, as we shall subsequently discuss, there are certain parameters which impede the attainment of these objectives.

Within NASA and private industry it appears that interdisciplinary research is accomplished with more efficiency and effectiveness than within the university. In our research it soon became evident that [the complexity of NASA's tasks demanded the input of professionals in many disciplines. They must work closely with one another to resolve various complex problems. Without this interdisciplinary methodology NASA's success would be probably far less spectacular.] One could postulate a number of hypotheses for the success of interdisciplinary research within NASA, however, we believe that there are two primary reasons for it.

First, when multi-disciplinary action is necessary within NASA we have found that "tiger teams" have been formed under the leadership of one person. These [tiger teams were brought together to identify the specific causes of the problem assigned and to recommend viable solutions.

In this example as well as in others which we have investigated it
appears that the personality of the individual project leader has
great importance in welding a problem solving team together. We
often find that the individual in charge of a problem solving team
molds a team of several discipline-oriented individuals by his ability
to manipulate, persuade, and influence the team members. Additionally,
many problems of this type have a specific definable end-objective--in
short, team members know what must be done even though they may not
immediately know the procedure for doing it.

Within the university structure one may find a different set of
variables than those found within NASA. The individual at the univer-
sity level often does not perceive the responsibility or rationale for
problem-solving in the same manner as a NASA line manager. Further,
his efforts to manipulate and influence research team members may be
far less effective than his counterpart within NASA.

Another factor which should be mentioned which distinguishes
interdisciplinary research at the university level from interdisciplin-
ary research at NASA is the fact that [in some cases the sponsoring
agency may not specifically define the problem for the university pro-
ject team to solve.] This lack of problem structuring, although it has
many advantages, may create some problems in welding a viable research
team together unless it is carefully managed. Our own project has been
one that can be characterized as "free-ranging exploratory research".

Other Deterrents of Interdisciplinary Research

Most of us have our own perceptions regarding the reasons for the
difficulty in achieving interdisciplinary research. However, allow me

to review a few variables which appear significant to us in discussing this type of research. It should be made clear that the following variables are not ranked in any ordering system.

1. <u>The University Structure and the Demands for Professionalism.</u>

The structure of the university by its "traditional" und" segmentation and departmentalization at best often makes the achievement of interdisciplinary research difficult. Traditionally, universities are organized according to specialized subject matter. Professionalism within and external to the university structure comes from expertise in these areas of specialized knowledge.

This brings me to my first point and let me use a brief example to illustrate it. Suppose we have an interdisciplinary group which will research a problem in urban development. Let's say that the research team consists of a professor of civil engineering, a professor of political science, a professor of sociology, and a professor of real estate. The professor who can identify most closely with the problem in terms of professional aspirations likely will demonstrate the greatest personal commitment to the research. Those professors seeing little professional reward may be more likely to devote minimum efforts to the project. In other words, the perceived pay-offs from participating in the research may cause one to devote varying amounts of personal commitments to the project. We believe that the university system with its inherent penalty and reward system especially in terms of "professionalism" often hampers interdisciplinary research.

2. Individual Differences Among Participants

The second variable which I shall discuss is the individual dif-
ferences in research styles exhibited by project participants. Some
researchers are anxious to delve immediately into the research while
others wait before committing themselves to any type of output or intel-
lectual participation. Other researchers pace themselves rather spor-
adically. Such disparities in both output and participation by members
of the research team may lead to lower degrees of team cooperation and
concomittantly hamper the goal of interdisciplinary research.

3. Degrees of Commitment

The third variable which often obstructs interdisciplinary
research is the differences in time commitments to the research. This
point may or may not be related to points one and two above. If a
researcher is devoting full-time to a project his progress may take him
much further than his colleagues who have lesser time commitments. Con-
sequently, he may be affected in two ways: First, because he has devoted
more time to the project his adv aces on the problem area may outstrip
that of his colleagues. Because of his pace he may derive little or no
benefit from the other project participants. He may find himself bring-
ing others up-to-date and educating them on various aspects of the
project. In general, this retards the all-important joint-learning
process of interdisciplinary research.

4. Research Management

Another factor which may curtail interdisciplinary research is the
method of research administration at the university level. A program
which initially is characterized as one where major policy decisions

can be resolved rather quickly may face the danger of becoming top
heavy with administrators over an extended period of time. It seems
to us that there is a direct correlation between the ratio of adminis-
trators and the inefficiency of a viable research program. Faculty by
their nature are supposed to be creative individuals, however, their
problems in coping with the various rules, policies, and general red
tape often takes considerable amounts of time and effort, and stifles
their creativity.

There is also the problem of the composition of a research team.
A basic problem may develop between a research team and the program
administrators in determining and deciding the faculty composition of
a research team. Faculty people may desire certain individuals for
their competence in an area of knowledge or they know that the indiv. is
will make good team members. By contrast, administrators may have other
objectives, such as, trying to balance the research funds among several
departments or colleges in order to get an "equitable" representation
of faculty members. The objectives of both the researchers and the
administrators are commendable, however, some satisfactory balance must
be achieved.

Competition Among Research Participants

The final deterrent to achieving interdisciplinary research is the
nature and degree of competition among the various research project
members. It is natural that some competition is present when faculty
members exercise their mental capabilities and skills, however, the
danger of too much personal competition and even distrust may be a
problem when a large group of faculty people are working on a joint

research project. Unabated personal competition and distrust eventually may lead to conflict within the group. Group conflict may then evolve into a preoccupation of studying the other research participants' overt and covert interpersonal group strategies--rather than sharing knowledge and methodologies with them. Unquestionably some benefit is derived from the experiences associated with group conflict, however, these experiences do not necessarily meet the objectives of either the project or the sponsoring agency.

We have briefly reviewed some of the restraints which may impede interdisciplinary research. There are many others which were not discussed, however, these seem to be the main obstacles. Part of the problems encountered are the result of a transition process from discipline oriented research to interdisciplinary research.

The Transition from Disciplinary to Interdisciplinary Research

As is apparent in the preceeding discussions there are several difficulties which are encountered in encouraging and implementing interdisciplinary research. We believe that some of these difficulties are due to certain conditions which are associated with the transition processes from disciplinary research through multi-disciplinary research to interdisciplinary research. In order to explore the conditions associated with this transition process, it is useful to consider the following definitions:

1) Disciplinary research is defined as investigative activities within a particular area of knowledge associated with a particular project. For example, Project A might involve a research topic in the engineering discipline staffed entirely by engineers, Project B might

involve a sociological project staffed entirely by sociologists, and

Project C might involve administrative problems and be staffed entirely

by those in Business Administration. In essence each project is asso-

ciated with a particular discipline and the members of the research

team are drawn from that discipline. Their individual professional

objectives, are congruent with the objectives of the research project.

2) Multi-disciplinary research involves the bringing together of

members of a research team from several disciplines. Under such an

arrangement, rather than having three projects, (for example, Projects

A, B, and C identified above) there might be just one Project. The

members of the research team would make contributions toward the objec-

tives of that project but their contributions would be in terms of their

own discipline. For example, engineers would make engineering contribu-

tions, sociologists would make sociological contributions and the

researchers from Business Administration would make administrative con-

tributions. In such a case the contributions of each group are separate

and identifiable by discipline, although, when they are joined together

as component parts, they satisfy the general requirements of a single

project.

3) Interdisciplinary research, represents the joint efforts of

research team members from several disciplines. The efforts of these

team members are directed toward fulfilling the responsibilities assoc-

iated with the objectives of a single project. In fulfilling these

responsibilities they engage in cooperation and sharing the disciplinary

knowledge and methodologies of one another. In such a case, a complex

set of interrelationships among the team members exists. We believe

that the natural course of events would lead from disciplinary research through multi-disciplinary research to interdisciplinary research. That disciplinary research can be effective need hardly be questioned. Such research has been conducted for decades in colleges and universities. The success of this type of research is due, in part, to the fact that the members of research teams, all of whom are associated with the same discipline, have been similarly trained and have chosen their professional careers along certain patterns of professional objectives. They have very little difficulty understanding one another, communicating with one another, and identifying with the norms and expectations of their professional group. If a research project ;is defined in terms of one discipline, it is quite likely that effective research will result since the personal objectives of the members of the research group are congruent with the objectives of the research project. The traditions surrounding this type of research strongly reinforce its continued existence and in a sense inhibit the accomplishment of effective interdisciplinary research.

Many current research projects are of such a complex nature that they cannot be completed successfully by drawing on the members of one particular discipline. When this case arises, one feasible solution is to develop a multidisciplinary research team. In such a case the project objectives are determined and the contributions from each discipline are specified. The research team members are then selected from the specified disciplines to contribute in sub-areas of the total research project for periods of time commensurate with the amount of research required within each sub-area. Although this type of research repre-

sents a departure from disciplinary research, it does allow for the research team members to continue to identify personally and professionally with their discipline. Thus the objectives of the sub-areas of the research project which are defined in a disciplinary way are consistent with the personal and professional objectives of the individual. The effectiveness of such an arrangement rests on the skill with which the research project is divided into sub-areas and defined in disciplinary terms which will meet the total requirements of the entire project.

Interdisciplinary research as defined above involves a complex set of interrelationships among the research team members. In order for it to be effective, it would seem that the members of the research team should all identify with the objectives of the research project. Their discipline oriented professional and personal objectives might need to be subservient to those of the project itself. Under present circumstances, this creates a lack of congruency between the personal and professional objectives and the objectives of the research project.

It would seem that for interdisciplinary research to flourish, the professional and personal objectives of individuals should cross disciplinary boundaries. In the past this has hardly been the case, but in the future it seems a certainty. Many of the researchers and professors now emerging from interdisciplinary or multi-disciplinary programs in universities bring with them an interdisciplinary approach to problem solving. These individuals are receptive to and utilize methodologies associated with several disciplines. Their open mindedness with respect to working with members of other disciplines enhances the

identification of personal and professional objectives with those of the project. Although this development may ultimately solve some of the problems of the transition from disciplinary to interdisciplinary research, the point in time when such individuals are readily available for research is some distance in the future. For the present it would seem reasonable to accept the proposition that we are in a transition phase from disciplinary research through multi-disciplinary research to interdisciplinary research. We would suspect that this is not an unusual state of affairs in other efforts to encourage interdisciplinary research.

We believe that certain recommendations should be considered in establishing an interdisciplinary research project. The final section of our paper lists and details several specific recommendations which will hopefully foster interdisciplinary research.

Recommendations for the Improvement of Interdisciplinary Research

The following discussion covers fourteen points which hopefully will improve the conduct of interdisciplinary research within universities. The recommendations hopefully will make the transition from disciplinary research to interdisciplinary research more effective.

Recommendation 1: In order to develop a unified thrust for an interdisciplinary research project, it would seem advisable that the parties interested in the project develop the initial proposal jointly. Developing an interdisciplinary proposal from a series of separate proposals which are then joined by their assumed compatability leads to a lack of unity and commitment to common objectives. The joint development of an initial proposal by members of separate disciplines

would assist in personal identification with common objectives which hopefully would be clearly understood by the participants involved.

Recommendation 2: The major focus of an interdisciplinary proposal should be stated as a set of objectives and the representatives of different disciplines should be encouraged to participate only in those areas of research where their disciplines apply directly to meeting these objectives.

Recommendation 3: Once an interdisciplinary team has reached a concensus with respect to their commitment to the objectives of the research, it is inadvisable to add a relatively large number of additional researchers to the project. Additional researchers should not be superimposed on the project since this introduces additional manpower and additional expenses which severely impact the budget initially proposed for a project. The introduction of a substantial number of additional personnel where a fixed budget exists simply results in pressures to bargain among the interdisciplinary team members for significant shares of the research activity. Such bargaining tends to fractionate the interdisciplinary effort rather than enforce it.

Recommendation 4: Projects should be organized in such a manner that each is directed by a single project director rather than by multiple directors. The establishment of a single project director, of course, has benefits in terms of establishing the point of responsibility for the project. Where multiple project directors are involved, especially in an academic environment where the directors are not working side by side in the office day in and day out, the risk of poor coordination and communication is ever present.

Recommendation 5: Should negotiations among the participants in an interdisciplinary project reach a stage where conflict exists, every effort should be made to keep this from reaching the proportion where the Deans of schools or colleges and Vice Presidents of the university become involved. The resolution of issues at that level may be based on the objectives of the schools or colleges and the objectives of the university as well as the politics of academia. The trade-offs negotiated at that level may reflect long standing negotiation practices among the university officials in terms of the objectives of the schools or colleges rather than in terms of the goals of the project. Any resolution obtained might reflect viewpoints beneficial to the school or college and may be quite inappropriate as a useful resolution for the project itself.

Recommendation 6: Professors generally operate in an environment characterized by a lack of structure and rigidity in terms of how results are accomplished. Essentially, the administrators in academia rely on self-direction and self-control on the part of professors in performing their tasks. These attitudes carry over to the performance on research projects. In interdisciplinary research the performance standards are even less clearly defined than within a given college where the norms of behavior and performance are reasonably well known by those involved within a given discipline. For these reasons it would seem appropriate that a research project be structured in such a manner that performance commitments be made by the participants and that they operate within certain cost and schedule constraints.

Recommendation 7: Joint field trips to NASA centers should be
encouraged as they provide a useful opportunity for understanding
among project participants from different disciplines. In large uni-
versities it is common for people in different disciplines never to come
into contact with one another. Thus a real opportunity for personal
relationships often occurs on these field trips.

Recommendation 8: The time frame for research projects need not
require the same commitment on the part of all the investigators involved.
In the case of the project management study the time frame is approxi-
mately two and one half years. It is apparent at this time that the
commitment of particular individuals may . be less than two years and
others may be longer. In an interdisciplinary study the time commit-
ments of particular individuals should differ rather than having all
researchers locked into the same time frame.

Recommendation 9: Nominal time commitments may not result in
significant results or participation on the part of some researchers
in an interdisciplinary study. This is particularly evident during
the academic year when participants with nominal time commitments are
engaged in teaching and other activities. It is suggested that a
minimal commitment on the part of a researcher on an interdisciplinary
team be one-third of his time during the academic year and more during
the Summer. If a researcher participates at a level below this, his
contribution to the team and the project may be marginal.

Recommendation 10: Although it can be assumed in interdisciplinary
studies that different methodological approaches will be proposed, it
would seem appropriate that discussion of methodological approaches be

held after the areas of inquiry have been designated and unified. At this point in time the methodologies can be incorporated in terms of the areas of inquiry rather than having the methodologies dominate the selection of areas of inquiry.

Recommendation 11: The contributions of graduate assistants should be related to the unified thrust of the project and the particular areas of inquiry within it. This is in contrast to the practice of having a graduate assistant selected by a professor in the same discipline. This practice tends to reinforce disciplinary alliances and fractionates an interdisciplinary effort. To overcome this problem it is suggested that graduate students should be made aware of research programs through graduate seminars and fellowship programs. Once they become interested in a particular project they could be considered for appointment on the project team. The acquisition of graduate assistants on interdisciplinary projects of this type should take place when the student has reached the writing stage of his graduate program. That is, when he is approaching the master's thesis or doctoral dissertation stage. This, in itself, provides commitments to certain performance, time, and cost objectives.

Recommendation 12: Control mechanisms should be utilized periodically to see that performance objectives are being met in terms of completion of working papers and reports, that a general schedule is being met and that expenditure levels are in line with the projected budget over time. Although effective interdisciplinary research does not operate under the administrative control systems characteristic of a single college or school, successful completion of an interdisciplinary effort requires that some control mechanisms be established. As a

cautionary note, it is suggested that the control mechanisms should not be employed too frequently or too rigidly lest they interfere with the general concept of academic freedom so highly prized by the researchers in conducting their investigations. Examples of suitable control mechanisms are integrated publication schedules for working papers and reports which indicate the people responsible and due dates, cost tracking charts to control expenditures, periodic briefing meetings for progress reports, etc.

Recommendation 13: An organizational framework should be established in which the professors and graduate assistants can perform their tasks on a revolving basis. The nature of research projects should be such that particular professors could be involved on the research at different points in time and for different lengths of time. Graduate students could be on a project from a relatively short time period of three or four months to perhaps a year or more for a doctoral dissertation. In general, it would seem feasible that such a state of flux could exist effectively and meet the objectives of the individuals as well as the objectives of the project.

Recommendation 14: Since an interdisciplinary team can become quite introspective in terms of its research design and methodological approaches, it would seem advisable to continue the practice of bringing other researchers in the area of inquiry to the campus to share their experiences and view points. In addition, it is also advisable to promote visits of NASA personnel to the campus to provide a broader perspective and empirical refferents for those professors who may not have the time or inclination to get into the field for interviewing.

A promising course of action for the present is to encourage and promote multi-disciplinary research utilizing the recommendations set forth earlier and to develop an organizational entity such as an institute to facilitate the implementation of the recommendations. Interdisciplinary research must come to the university and will, in time, exist within the university. However, it seems reasonable to expect that the transition process will be slower then that which NASA might desire at the present time.

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