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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

TENTATIVE PROGRAM FOR RESEARCH AND ANALYSIS OF ORGANIZATIONAL BEHAVIOR AND ADMINISTRATION OF SCIENTIFIC AND ENGINEERING FACILITIES

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MANAGEMENT REPORT

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FOREWORD

This report was prepared under the auspices of the Manned Spacecraft Center's Visiting Faculty Appointments Program. Dr. Juralewicz, who in academic life is an Assistant Professor of Management at the University of Minnesota, was a participant in this program in the summer of 1967.

His project for the summer was to design an approach which could be used to investigate the phenomena of management and behavior in scientific and engineering organizations. The results of his research are presented in this report. Subsequent to designing this research approach, Dr. Juralewicz performed a detailed investigation of these phenomena in one of the divisions in the Engineering and Development Directorate at MSC. The results of this research will appear in a separate report.

Richard E. Stephens
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TENTATIVE PROGRAM FOR RESEARCH AND ANALYSIS OF ORGANIZATIONAL BEHAVIOR AND ADMINISTRATION OF SCIENTIFIC AND ENGINEERING FACILITIES*

By Dr. R. S. Juralewicz

PURPOSE

The purpose of this paper is to present some ideas and concepts on one of many possible approaches that could be used in a research project for the investigation and study of organizational behavior and administration of scientific and engineering facilities. As such it is a collection of thoughts stemming, rightly or wrongly, from some of the most important current literature available on research management and management of scientific personnel. Although the orientation of the effort proposed in this paper is behavioral, the attempt was to incorporate many of the traditional or "conventional" management concepts and employ a total "systems" concept to the study of scientific and engineering activities.

Briefly stated, the objectives of a research project of this type would be threefold: (1) to develop a research model for in-depth study of the organizational modes and management techniques that exist in research and engineering facilities, (2) apply the model to the analysis of an existing facilities or laboratories, and (3) identify the strengths and weaknesses, functional and dysfunctional characteristics of the facility's organization making recommendations where applicable.

This paper will outline a tentative program and approach which should lead to the solidification of a research format to achieve the above objectives.

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*This paper should not be construed as a final program for management research and analysis of laboratories, but rather a tentative approach and thought-generating instrument to assist in solidification of a final research format. It is the first event in the following series of events for this type of project: (1) Tentative program for research; (2) Exploratory study and observations in laboratories; (3) Formalized research program and design of measuring instruments; (4) Pilot study and pretest of instruments and techniques in laboratories; (5) Modification and solidification of measuring instruments and final research format; (6) In-depth study of a facility; and (7) Research report.

PERSPECTIVE

The posture suggested for this study is that of a "functional point of view," i.e., a systems approach to determine and identify the underlying causes of behavior of individuals, units, and facilities, as they affect the behavior of the total organization. The focus, of course, would be on the research and engineering phases of operation. With this posture one would not be primarily concerned with the question "should we expect a certain type of reaction within or between facilities" but rather "what gives rise to a given set of activities or situation." All too often there is a tendency to classify a given set of behavior or interrelationships of activities as "good" or "bad" without identifying their underlying causes. The functional point of view forces us to concentrate first on the latter before the former.

APPROACH

Organized human behavior is a result of multiple causes and multiple systems stemming from the environment. For example, a manager must deal with several systems--to mention a few, the formal system involving such elements as size and interrelationships of units, a social system, a technological system, a personality system--all of which interact with one another resulting in functional and dysfunctional effects within the organization. Thus we are forced to use a systems approach in this study to reduce to comprehensibility the complex interdependence of forces which culminate in organizational behavior in research and engineering facilities.

A multidimensional framework is suggested as the guiding system in this type of study. With this approach, the activities and interrelations of any given facility would be studied in terms of four dimensions or inputs: organizational inputs, technological inputs, people inputs, and behavioral-social inputs. This framework is illustrated in figure 1. Broadly speaking, the organizational inputs involve elements of organization structure, leadership styles, formal relationships, authority, responsibility, formal rules, policies, procedures, control, information networks, goals, strategies, and schedule systems. Type of technical facilities, changes in volume and type of work, obsolescence rate of equipment, skills, and knowledge, retraining, transfers, technical groupings comprise some of the technological inputs. People inputs include skills and knowledge of personnel, demographic characteristics, social status, behavioral patterns, motives, needs, and expectations. Rewards and punishment systems, influence, power, norms, and group membership must be considered under behavioral-social inputs.

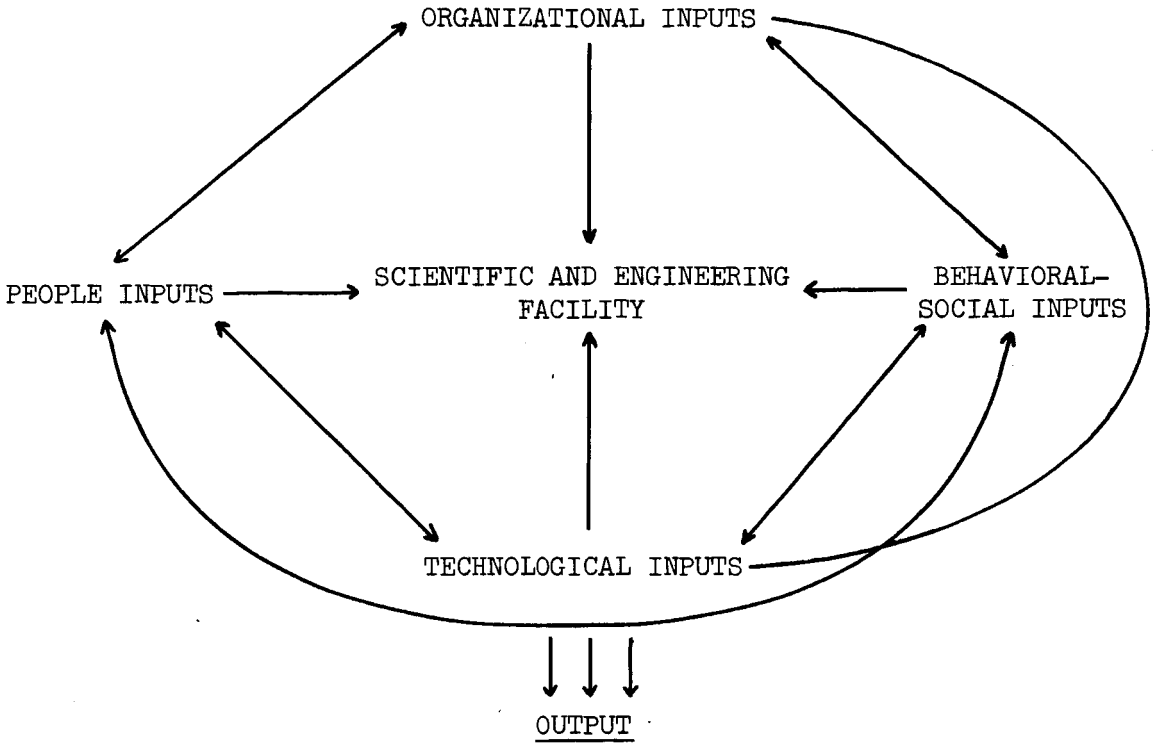

Figure 1.- Multidimensional framework showing four inputs and their interrelationships for a given facility.

This global guiding framework must now be broken down into a useful research model with specific measureable factors and practical methodology. Tentative models are discussed in the following section.

TENTATIVE MODELS

The research posture should be one of looking at organizational and management activities both within each research and engineering facility, i.e., internal analysis, and the interrelationships, communications, and control mechanisms between facilities and other agencies, i.e., external analysis. The information could be gathered by a variety of techniques such as observations, standardized interviews, and wherever possible, questionnaires.

Internal Analysis Model

The internal analysis model involves the investigation, measurement, and analysis of four categories: background factors, required and given behavior, emergent behavior, and consequences or results. This model is illustrated in figure 2.

These four categories, taken in total, define and describe the organizational modes and management techniques within each facility. The background factors define the required and given behavior, i.e., they theoretically determine what is required and given behavior. These two categories thus provide the starting place for the actual behavior that emerges. Both the required and emergent behavior lead to consequences and results. Assuming we wish to alter the consequences and results in a more favorable direction, we can operate or change the background and required behavior (such as control procedures) which we have identified, thus changing the emergent behavior patterns conducive to more favorable results. This model, then, is a dynamic systems model of interrelationships which will allow us, once we have identified the most important organizational elements within each category, to make operational changes in the organization with somewhat predictable consequences.

Briefly, some of the elements and questions which would be asked within each category are outlined below.

A. Elements

1. Background factors

a. Technology (type of technical facilities, pure test vs. research activities, obsolescence rates)

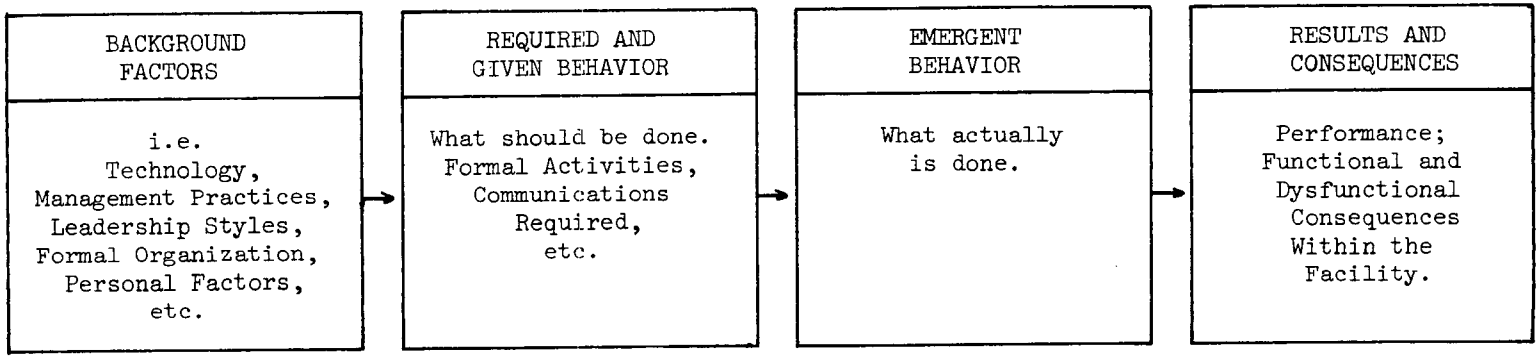

Figure 2.- Internal analysis model for diagnosing operational patterns with a facility illustrating four main categories for focus.

b. Job design (duties, responsibilities)

c. Physical conditions (layout, work conditions)

d. Management policy and practices (objectives, how achieve objectives, coordination within)

e. Leadership behavior (relations and attitude toward the personnel)

f. Formal organization

g. Rules

h. Personal and social factors (age, education, G. S. level)

2. Required and given behavior

a. Required activities (test, evaluation, what a person does)

b. Required interaction (communication and contact between personnel)

c. Required sentiments (ideas, beliefs, and feelings about work and others involved)

3. Emergent behavior

a. Emergent activities

b. Emergent interactions

c. Emergent sentiments

d. Norms

e. Internal social structure (informal leaders, group members)

4. Consequences or results

a. Performance (productivity, effectiveness, satisfaction, development and growth)

b. Functional-dysfunctional effects within the unit

B. Some typical questions (managers and staff)

1. What do you do in your job? What is your job called?

a. What about work planning?

b. What about review of work and handling of specific problems

c. Amount of time on supervisory type matters. Amount of time on other duties.

2. How would you reorganize if given the chance?

3. To whom do you usually go for advice?

4. What are some of your problems and how are they handled?

5. How do your personnel feel about the kind and amount of information they get?

a. How do they get more information?

6. If you could be head of any facility, which one would you select?

7. How do you feel about the way things are done in your division?

a. How much are your ideas and recommendations considered when changes are made which affect work in your division?

b. What kind of support do you get in the division?

C. Some typical questions (nonmanagers, operating personnel)

1. Do you make decisions on the job you are doing?

a. Would you like a job where you make more or less decisions?

2. Do you feel you get accurate information?

3. How much do people help one another in getting the job done in time?

4. In many places, one person is contacted to give help since he knows the real information:

a. Is there one person here like that?

External Analysis Model

The external analysis model involves the investigation, measurement, and analysis of four categories: interdivisional (or interfacility) background factors, required interdivisional behavior, emergent interdivisional behavior, and total organizational consequences or results. The model is illustrated in figure 3. Briefly, some elements and items for consideration within each category are outlined below. These elements are somewhat similar to the elements discussed above for the internal analysis model, however they do differ considerably in that they take on a more global posture concerned with interrelationships between divisions, facilities, and agencies with emphasis on coordination, control, and flow of communication.

A. Interdivisional background factors

   1. Technology (technical processes involved)

   2. Leadership (behavior of managers and staff regarding people and material placed in their command)

   3. Status between divisions

   4. Occupational groups

B. Required interdivisional behavior

   1. Required activities (what tasks are required and performed)

   2. Required interaction (who initiates action)

   3. Required sentiments (autonomy, dependency)

C. Emergent interdivisional behavior

   1. Emergent activities (shared technology)

   2. Emergent interactions (common leadership)

   3. Emergent sentiments

   4. Interdivision social structure and membership categories

D. Consequences or results

   1. Performance (maintenance of interdivisional relations, maintenance of individual division)

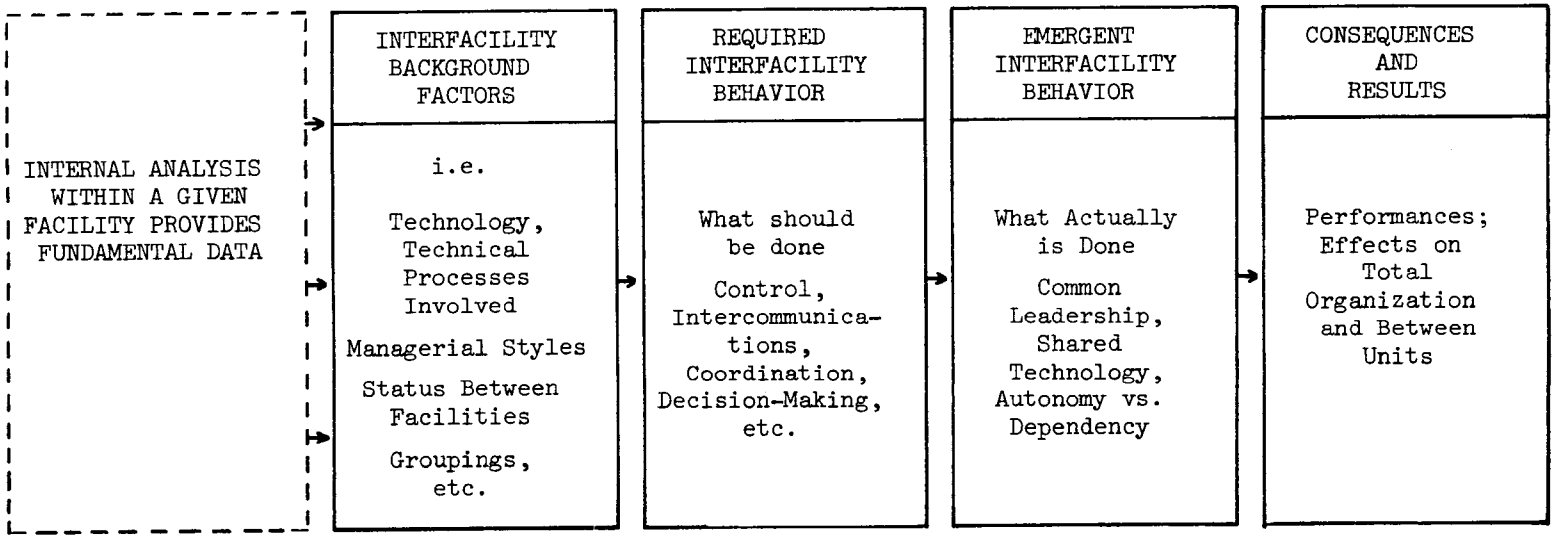

Figure 3.- External analysis model for diagnosing operational patterns between facilities.

2. Functional-dysfunctional effects between units and total organization

SOME ADDITIONAL NOTES ON METHODOLOGY AND MEASUREABLE VARIABLES

The measurement techniques suggested would involve observations at the workplace (event-process analysis), standardized interviews, and wherever possible, questionnaires. As discussed in the footnote, page 1, the development of the measuring instruments in event 3 in a series of 7 events and follows the exploratory phase of study and observation within the facilities. Reliability checks (consistency of measurements) and validity checks (are we measuring what we want to measure) will be incorporated in the study plan.

The following lists additional variables which should be considered in this type of study and several thoughts on methodology and related problems.

A. Organizational characteristics

1. Span of control
2. Number of levels of authority
3. Ratio of administrative to engineering or scientific operating personnel
4. Range of time span an individual can commit resources to a project
5. Proportion of personnel in one unit who can interact with personnel in another
6. Quantity of formal rules
7. Specificity of project or job goals
8. Specificity of required activities
9. Range of skill levels
10. Amount of knowledge-based authority
11. Amount of position-based authority

12. Opened or closed systems of organization (for example using Barne's criteria of degree of autonomy, interaction opportunity, and upward influence)

B. Interaction and communication patterns

1. Within groups or units

2. Between groups or units

3. Content of communications, i.e., work related, non-work related

4. How communications originate

5. Communications with outside personnel but within the total organization

6. Communications with personnel outside the organization, i.e., contractors

7. Some possible methods

a. Observation at the workplace

b. Interviews

c. Sampling at 15 minute intervals on a random schedule over 2 or 3 weeks

d. Records of phone conversations

e. Communication file (over past 3 years)

C. Coordination vs. autonomy

1. Who makes decisions? How often?

2. Ratio of technical to non-technical decisions

3. Degree of centralization or decentralization in decision-making

D. Motivational elements

1. Maslow's approach on need hierarchy as the operating framework

2. 10-14 items incorporated in a questionnaire

E. Leadership styles

1. Two dimensions: consideration vs. initiating structure

2. Incorporate 4-5 items on a questionnaire based on Ohio State's work

F. Respondents background

1. Division or unit

2. Age

3. Position title

4. Type of job function, i.e., research, test

5. Rank (G. S. level)

6. Level of education (degree, type of)

7. Years in NASA

8. Years in present position

9. Years at present rank

10. Number of other employers prior to NASA

G. Performance criteria

1. Actual vs. budget cost over past 3 years

2. Actual vs. estimated time to complete project over past 3 years

3. Ratio of output (or index of output such as actual cost) to man-hours over past 3 years

4. Output of respondents in terms of patents, articles, and books

5. Ratings by supervision

   a. Contribution to general or scientific knowledge

   b. Overall usefulness to the organization in carrying out responsibilities

6. Utilization of engineering and scientific personnel (based on questionnaire regarding how personnel spend their time)

H. Interview schedule

1. Program managers

2. Personnel within the engineering and development areas

3. Divisional managers and staff

4. Branch managers and staff

5. Section managers

6. Program sub-managers (within divisions)

7. Individual engineering and development personnel

I. Two suggested alternative approaches to development of a research format

1. Descriptive and prescriptive approach

   a. This approach would involve a study of organizational behavior and managerial practices within the divisions focusing on structure, decision-making, setting objectives, achieving objectives, and functional analysis of behavior.

   b. The study would include interrelationships between divisions or units focusing on coordination, dependency, work flow, communications, initiating structure, and mutuality of values.

   c. Identify problems

   d. Recommend solutions

   e. Techniques-observations, interviews, questionnaires

2. Experimental design approach

   a. Same as items 1-a and 1-b above

   b. Conduct a comparative analysis between high and low performance groups within a division or between divisions. This necessitates development of performance criteria or criterion.

   c. Summarize findings. This will include identifying problems and recommending solutions based on comparative data.

d. Techniques-observations, interviews, questionnaires, and development of performance criteria or criterion.

2. The experimental design approach, item I-2 above, would be the most desireable and recommended approach to follow since it lends itself to comparative analysis of elements which would best lead to identification of the principal variables that contribute to operational effectiveness.

SUMMARY COMMENTS

The approach contained in this paper is a tentative one having the purpose of generating thoughts leading to the solidification of a final research format for use in an in-depth study of the organizational modes and management techniques that exist in research and engineering facilities. The approach is based on the integration of two popular schools of managerial and organizational thought; one involving the traditional concepts of authority, responsibility, control, and coordination and the other involving the behavioral concepts of work group, intergroup, motivation, perception, and interaction. Knowledge will have to be obtained and incorporated about information transmission, strategies, choices or decision-making, and sequencing in order to develop a system of strategies for cooperation and effectiveness within and between the laboratory facilities. The traditional school's emphasis on efficiency at work and the behavioral school's concern with effective collaboration of men must be merged in this search for an optimum system to meet the demands of engineering and research project effort.

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