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Report No. C-69-1

SCIENTISTS, ENGINEERS AND MANAGERS - PARTNERS IN SPACE

by

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Prepared for the

Office of University Affairs

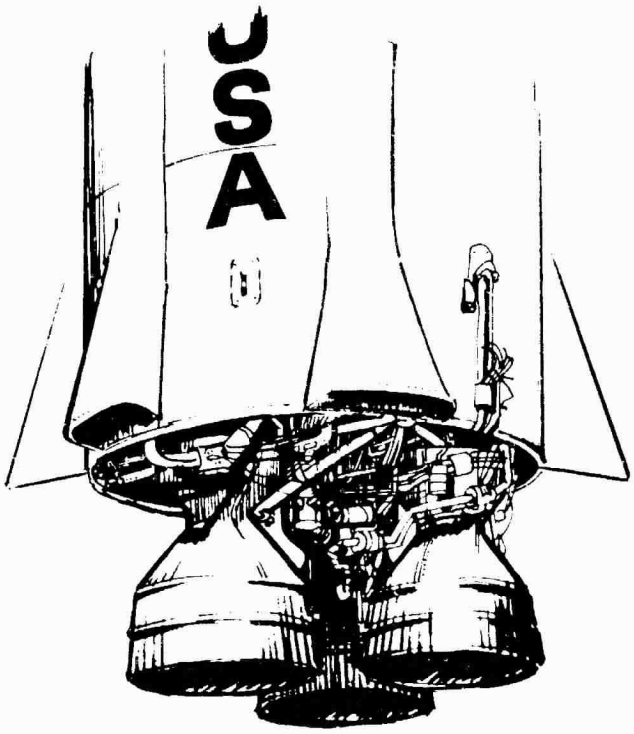
National Aeronautics and Space Administration

under Grant

NGR-33-016-067

December 1968

New York University Graduate School of Business Administration
100 Trinity Place, New York, N.Y. 10006



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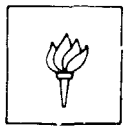

NASA Grant NGR-33-016-067
New York University Graduate School of Business Administration
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PARTNERS IN SPACE

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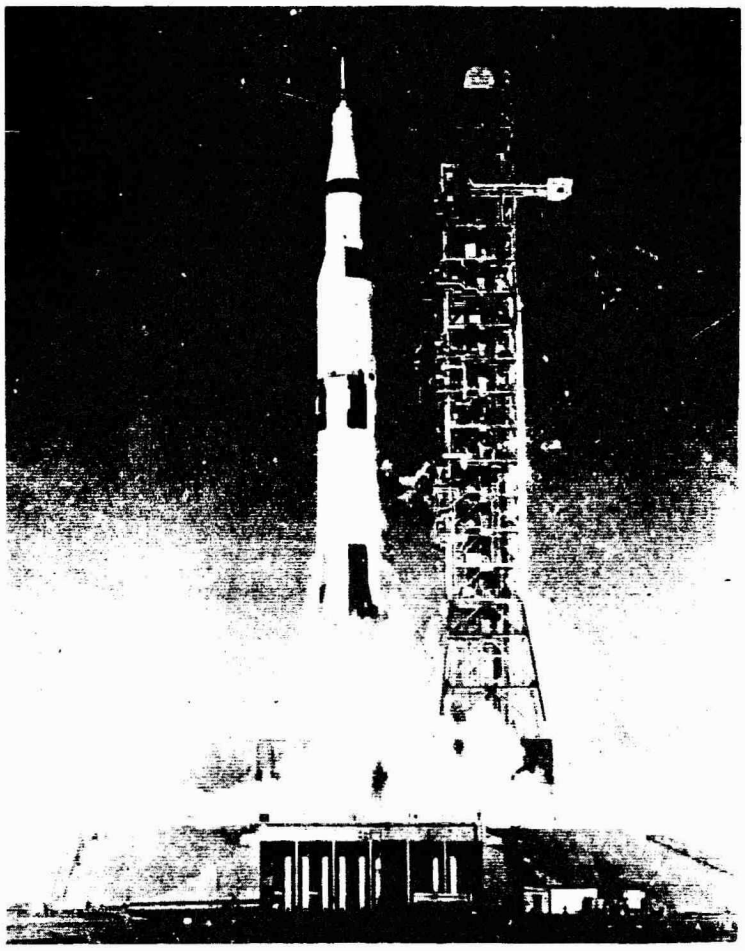
Photograph Credits: NASA
Page iii: Launch of Apollo 6 From Cape Kennedy, April 6, 1968.

Illustration 33: Gemini XI over India.



TO THE UNITED STATES AEROSPACE TEAM

NASA Photograph

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Chapter 1 – INTRODUCTION

Project Objectives, Approach and Scope

This report summarizes research efforts which were conducted within the following framework:

. . Objectives:

* Purpose: Identification of the major factors in management practices and attitudes as well as their effects, which help obtain a better understanding of the interdependence of engineering and management in the aerospace industry.

* Significance: Expansion of the spin-off of management attitudes and practices from aerospace into other segments of the public and private sector and, reciprocally, from the experiences of other types of business into the aerospace industry.

. . Approach: Analysis of research findings, the literature and unpublished documents, interviews with scientists, engineers and executives.

. . Scope: Time and budget limitations of the project imposed two major constraints:

* We had to confine ourselves to discussing in detail the influence on engineering management of only one of the areas of behavioral science. We chose that of motivation because of its all-pervasive impact on just about every phase of executive practice. Many other sectors of psychology, sociology and anthropology as well as other disciplines also affect executive attitudes and actions. We took their conclusions into consideration, without, though, explicitly identifying and describing their role. It is our hope that future projects may be possible which would explore these fields further in their potential contributions to engineering management.

* It was also necessary to delete observations on those phases of engineering management which are already well documented in the literature. This should not be taken to imply that further research would be less promising. On the contrary, it is most assuredly needed. However we felt that, in comparison with the areas covered in this report, those that were left out had a lower priority.

. . Results: Drawing more widely applicable conclusions from specific instances, this study proposes specific steps for the practice of engineering management which will

* raise its own productivity and that of those whom it manages

* foster innovation

* that is, promote progress.

We set ourselves the task of delving into the nature of the managerial tasks. Knowing better what each is, would enable us, we felt, to spell out specifically what the manager needs to do so as to assure the results cited.

The research convinced us that this, while useful, is nevertheless only one part of the whole story of the practice of engineering management. The other has to cover what the executive thinks; what attitudes he has; what beliefs and concepts he holds. Consequently we also probed these areas since action without thought is as unacceptable as thought without action.

How the Study Was Conducted

The groundwork for our analyses was laid through an extensive search of the literature (see bibliography at the end of the report). For the discussions with the managers and engineers, we drafted lengthy interview guides, which included many quite specific questions. This assured some measure of comparability for the responses we received. Additional input to our efforts came from research that one or both of the authors had been conducting, at times over prolonged periods, on topics included in, or tangential to this project.

All material was recorded and classified by subject matter. Each of these categories was then subjected to creative analysis in discussions among the authors which took up many hundreds of hours. We conducted some repeat interviews; they clarified several points which needed or deserved further elaboration; and they probed more deeply into events and problems which our analysis had brought to the fore. We then attempted to fit our observations into a comprehensive framework that could accommodate all major aspects of engineering management including those not dealt with here.

When this was accomplished, the conclusions were assembled in a first draft which amounted to over 400 pages. It was condensed in two subsequent versions to its present size by editing, the exclusion of repetitive and less significant comments and – most productively – by the omission of those observations which are already authoritatively reported in the literature. "Decision Making" and "Communications" are examples of two major sectors thus treated. These pages therefore concentrate on those segments of engineering management in which more recent, authenticated research findings as well as our own analyses and conclusions hope to make useful contributions.

We found a good bit of virgin territory. The chapter on "Direction of Operations" is an example of such an excursion. Of course our analysis bases itself on many findings which are already in the public domain. Yet as far as we could ascertain, its conclusions are novel. What is more important, they concern engineering management practice at its perhaps most sensitive interface with scientists, engineers and other technical personnel.

The report discusses first the engineer and his work (Chapter 2).[1] It then takes up the impact of engineering management upon such work (Chapters 4 to 10) after a recap of the most pertinent findings of behavioral science research in one key area of executive concern, that of motivation (Chapter 3). Each of these chapters includes manifold conclusions in some detail. The more important ones are recounted in the final, the eleventh chapter.

We are quoting within the context of this report some of the answers to several questions which the companion study received in what we refer to here as the "NASA-NYU" Survey" or the "NASA-NYU Questionnaire." Although this survey was conducted by the project personnel under this research grant, NASA has no responsibility whatever for any part of it. The survey was conducted through a questionnaire. Concerned with the utilization of scientists and engineers, the questionnaire was administered[2] to 2100 scientists, engineers and their supervisors (excluding technicians and draftsmen). It contains a total of 91 questions on 29 pages. The twelve companies involved in the survey include several in the space-defense, others in the private sector (capital and consumer goods) and some active in both. As of 11/1/68, 1311

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1. The focus on engineering management handed the authors a double-edged sword. Both factors – the engineer and his work as well as engineering management – deserve treatment in balanced proportions. However, the companion study to this project had staked out a proper claim on the discussion of problems of the first factor, the engineer and his work. This is why we felt justified to present this particular field in much abbreviated fashion and to concentrate in this project on the second factor, engineering management.

The companion study has been carried out by Dr. Fred Landis, Professor and Chairman, Department of Mechanical Engineering, School of Engineering and Science, New York University, in cooperation with one of the authors, Mrs. Dhun Irani. The reports resulting from their efforts cover extensively those areas which we are slighting in these pages.

2. The questionnaire was distributed through the engineering management of the companies. It was returned directly to NYU by the respondents. We pledged strictest confidence: No individual was identified; the companies are not known to one another or to NASA (although each firm is receiving a statistical summary of the answers from its own employees and a copy of NYU's composite report to NASA which describes this opinion survey in greater detail).

usable questionnaires had been returned out of a total of 2100. This amounts to 62.4% of the total mailing. Any survey figures quoted in this report are only preliminary and will therefore vary from the final results. Unless specifically indicated otherwise, accountability for all statements made in this report remains with the authors.

A Sincere Word of Appreciation

Above all, the authors are profoundly grateful to NASA for the research grant which made this study possible. The Agency's interest in the impact of management in aerospace work has been a mighty incentive in our efforts.

We are keenly aware of the large debt which we owe so many individuals and companies without whose support the study could not have been made. Their number is so high because of the generosity with which executives, engineers, scientists and many others reacted to our request to learn from their experiences.

In the interest of facilitating valid results from the NASA-NYU survey (see Footnote No. 2), the companion study pledged to keep anonymous the names of the twelve companies who agreed to participate in it, and of their representatives with whom we talked. This situation leaves us now keenly embarrassed because we cannot address our sincere appreciation to each specifically. As they include a cross-section of the aerospace industry, we would like to bridge the gap which this omission creates, by inscribing these pages

to the United States Aerospace Team

although as magnificent a force as that indeed deserves a much more memorable expression of gratitude than this study.

There are two corporations, though, who gave us the benefit of their views outside the scope of the NASA-NYU questionnaire. Thus they need not remain nameless. The first is Texas Instruments, Inc., Dallas, Texas. Their response to our request for discussions was as great as the practice of TI (engineering) management is representative of the finest anyone could hope to see anywhere. Mr. C. J. Thomsen, Senior Vice President, in particular, furthered our study to an extent that could only be described in superlatives. We learned more in the few days which we spent at TI than in any other visit. Dr. M. Scott Myers gave us access to some as yet unpublished findings of pertinent research. We met numerous others – executives, engineers and scientists,

led by Mr. W. F. Joyce, Senior Vice President; Mr. Ralph T. Dosher, OST Coordinator; Dr. J. Ross Macdonald, Director, Central Research Laboratories. They gave us the opportunity to discuss just about every aspect of engineering management with complete frankness.

Mr. Harleston R. Wood, Chairman of the Board and President; Mr. Howard W. Read, Executive Vice President, Alan Wood Steel Company, Conshohoken, Pa.; and their associates (including Mr. W. E. Shepherd, Operations Vice President and Mr. Richard Jabelin, Chief Engineer), received us so hospitably that our visit there constituted another significant boost for our study. The opportunity to compare, with executives of this calibre, the differences in management styles of two as different industries as steel and aerospace was most interesting and helpful.

Many others have been of assistance which demands specific mention. They would however be the first to insist that the pages in this report belong to the subject matter. It is with this in mind that we request the readers to view the following list of those who have given the study so unstintingly of their time, talents and experience as reflecting contributions whose magnitude is large.

* Mr. Donald L. Bouquet, Chief Design Engineer, Lockheed Georgia Company
* Dr. Lee E. Danielson, Professor of Industrial Relations, The University of Michigan
* Col. C. E. Davies, Secretary Emeritus, American Society of Mechanical Engineers
* Mr. Sal F. Divita, International Business Machines Corporation
* Dr. John W. Enell, Vice President Research, American Management Association
* Mr. Jack F. Jericho, Executive Director, American Institute of Industrial Engineers
* Mr. Frank J. Johnson, Director of Value Engineering, Lockheed Georgia Company
* Mr. Harold F. Smiddy, retired Vice President, General Electric Company
* Mr. Kenneth H. Speiser, Group Leader, Grumman Aircraft Engineering Company.

We wish to express special appreciation to Dr. Joseph H. Taggart, Executive Dean, Schools of Business, and Dean, Graduate School of Business Administration; to Dr. Clifford D. Clark, former Vice Dean and Dr. Murray E. Polakoff, Vice Dean of the Graduate School of Business Administration. When the odds against fulfillment of the objectives of the project seemed at times overpowering, their encouragement and assistance contributed much toward conquering the obstacles.

Members of the administration and faculty of the Graduate School of Business Administration

vied with one another in wholehearted support of the work. The authors wish to thank each individually and all of them collectively:

* Dr. Arnold Corbin, Professor of Marketing
* Dr. Peter F. Drucker, Professor of Management
* Dr. Herman E. Krooss, Professor of Economics
* Dr. Fred Landis, Professor and Chairman of Mechanical Engineering, School of Engineering and Science
* Dr. Robert Lindsay, Professor of Finance and Research Adviser, Schools of Business
* Dr. Harold W. MacDowell, Professor of Marketing
* Dr. Patrick J. Montana, Assistant Dean
* Dr. Lawrence S. Ritter, Professor and Chairman of Finance
* Dr. Morris I. Stein, Professor of Psychology, Graduate School of Arts and Science
* Dr. Dale E. Zand, Professor and Chairman of Management.

Miss Marie F. Daly, Assistant to the Dean, and Miss Dolores Briante, Administrative Secretary to the Executive Dean, supported the project in particularly effective fashion by assuring it the needed equipment and other support facilities and personnel. The NYU Computer Support Group headed by Mr. Albert J. Braun, Jr., and Mr. Andrew Lamparter, our Chief Programmer, must be singled out for their collaboration. The School and University Libraries in general – and Mr. Hermann F. Robinton, Curator, as well as Miss Ruth D. Grotheer, Associate Curator, in particular – and the United Engineering Center Library facilitated our extensive literature search to an important degree.

We are especially grateful to Drs. Arthur Levine and Paul D. Lowman, Jr. of NASA who made photographs available for the illustrations, and to Mr. Eugene C. Richman, Art Director of the University, and Miss Martha Herman who were responsible for the design of the sketches in this report. Mr. David Sortor contributed weighty help in the editing phases through his exemplary mastery of the written word. Miss Nora Burke, Secretary to the Vice Dean, aided at several crucial stages in the preparations which led to this report.

Mrs. Roberta Johnston and Mrs. Ruth Stockton supervised the typing of the various versions

of the manuscript in their usual effective and helpful fashion. The task to fight her way successfully through severely marked-up drafts and manuscripts fell to Mrs. Lois Ann Morris for whose patience we are truly grateful. The credit for the appearance of these pages belongs to the NYU Publications Bureau and to Dr. Landis for supervision of the physical production of the report through his staff.

With so much cooperation, the project could cover the rather ambitious scope it had set for itself, in the relatively short time at our disposal. We sincerely hope not to be found wanting too much in our conclusions although, as students of management, we found ourselves in the company of masters.

Chapter 2 – THE ENGINEER: THE MAN AND HIS WORLD

The Man

Who is he? . . . He is creative but can be happy in routine work. His imagination has spanned the horizons but he can feel comfortable in a self-created rut. He is capable of handling the most complex technical problems but he can shackle himself with details. He has given the world a new shape but sees it through a pair of blinders. He has fashioned the most practical things but he can be an unrealistic idealist. He complains loudly when he is not treated properly but he can fail miserably in his relations with people. He expects others to respect his competence but can disparage theirs. He wants freedom for himself but can be dogmatic with others.

Our purpose is not to describe one man but a whole breed of men who number over one million. The previous paragraph attempts to describe the two terminals of a wide spectrum. We have chosen for our portraits of an engineer as well as a manager (in later chapters) what a competent professional is, could be and should be. We realize that this calibre has not yet been universally attained. But we agree with the large cross section of practicing engineers and executives who believe that the existing trend toward excellence will have to be maintained or accelerated if NASA's potential is to be assured also for the future. We realize that there is probably not a single engineer in whom we could find all the traits cited here. And we appreciate that many an engineer or manager who reads this is likely to take exception to one or several of the points included. However we have ascertained that such objections are not aimed at one or a few but, in the aggregate, at every single item. They thus indicate quantitative differences. Our comments intend to be qualitative.

The pages which follow are a composite also with respect to the sources of information[1] which we used. Until much more becomes known about homo sapiens, any topic that deals with so many people must tend toward general comments.

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1. It is the result of experimentation, opinions and data, observations and interviews, research findings and analyses by many different parties including the authors. It includes the literature

With this qualification, we report further that the engineer is generally self confident. He is likely to be inner-directed; toward the "introvert" side. He is meticulous; often intense and ambitious; usually critical and competitive. He is a dedicated man, willing to put more into his job and often expecting to get more out of it. He is sincerely and deeply proud of his work; he thoroughly enjoys challenges which he feels he can meet even if this means extending himself. He is eager to prove himself and his many skills.

Probably more than anything else, the engineer wants more responsibility, challenging work. He sets high standards for himself and generally expects others to live up to them too. As a corollary, quite a few are easily frustrated; some feel alienation toward the man who, in their opinion, lives or works by less demanding criteria.

Most engineers dislike routine, although almost all need some of it as "occupational therapy" or relief from highly demanding work. Most abhor "administrative work." If caught up in such tasks or other "disturbing" situations, they are quite likely to concentrate, even more than otherwise, on questioning the things which are "wrong"' They can become overly sensitive to criticism.

The engineer treasures freedom. This expresses itself in many ways, to wit:

- . . He cherishes participation and believes that there are many more occasions for this in business (government, education, politics, and so on) than are habitually utilized, f.i., in the making of decisions which affect him or his work.
- . . He just about craves the freedom to work in his own style. Thus he quarrels frequently with the procedures he is asked to follow.
- . . He likes an atmosphere of free inquiry even when it lacks usefulness for his immediate task.
- . . He is quite insistent in his preference for a climate where he can pursue new ideas which may not make an immediate contribution but have rather longer-range significance (at least in his view).

(Footnote 1 continued)

(see bibliography) and those firms and individuals who are mentioned in Chapter 1 as the primary sources of information for the entire project.

In addition, this part reflects the views expressed by several hundred managers of research, engineering and related fields in a series of workshop seminars on the management of professional employees. The latter were not only in agreement with the others; at times, they could add particulars which have, to the best of our knowledge, not yet found their way into experiments or the literature.

Finally, these pages mirror the opinions of hundreds of engineers with whom we discussed problems of engineering management and, to a lesser extent, the draft version of this Chapter.

. . He resents rules which "impede work." This may evidence itself occasionally in downright refusal to comply with a directive which he feels is inimicable to the demands of the situation (as he sees it).

The engineer relishes recognition. He wants it in two ways – first as an individual (he is generally not satisfied to bask in the reflected glory of a prosperous firm) and secondly as an engineer (whose successful work is one of the cornerstones of his company's reputation). He resents, often profoundly, the lack of appreciation of himself and of his work and thus the absence of appropriate status.

Close professional associations are welcomed by the engineer. Some, although by no means all, are fiercely proud of being a member of a profession. A large group wants to publish their work.

Nearly all prefer to be judged by their peers. They consider it inequitable when this takes place, instead, by individuals in the company hierarchy which made the rules involved in the first place. They are much more ready to submit to the authority of technical competence than that of managerial status. Many are obtaining further education or intend to do so; a growing number of those in university programs, however, seems to seek as their second degree one outside the immediate field of engineering.

They can get themselves stuck in a specialty. Concentrating more and more upon one subject brings more expertness. In consequence, management – most of the time, an engineer himself – is tempted to keep such a man where he is because he knows more about this topic than anybody else. And not infrequently the engineer himself is quite comfortable in his role as a recognized authority. However, working in the same area for, say, six years does not necessarily gain six years' but perhaps not much more than one year's experience repeated six times. Engineers with a bend to specialize are also likely to identify themselves first with that field and only secondly with engineering as such.

The engineer has high analytical abilities. He does not – can not; should not – take things at face value. He needs verification. He is likely to disregard intangibles or to consider them lightly because they are harder to analyze and synthesize. He exhibits a strong questioning attitude. This skepticism leads him to study and investigate a problem (too?) thoroughly. He prefers to suspend judgment until adequate data are available (even when the pressure of the project, or of his supervisor, prods him toward speed rather than perfection, precision or accuracy). Like other creative individuals, he reaches decisions slowly because he first needs to have "all the facts."

He is apt to refrain from making claims until he can substantiate them (often in considerable detail). As a by-product, his analytical mind finds it harder to understand someone whose thinking habits are different, such as the manager's (more integrating) mind.

We heard some little-flattering remarks when sounding out the views which engineers employed in a variety of tasks have of management. Our coverage of this point went also well beyond the twelve firms which participated in the NASA-NYU study. "They are bureaucratic hacks who shuffle papers and constitute mainly an obstacle in the way of creative individuals," was one comment which differed from numerous others mainly in its vivid hues. When urged to be more specific, the following comments are most revealing and representative. They varied a lot in style but little in substance. They are included here because they were mentioned often enough to be significant.

. . On the managers themselves:

* "They don't know anything; they have no knowledge in depth."
* "What are they doing? – uncreative, unoriginal things."
* "They have a passion for a fast buck."
* "Of course they could provide leadership; but they don't."
* "All they do is exploit others for their own purposes."

It is an understatement that this shows a lack of understanding of the nature and mission of management. Right or wrong, these views exist, and not just in one or two isolated cases. Chapters 4 to 10 offer comments on how these impressions can be mitigated or wiped out by specific attitudes and actions on the part of executives.

. . On the management of the work:

*1. "Everything here is on a crash basis. . . . Schedules and budgets are impossible; we need more facilities, more people; who wants so much overtime?"

*2. "They (the managers) sure misuse our talents; most men are over-skilled for their jobs; they pinch overhead pennies and waste engineering dollars."

*3. "They over-simplify problems because they can't solve the real ones."

*4. "He (the supervisor) manipulates professional engineers as if they were a group of insensitive automatons."

*5. "The big boss (the section chief's boss' superior)! I've never seen him; but I heard he is a good accountant – or is he a lawyer?"

*6. "We never know what happens and why; I feel excluded as if I were on a deserted island way out in the Indian Ocean."

*7. "Management is incapable of judging people in their technical performance."

*8. "All they do is to keep the system going, not to further the work."

*9. "I have worked in two other aerospace companies in the last five years; they are all the same. Toe the line; don't think on your own, especially if you come up with something the boss doesn't like or doesn't understand; just do what the system tells you."

*10. "Our company forces us to overspecialize; but you should have heard what they promised us in the (employment) interviews."

*11. "All my boss wants is power and money."

*12. "What do you smell when you breathe here – conformity, fear, mistrust. And that's what they call 'service to the nation!' "

These comments reach into every major aspect of management practice and philosophy. Their roots and remedies are discussed later on in detail:

Comment	Subject matter discussed in Chapter	Which deals with
1, 2	5	Planning
3, 4, 5	6	Direction of Operations
6, 7	7	Review and Feedback
8, 9	8	Control
10	9	Personnel Management
11, 12	10	Managerial Philosophy

Of course, not all remarks were negative. Again selecting those which reflect something approaching a concensus, we quote a smaller number.[2] Repeating in reverse the sentiments just recorded, they put emphasis on the importance of the various subjects included in this report.

2. It is interesting to note the frequency with which the word "I" appears (in all but two or three of the opinions, that is 7 or 8 times) in comparison with the earlier quotes (in which it showed up only 2 or 3 times in a larger total).

They provide an insight into some of the things to which engineers react favorably, thus corroborating points dealt with later on.

. . "What an opportunity for me! 25 years old, one year on the job and now in charge of a million dollar job!" (Responsibility)

. . "I get a lot for myself out of the work I do. With all this experience, I may be able to go after a Ph.D." (Growth)

. . "I like it here because you know your work is appreciated." (Recognition)

. . "The salaries are actually not so hot. They pay more at - - - -. But here I do what I really like to do. And that more than makes up for the difference." (Motivator)

. . "You always know where you stand – well, nearly always. The work is much more advanced than at - - - -. But I can always get my hands on the data I need – well, most of the time, anyway." (Information)

. . "I like - - - - (the project leader). He is a tough character. He is not an engineer but you would never know it. He put our group where the action is." (Leadership)

. . "There is one thing about this place; they're honest, almost to a fault. Sure, there are politics. But they try to be fair even when it hurts." (Philosophy)

. . "In my previous job, they said they had an 'open door policy' but I could never find one when I needed one. Here, they don't talk about it but you can get to see the President if you want to. When you do, though, you had better have your story straight." (Climate)

. . "They don't make it easy to earn your pay. You have got to produce – much more than when I worked for - - - -. The funny thing is, I actually like it. It's stimulating. You want to do even more. For the first time in my life, I feel as if I were helping to accomplish something really worthwhile." (Climate)

Representing the other side of the same coin, we probed the relationship between engineers (and scientists) and their management in extensive discussions with many executives. The results as stated below reflect a representative cross section of opinions and experiences:

. . "With increasing complexities, fewer individuals will be self-sufficient on their own or with their individual knowledge and experience. More teamwork and more co-operation of specialists will become the rule. Yet too many engineers and scientists are lone wolves."

. . "Why do they always have individual views and goals which are contrary to those of their company and of the mainstream of the community?"

. . "They demand rigorous logic and use it in their work. Why are they so narrow in other things?"

. . "Their work is too often too idealistic. For example, my engineers are masters of mechanical knowledge. They are supremely confident in the proved usefulness of their engineering know-how. So they are tempted at times to design machinery which is too expensive, too uneconomical, too complicated. And then they are surprised if management is a trifle less than deliriously happy with their accomplishments."

. . "Their work has made magnificent developments possible. But their very success in applying their knowledge to technological problems has made them use the same principles also in dealing with people. Man is not a piece of machinery which operates under predictable results."

. . "Are we emphasizing specialization too much in the hiring of our engineers and scientists?"

Naturally, there were also many highly favorable, some downright enthusiastic observations by managers about their scientists and engineers. We do not repeat them here because this report deals with the management side of engineering management and with engineers only to the extent that this has an influence on the executives.

We have recorded perceptions by the individuals involved – by engineers on their work and their management as well as by engineering supervisors (in all echelons up to and including top management) on their tasks and their crews. Both groups meet in the performance of the firm's work on a NASA contract. As we have seen, this arena does not look the same from these two different vantage points. What does all this add up to? It seems to us that there are three basic conclusions:

. . Many of the traits, attitudes and values cited - although not always the extent of their presence – are necessary for the engineer to cope with the demands of his work. After all, he deals often with as yet unproven ideas.

. . The reactions we quoted, constitute a classic example of the consequences when the power of motivation[3] is slighted. The large majority of the comments and other observations deal with items which are pertinent to motivation (see Chapter 3).

. . The situation represents an indictment of many existing management practices. This is why this study addresses itself to the major aspects of engineering management (see Chapters 4 to 10).

3. These conclusions are made with regard to engineering management because this is the domain of this project. We do not mean to convey the impression that they are valid only for engineering management. Attention to motivating influences is neglected in other areas, too – perhaps even more so.

His Work

In a growing profession[4] with well over one million practitioners, a general statement of the nature of its work will prove itself, not infrequently, by the exceptions rather than the rule. With this qualification, it may nevertheless be stated that the essence of engineering is "Design," when this term is used in the broadest possible sense. Engineering has as its objective the creation of a plan or a blueprint. It sets forth in the design the "mechanism" which, when transformed from the drawing into an actuality, performs its mission with predictable results. The design represents the optimum integration of components into the best possible system.

To make a (more) successful design feasible, much additional work has usually to be done. To wit:

- . . investigation of the need for the design
- . . formulation of the mission which the design should execute and of the problems which it should solve
- . . identification of the functions which the design needs to perform to fulfill its mission
- . . examination of the conditions under which operations will take place
- . . establishment of anticipated results (outputs, including design and performance criteria (such as inputs, constraints, cost, reliability, size, maintenance) and many other characteristics).

This requires

- . . (potentially vast reams of) information
- . . analyses of, at times, the most complex and diversified nature
- . . trade-offs which suboptimize portions to increase the magnitude of optimum in the system as such.

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4. The latest available figures show that the total number of engineering degrees (Bachelor's, Master's and Doctor's) conferred at the start and close of the 20-year period since 1949 is about the same. It stands at slightly above 50,000 (1949: 50,400 and 1966: 51,800). In between, a serious low point of approximately 27,000 occurred around 1955. (Figures from Office of Education, U.S. Dept. of Health, Education and Welfare).

During this same 20-year span, the population of the country increased by roughly one third (from approximately 150 to nearly 200 million).

In many cases, design would be impossible without these auxiliaries. Important and influential as they are, they exist, from the design point of view, solely to increase the soundness of the design. The design itself represents the heart of the engineering effort. It synthesizes, from knowledge and experience, the components, parts, sub-assemblies and assemblies, sub-systems and systems needed. It studies the interplay among themselves as well as with their environment. It calls into action the entire creative process of human thinking which extends from initial conceptual thought to the refined and detailed plans in their ultimate shape.

In its historic definition, the Hollister Committee stated nearly two decades ago that[5]

> "an engineer is characterized by his ability to apply creatively scientific principles to design or develop structures, machines, apparatus, or manufacturing processes, or works utilizing them singly or in combination; or to construct or operate the same with full cognizance of their design, and of the limitations of behavior imposed by such design; or to forecast their behavior under specific operating conditions; all as respects in intended function, economics of operation and safety to life and property."

It added ". . . it is believed that in its full import, ability to design is the professional hallmark of the engineer. . ." and it commented further that "training for design of engineering works . . . is a recognizable criterion of engineering education."

Engineering of, say, 1950 is indeed quite different from the work of the profession today. However, its basic essence has remained design although this term has acquired much extra breadth and is still growing.

All branches of engineering are engaged in making designs[6] of products or services <u>for</u> their respective managements. One exception is the Industrial (or Administrative or Management) Engineer; his task is to make the design <u>of</u> management itself. Others are those engineers whose responsibility does not end with the completion of the design but includes the supervision of its transformation into a structure.

5. Eighteenth Annual Report, Engineers' Council for Professional Development.

6. Our comments center on the engineer's activities. They omit the discussion of the professional aspects of this work at this point because they are the basis for other observations.

For the purposes of this report, these differences are not important. In the first instance, only the objective of the design is involved, not the scope of the engineer's work. In the second, the engineer assumes the duties of management in addition to those needed for the design work.

Engineering is rooted in science. Through its research (and development) work, science provides the basic knowledge which the engineer applies. The creation of such knowledge is the end result of scientific work. At the same time, it is the means by which engineering performs its function. In turn, this creates the design just discussed as the end result of engineering activities.

The means-end-chain (Illustration 1) continues when management uses the design as its means to respond to existing needs in the conduct of the business. Engineering can thus be viewed as the link between science and management.

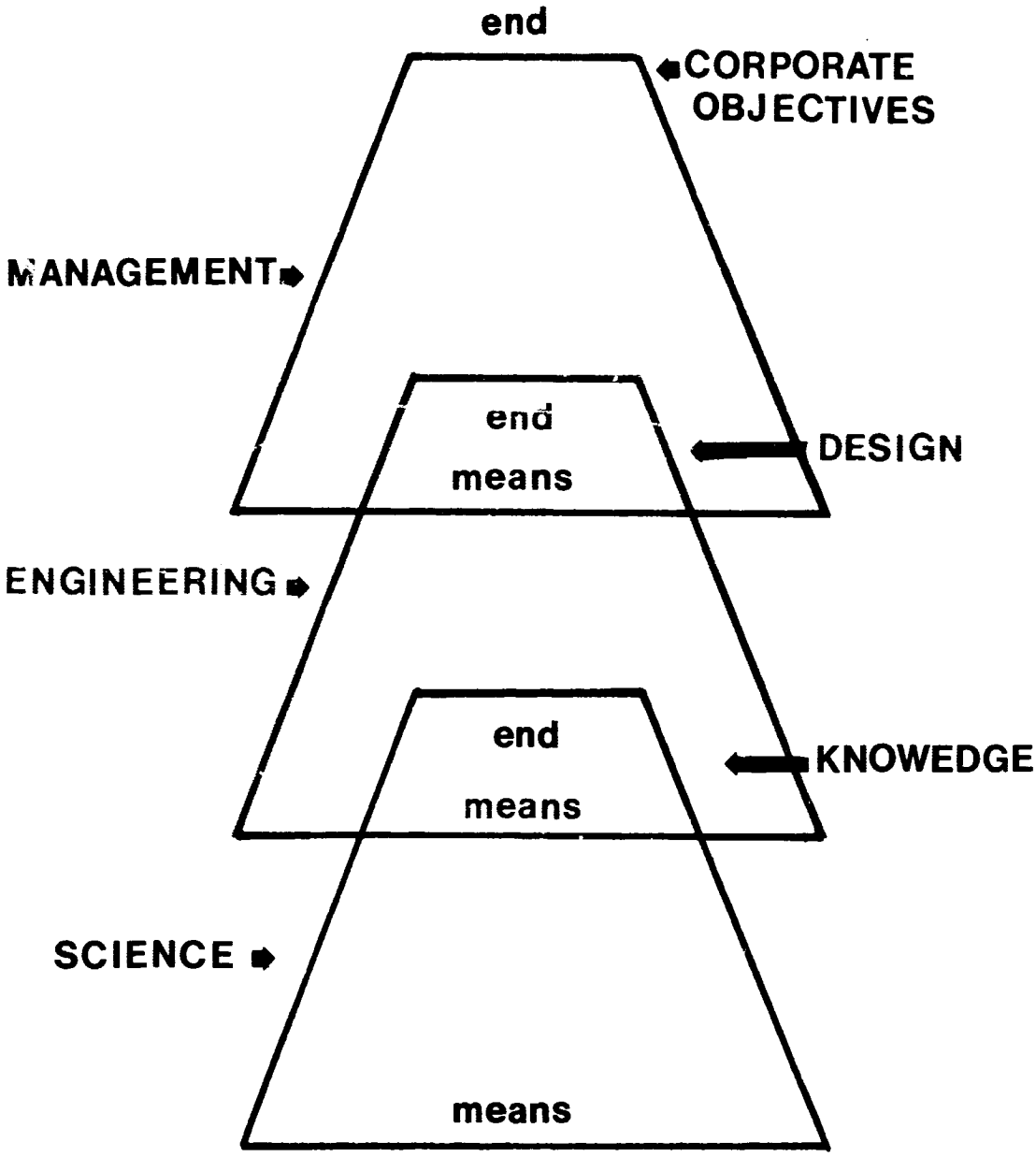
From the engineer's point of view, the design is his target. It dominates every moment of his thinking and every ounce of his efforts. From management's point of view, though, the design does not play such a monopolistic role. It is the means – important and influential; but still only the means – to some other end, namely the attainment of the organization's corporate objectives. It is they, these objectives, which properly occupy management's primary consideration.

Science and engineering and management are profoundly inter-dependent. One without the other(s) is seriously handicapped. The interface between these three partners thus becomes the crucial and the focal point on which the research has been carried out for this report.

Creativity

Creativity is inherent in the theme of the engineer's mission, design. It is certainly the crux also of (much) scientific work. And it will become an ever more sought-after quality in one of the manager's basic tasks, that of planning.

Does all engineering work require creativity? Despite wide-spread differences of opinion, the answer seems to us to be: No, it does not; there are many activities which do not call upon



A THREE LINK MEANS-END CHAIN; knowledge-design-corporate objectives

illustration no.1

creativity, at least not to any large extent. Nevertheless we like to pose the question: Is this situation caused by the nature of the engineer's work or by the manner in which management makes him operate? The paragraphs which follow, hope to offer a few observations which may be useful to engineering executives and their personnel managers.

Attempts to isolate the distinguishing characteristics of highly creative and original people are of relatively recent origin. Many of the studies are not directly comparable nor does one always supplement the others because there are too many different definitions and levels of creativity. Four conclusions appear reasonably certain:

- . . Guetzkow[7] claims that creativity is distributed among people as are most personal characteristics.
- . . Creativity and conformity are antithetical.
- . . Real creativity is an extremely personal, private affair. An idea can originate only in the mind of an individual. Others can help, perhaps through group efforts. They can contribute to the solving of problems; to the germination of an idea; to cross-fertilization, stimulation, improvement and similar aspects. And there is always the possibility of a levelling influence from or through the group.
- . . Costello maintains that identification of creative potential prior to actual creative performance is still not reliably possible. But not just an isolated firm has expressed its favorable experience with Guilford's tentative test items (ability to see problems, fluency and flexibility of thinking, originality, redefinition and elaboration).

Two other conclusions which seem pretty well substantiated, concern correlation of creativity and intelligence:

- . . A high I.Q. is not necessary for creativity in some fields (graphic arts, for instance). What is more important for this study is, however, that superior intelligence is highly desirable in other endeavors (much aerospace work, nuclear physics, etc.).
- . . In neither case has there been found a close, if any relationship, between on-the-job creativity and performance on intelligence tests alone unless the latter are supplemented by quite a few other tests.

Based on many sources including the discussion by Berelson and Steiner of a long series of experiments, we have compiled a summary of typical traits of creative individuals. The points

7. The bibliography (at the end of the report) identifies all sources of reference in detail.

made below appear generally valid but they do not apply to every individual nor to all situations. In comparison with less creative persons, the more creative individual is likely to

. . see the gap between what is and what could be
. . be more achievement-minded; freer and less rigidly controlled; more autonomous
. . exhibit less conformity and conventionality, both intellectual and social
. . have more independent thoughts, judgment and action
. . work more slowly and more cautiously
. . place higher values on practical matters and utility
. . be more dynamic, less anxious
. . show a preference for, and interest in, complexity and novelty
. . emphasize harmony and form
. . know how to impose order on experience
. . possess higher aesthetic sensitivity
. . make fewer black-white distinctions
. . concern himself less with petty restraints
. . evidence a less dogmatic view of life and a less authoritarian attitude[8]
. . appreciate, and appear to have, a better sense of humor.

The majority of these traits parallels those discussed a few pages earlier when we tried to answer the question with regard to the engineer: "Who is he?"

There is little quarrel with the fact that, quite aside from the matter of identifying creativity, there is a problem of using it. Some of the more frequent obstacles are. .

. . caused by the creator himself; for instance through
  * his fear of being too aggressive
  * lack of belief in himself
  * failure to investigate the "obvious"
  * mix-up between cause and effect

8. Gardner comments on the creative individual's "independence or attachment . . . (which lie) at the heart of his capacity to take risks and to expose himself to the probability of criticism from his fellows"; he stresses his "tolerance of ambiguity," his capacity to tolerate intense conflict and his willingness to suspend judgment.

* overemphasis on competition (naturally he likes to see his idea carried out; and, considering himself quite qualified to do that too, he often fails to enlist others whose help is needed because they are more competent in implementation; this inclination to work by himself can thus endanger the very life of his cherished idea)

* similarly, there can be overemphasis on cooperation (too many cooks can spoil the broth also in aerospace)

* fear that his idea will be rejected; a creative person very often is a sore loser.

* and still more.

. . caused by others; for example through

* fear of ridicule as response to a "far-out" suggestion; of criticism by superiors

* anxiety at the possibility of exploitation of the proposal to the detriment of the author; of outright theft of the idea

* alarm at possible psychological damage (self-esteem; through lack of social acceptability; etc.)

* and others.

As varied as the possible situations are, the remedy is almost always the same: better managerial practices – in planning, organization, supervision or any other part of the executive's or his superiors' thoughts and actions. Chapters 4 to 10 contain suggestions on how supervisors can increase the creative output of their people through proper reaction to achievement needs, emphasis on results, various other steps and attitudes.

May we be permitted one final word of caution in the form of a possibly premature question: Are organizations ready to utilize effectively, a, say, five-fold (or just two-fold) increase in the creativity of their technical personnel if managerial practice should succeed in making this a reality?

He and His Manager

Publications abound with research results and other papers which hold forth on what one knowledgeable author describes as "radical differences of what is really valuable and worthwhile" in the minds of management and technical professionals. He and we agree that one of the more concisive analyses of this divergence was made by Mooney:

> "The technical man tends to take a stance which faces nature. He has learned to submit himself with attentiveness and patience to nature, for only in this way can he get nature

> to yield some margin of fresh benefit for himself, his organization and mankind. Nature is his prime authority. Whatever he derives by way of professional authority comes from this primal source.
>
> "The manager[9] tends to take a stance which faces society, assuming his authority is derived from lines of institutional organization. He is trained to submit himself to the larger needs of the organization of which he is a part. Social agreements, implicit and explicit, are his prime authority. Whatever he derives by way of authority for himself comes from this social source.

Mooney goes on to describe the differences in motivation between the two groups. He identifies "curiosity about nature" for the technical people and the desire to "operate a smoothly functioning organization" for executives.

To this we have to add, as a third disparity, the fact that engineers (and especially scientists) have made considerable headway toward establishing the professional character of their work. On the management side, however, there is as yet not even full agreement that such a path is appropriate or possible for executives. It is our conviction that management will have to aspire to the status of a profession. We also believe that a continuation of many developments, especially in more recent years, runs in exactly that direction. If they progress at the same or at an accelerated pace, aspiration can soon transform itself into accomplishment. But for the time being, this difference in the character of the work exists; it adds fuel to the situation.

The fourth point is even more decisive. There is a peculiar contrast in our country. Our society is technically oriented; it is dependent upon technology as no other nation. Yet our whole culture is infused with the values of the managerial group. Neither prestige nor image of the engineer is near that of the manager – at least when we disregard some of the more recent outbursts of that tiny minority of people who find fault with just about everything, excepting themselves.

A few years ago the Professional Engineers Conference Board published a survey in which engineers responded in the following fashion to the question: "In terms of prestige, do you think an engineer would be better of in 5 years by staying in engineering or by going into management?"

9. Allport, Vernon and Lindzey show remarkably similar value and interest patterns between general and research managers. This does not help to bridge the gap between them and engineers-scientists.

Out of a total response of 295, 6% felt engineering had the better prestige, while 14 times that many (85%) believed that management had the edge; 7% said it was the same either way and 2% had no opinion.

Much of our promotion system, not only in industry, reflects this situation. When a good engineer has done some outstanding things, he is too often "advanced," as a reward, to a managerial position whether his abilities and experience warrant this or not. Similarly, the title "Chief Engineer" does not, as a rule, command the same respect as "Vice President of Engineering." This same society has an entirely different image when it comes to, say, the "Chief Surgeon" in a hospital; nobody has yet come up with the idea to make him a Vice President.

It seems to us that all this is the result of the much broader problem of lack of proper recognition of the engineer by the public and not merely by management. We have here the same situation as we shall encounter again on several later occasions when management's attitude is caused by the views of its broader surroundings. In their leadership function, though, it behooves executives to take the lead in changing such a situation; as a minimum, they ought not to take advantage of it.

The matter is not improved by the fact that, in a number of countries outside the United States, the engineer's status in society is much more firmly established than that of the manager.

These are four weighty points. They (and others not mentioned) readily explain why things look different through engineering or executive eyes. We nevertheless believe that

- . . the existing differences have been exaggerated; if not that, the tendency to stress dissimilarities in the place of common interests has not helped
- . . perhaps the most basic dissent concerns the means to bridge these differences; it should be possible to get agreement on the end because both groups are so profoundly dependent upon each other.

What can be done? The greater the contrast in values is between two sides, the heavier is the tendency on both to reduce interaction with each other. Conversely, dealing in similarities leads to more understanding and cooperation. This maxim provides one major clue for suggestions on how to proceed. For instance, the lives of engineers and managers alike are characterized by the need for continuing learning in their respective fields. This is one common anchor point that deserves much wider utilization.

Where some engineering executives do not have sufficient technical knowledge, the situation is bad in two ways. First, it makes mutual understanding and respect more difficult. Secondly, nobody can manage people in an activity with which he does not have, and maintain, some degree of familiarity. As pointed out elsewhere, this does not require the supervisor to be the best-oriented individual in technological matters. On the contrary, if he were, his managerial responsibilities might deprive his employer of the full benefit from that man's talents.

Much additional progress can be made through increased understanding of the respective roles entrusted with technical and managerial personnel. Efforts at further analyses of the causes for the existing irritations could contribute a lot of light.

Such studies could start with another point that is common to supervisory and technical personnel. Both are in the service of the public. Most customers do not care whether the excellence of the product or service they buy, is the result of engineering, managerial or other skill(s). Theodore Roosevelt's admonition to management and labor 60 years ago has equal validity today when applied to executives, engineers and scientists. Each needs the other – for his own benefit, in the interest of the organization of which they are members, and of society. This dependence will steepen with increasing specialization.

Another situation that deserves a better appreciation is the nature of the relationship between (science) engineering and management discussed earlier in this chapter. The engineer's objective, the design, is the starting point for the manager's efforts who uses the design as a means through which he endeavors to attain the objectives of the enterprise. Thus the design appears – must appear – to the executive in somewhat different, and possibly less exalted role than to its creator.

Still a different, and indeed a fundamental, cause for possible misunderstanding is the widespread belief that engineering is limited to the function of designing the product. Yet engineering is actually a methodology which serves many functions. Its approach to problems has evolved so that the engineer is able to do his job, that is to make his design; and engineers have applied this capability to a wide spectrum of tasks, in the service of such functions in business alone as

* R & D
* production and mining

* manufacturing services
* marketing and customer services
* merchandising and advertising
* finance and banking
* insurance and real estate
* personnel and labor relations
* transportation and construction
* legal and other corporate affairs
* management and indeed many others.

What complicates the picture is that a considerable number of engineers are not engaged in engineering work but rather in selling, management, teaching and dozens of other pursuits. Their engineering know-how and experience may be a major contr r for their success in those fields; or it may not be. And there are many additional individuals with a full technical background who do not employ it at all or merely on occasion.

Some very real and immediate progress is certain to come from a clearer concept in the supervisor's mind of his role in his relationship with his crew. The idea of the boss with iron-fisted decisions and infallible judgment in every one of his actions is as obsolete today as the DC-3 in the field of interplanetary traffic. The effective manager is a resource person, a catalyst, a leader through whom the talents of his people can ring up greater accomplishments for their firm while, at the same time, assuring themselves of higher satisfaction.

Understanding can be further enhanced through ways which both groups – engineers and executives – must find to educate each other so that they will see their respective problems more clearly from the other's point of view. Again similarity helps in such endeavors. Theres no difference in the mission of a manager or an engineer. Each wants to fulfill his responsibilities. Each takes different form. The engineer's is mainly technical. The supervisor's is managerial in character, that is more on the human side. One cannot be measured on the scales of success of the other. All are accomplishments, different ones, each in its own sphere.

Raudsepp suggests that more frequent and less defensive communications might also lead to increased mutual respect for the function and contributions which each is making in his own area. Management needs to explain, more frequently and more convincingly, its policies and decisions, actions and plans. Wider participation in the development of these items is an even better approach.

Similarly, technical professionals have to learn more about the realities of corporate existence; the long-standing traditions which shore up the existing framework of our society; and the enormous number of variables and intangibles which form the basis for many an executive attitude, judgment or action.

The objective of increased understanding and enlarged interaction is not to submerge one activity (say, engineering) to the other (management). On the contrary, each must reinforce its role. But this does not exclude the need for much more profound appreciation of what the other is doing -- not merely for himself but for his associates in the organization and well beyond.

A number of firms have tried to accomplish this through the "dual ladder approach." It has not made as much headway in some companies as in others. It provides two parallel paths for each individual in the technical area to choose. One leads to the peak of engineering or scientific work, devoid of managerial duties; the other represents the opportunity to climb in the executive hierarchy, free from the actual doing of technical tasks (it is likely though, that an individual with an engineering-science background who selects a supervisory career, will manage engineering or related activities).

As an example of how one of the two parts of such a policy works, we quote from a corporation's "The Scientific Ladder of Advancement":

> "To ensure the continuing service of experienced scientists who desire little or no managerial responsibility, the opportunity of advancement to senior but non-managerial positions will be provided. These positions will parallel the usual managerial positions in the research laboratories of TI but will be distinguished from them by requiring appointees to perform scientific research exclusively."

Corresponding ranks are, for example:

On the Managerial Ladder:	On the Scientific Ladder:
Laboratory Director	Research Fellow
Branch Head	Senior Scientist

Crossovers from one column to the other are readily possible when the individual involved desires it.

It is entirely possible that the responsibilities of a research or an engineering manager are smaller in comparison with those of one of his scientific "subordinates." In that case, the salary of the latter could exceed that of his superior. This works in a number of companies to their and their men's full satisfaction. It does require the manager's adoption of a contributory leadership style along lines elaborated upon later on, especially in the chapter on managerial philosophy (chapter 10).

Where the "dual" arrangement exists, it has cleared up many a misconception. But it can bring results only when the people involved know what they are after. The choice to become a manager or to remain an engineer, is up to the man himself. It is he who has to weigh what he sees as the advantages and disadvantages in either career. His abilities, knowledge and experience as well as his interests and personality should have a mighty influence on his decision.

No man can become a good engineer merely by graduating from an Institute of Technology and then doing engineering work unless he is backed up by the requisite personal capabilities. Precisely the same situation faces the individual who ventures into executive responsibility after graduation from a Business School and works in one or several firms or government agencies; his success can come only when his talents support this knowledge and experience.

Those who are lured into engineering by whim that is not reinforced by competence will fail. The same fate awaits those who enter management, perhaps tempted by visions of power and money but lacking ability.

More often than not will the success achieved in one's job indicate if the career involved was properly chosen. But this is by no means always the case. There are quite a number of cases where reasonable results are attained by men whose positions are far from having been chosen on the strength of their capabilities and interests.

One reason for their seeming effectiveness may be their determination to exercise whatever extra effort is needed to assure accomplishments. Another may be the dedication of their subordinates who pull their chief through because of their rather than his contributions; (such a situation, however, gives the man some pretty high marks for at least a portion of required managerial talent). And there are indeed many other situations with the same end effect.

They all exist because the man does not know what he wants to get out of life. He may not have asked himself this question at all; he may not have been able to answer it properly; or he may not yet be ready to examine himself that thoroughly. To cut through this fog which inhibits his vision, he must obtain a clear(er) recognition of his personal objectives. This is not an easy task, especially not at the oft-crucial age of 18 or 20 or 22. Yet there is no way to avoid this self-examination unless one is content to be blown by fate across the seas of life at will.

"Just what do I want to accomplish in life through my work," i. the key question that has to be answered. And when it is, a second beckons: "Why do I want to go after . . . (whatever the case may be)"; the reply to this one may support, invalidate or cast aspersions on the first response and thus possibly start the queries all over again.

"Ability," "interest," and "rewards" are three of the fundamental parameters which each person needs to scrutinize deeply before deciding on his course of action. Such a probe is facilitated by projecting a minimally distorted picture of oneself five and ten and thirty years hence in pursuit of the goal we have tentatively set for ourselves. "Will I be content – more than that: really happy – in that surrounding, with these responsibilities and rewards, risks, problems and opportunities?" This is where additional frank and thoughtful reactions are needed.

This projected scene looks quite different for someone who pictures engineering as the acme of his ambitions than it does for the man who aspires to be a manager. We need to recognize our objectives before saddling our employer with the blame when our ambitions are not fulfilled because we do not know what they are.

One last point – do engineers make good managers? There is no general decision-rule, in our opinion; the answer can be "yes" or "no." It depends on the man himself; his abilities and ambitions; his strengths and weaknesses; his perceptions, knowledge and experience; his interests and courage to follow through on the conclusions at which he has arrived when examining his objectives.

If his reaction should favor the managerial path, a secondary question is whether he is likely to be successful in his (newly found) realm within the climate of the particular company concerned. His whole nature may be in basic harmony with the general thinking and attitude of the organi-

zation or it may not be. If the latter is the case, the differences are bound to appear more pronounced to the supervisor than to the engineer because as a manager, his own acts and thoughts will need to be more closely tuned to those of his colleagues.

The key that opens one's career to a proper match with one's profile is "to know thyself." Our stay on earth is too short to spend it in work – be it engineering or management – that pays good money but leaves the spirit hungry.

Chapter 3 – MOTIVES IN ACTION

Significance in the Success of Business

How can we bring into the business situation that interest, that drive, that commitment, which people exhibit so often at play or during their leisure hours? Many management policies, incentives, plans and other arrangements have been devised to encourage greater involvement of the individual in his work. It seems that some accomplish exactly the opposite.

The reason probably is that business has been set up to serve its own purposes. This is of course most appropriate. However, this does not mean that other aspects have to be disregarded. The needs of the community, the legitimate right of the customer to purchase a product at a price that gives him equitable value, the interests of the employees – these are just some of the additional considerations which affect the business as well.

It is only in recent years that an increasing number of businesses, following in the footsteps of a few leaders, are attempting to incorporate those ends as well. These companies have recognized three very basic points:

. . 1. Each individual has his own needs whose attainment is, within reasonably definable boundaries, as much in the firm's interest as in that of the person involved.

. . 2. A body of people, living or working together, has its own special and specific needs; much-desired extra dividends will accrue to the firm if these group needs are also met.

. . 3. A corporation which has the attitude that individual and group needs should be fulfilled as well as those of the company, should not be labeled softhearted. It is rather downright good business. It is in the selfish interest of the organization to enable wider need-attainment. As a matter of fact, in many cases, enterprise needs can be satisfied only when those of the people, singly and collectively, are.

It takes management skill of the highest order to recognize these three sets of existing needs and to find economically profitable ways to assure their fulfillment in mutually compatible fashion. Flexibility of high order is needed. There have to be continuing adjustments to changes in environment.

We dwell, at the outset, on some of the theoretic underpinnings of effective executive practice in the area of motivation. Before even the best-intentioned management can be fully successful, it has to understand the underlying causes; it needs to summon the latest available knowledge (and other resources) before it could hope to cope with a task of such magnitude and importance.

However, such a goal deserves management's best. The hundreds of millions who believe in Karl Marx's view that the interest of business and of the people are irreconcilable, bet that we cannot succeed. More significantly, there beckons the challenge of our own heritage: "It is for us, the living, . . . to resolve that this Nation . . . shall have a new birth of Freedom . . . " in its potentially most important sector, the over five million businesses in this country.

Man's Needs

Man is a creature of ever-expanding needs. He is a wanting animal. And his needs cover a wide variety. Abraham Maslow suggested the following hierarchy of needs:

. . 1. Physical – Physiological Needs.
Physical needs are life-sustaining needs such as the needs for air, water, shelter, temperature, etc. Hundreds of millions are still starved of these most basic ("low-level") needs. Availability of these material necessities is taken for granted in the vast majority of our industrial and commercial enterprises as well as in government and most other sectors. Therefore more attention can be directed to higher-level needs.

. . 2. Safety Needs
These stem from the desire to preserve one's good fortune, i.e., to be free from deprivation of, or threats to, one's more basic requirements. As survival is assured, man becomes sensitized to social and other needs.

. . 3. Social Needs
The main theme is "fellowship," that is, the desire to be liked, to be accepted, to belong. Man is a social creature. To be with others is felt especially keenly by those whose needs are not filled at work.

. . 4. Ego Needs
They refer to "dignity," that is, the pleasure which comes from self-respect, status, reputation and justice. When a man begins to feed his ego, he finds it much more insatiable than his stomach because he now begins to experience an enrichment of his sense of identity. This comes to a climax in the fulfillment of . . .

. . 5. Self-Actualization Needs
The focal point is a "sense of accomplishment." Self-actualization needs are met through

the utilization and development of one's potential and capabilities. Secure in his material and social requirements, the individual thinks of nourishing his innermost self. He wants to exercise a moral choice. He hopes to experience growth through greater intellectual and emotional development. He strives to realize his full potential.

There are four hallmarks of the fulfillment of self-actualization needs:

* (a) Recognition – both financial and non-financial.
* (b) Growth – professional and personal development. This is the opportunity to acquire new skills and new knowledge; it includes the chance to satisfy the curiosity to learn.
* (c) Responsibility – This refers to the possibility for self-expression, for the release of one's talents, abilities and creativity; it brings with it a feeling of importance and profound satisfaction with the results of one's work.
* (d) Achievement – The mastery of one's competence. The achievement need is especially pronounced in engineers, scientists, managers, writers and other creative people. The fulfillment of this need is therefore particularly significant for all of them.

Hallmarks of Fulfillment of Self-Actualization Needs
Recognition Growth Responsibility Achievement

Illustration 2: Significant Motives for Engineers

Three major conclusions from extensive research are of immediate importance to this project:

. . 1. Contentment Is Not for Sale

When gratification of one need is out of reach, we seek satisfaction through fulfillment of another. A typical example for this is the ever-rising demand for salary increases and more fringe benefits. Of course, there are many economic causes for such claims but there are also psychological reasons.

When work is tedious, many scientists and engineers often believe that management owes them compensation in the form of more money. Since frustration on the job prevents them from getting satisfaction in their work, they try to get it in peripheral areas of their job, for instance through more money. When an increase is granted, management expects better work; what it gets instead is the same or less; in addition there will be more demands since the strategy worked so well the first time around.

It would be much less expensive and much more effective if those managements who do not already do this, would recognize this situation for what it so often is: A cry for more meaningful work, not for more money.

By raising salaries and improving benefits, too many companies have concentrated too much on making their people's non-working hours nice; they have paid too little attention to making their work time more tolerable and pleasant.

This has enabled the employees to feed themselves well, to shelter themselves well, to clothe themselves well and thus to make their non-working hours comfortable and inviting. Yet the work day remains dull and a source for more demands to improve the pleasant situation at home.

When management considers work content as much as work environment, such added concern would harness many individuals' higher-level ambitions to the company's tasks. It would capitalize on every person's as yet unused potential. It would bring work of greater complexity into the reach of many more people. It would have greater value not merely for the firm and the nation but to the individual employee involved.

It would take a giant step toward making the engineer's personal goals coincide with those of the employer. And it would provide the most powerful incentive possible toward higher productivity – in the broadest sense of this term (including creativity, initiative, responsibility and still other contributions which too many employees now withhold from their firms since the prevailing climate focusses their attention to lower-level needs).

2. "We now pay them $100 more per month: Why aren't they happy?"

A satisfied need does not exercise any pull. Its continuing fulfillment is taken for granted. All of life, not just work, is a struggle to satisfy our needs. As soon as one is taken care of, others demand attention. For example, after an exhaustive day, we first want sleep above anything else; upon awakening we discover that we are hungry; after we have eaten we want to see a movie; and so.

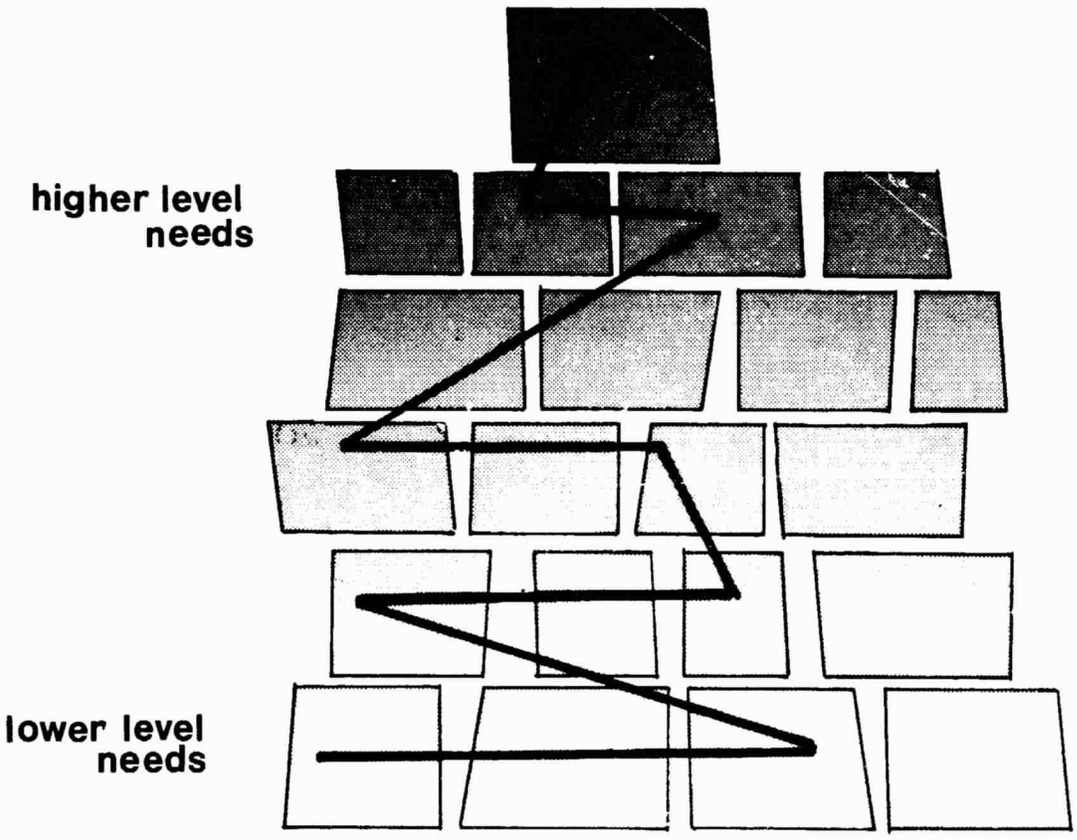
Once a need is filled, others take its place (see illustration 3). It is only after our physiological needs are satisfied, for instance, that we can afford to concentrate upon assuring their permanent presence ("safety needs").

Needs are fluid. Efforts to satisfy all needs once and for all are doomed to failure. This is probably one explanation for continuing dissatisfaction as long as management's attention is centered on working conditions and not also on work contents. (It also explains the increase in the length of many strikes. The economic pinch of not bringing home a regular week's pay is lessened because the men have saved more while they were at work.)

Dissatisfaction is here to stay. It is the most powerful force for more progress. Man is motivated by what he is still seeking, not by what he already has.

3. A Systems Approach in Need Fulfillment

The more fully lower-level needs are fulfilled, the greater does the opportunity become for higher ones to exert their influence. This requires more [illegible] on the part of the individual concerned and of his company. Practical ways for engineering management to accomplish just that are suggested in the remaining chapters of this report.



AS ONE NEED IS FILLED
MAN GOES AFTER ANOTHER

illustration no.3

> But when these higher-level needs are gratified, they bring markedly greater efficiency because they lead to a richer life and to a stronger individualism. Satisfaction of these higher-level needs is important in itself; it is even more significant because, being a means to an end, it permits analysis of the more fundamental goals of the person involved.
>
> In terms of need fulfillment, each individual must be treated as an integral whole. Thus it is not the stomach that is hungry; man is. The finest working conditions cannot satisfy many people when the work content is meagre. Gratification of one (type of) need must be viewed in the context of those which are not yet met, and vice versa.

The Nature of Motivation

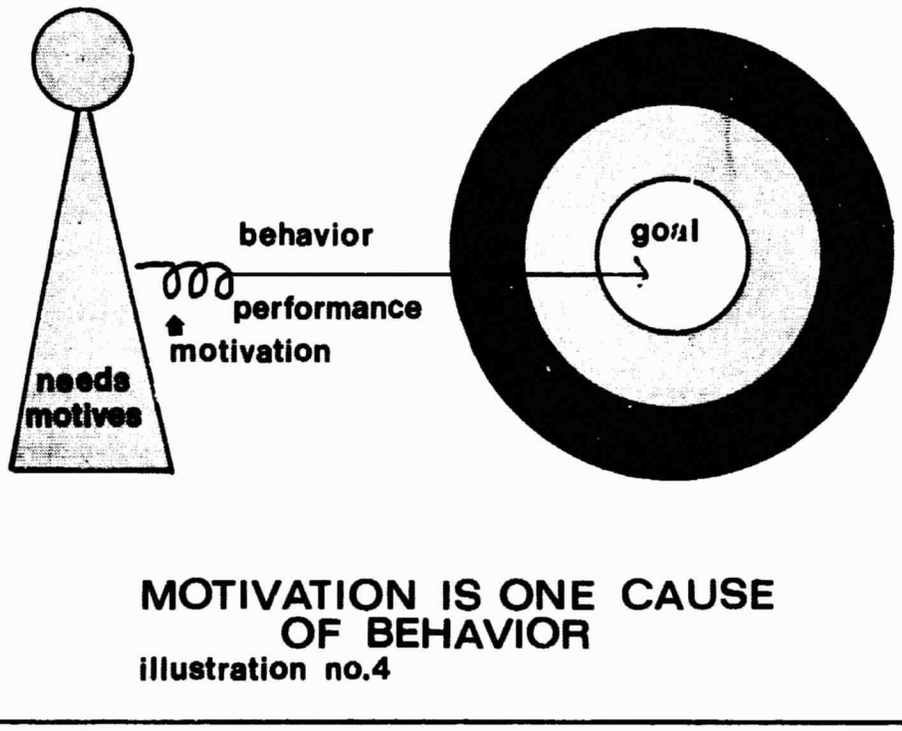
Needs represent wants, wishes or desires. They reflect valences or preferences. If a need becomes strong enough, it becomes a motive; it constitutes an urge (or tension) which has the potential to activate action. For example, an individual selects one from several alternate courses.

A motive entices an individual (or a group) to move in a specific direction in the expectation that this will bring satisfaction for this specific need. This is why most of us work – because we have to earn money to live. Motives thus constitute one cause for behavior; they "motivate" (see illustration 4).

There are many differing views on motivation in the literature. Some of which cannot be reconciled with one another. For our purposes here, we believe this (admittedly simplified) definition will serve best in the attempt to arrive at conclusions which are useful to the practice of (engineering) management in (the aerospace) industry:

> Motivation is motives in action; it means transformation of the potential energy of the motives into kinetic energy; i.e., action, behavior and resulting performance.
>
> Motivation is a process which is energized by the existence of one or several unfulfilled needs. It is an inner drive, a force which leads an individual (or a group) to act in a specific manner in the anticipation of reaching a goal which he hopes will satisfy the unfulfilled need.

The switch that permits the power inherent in a motive to become operative is exclusively under the control of the individual. He may, or may not, throw that switch, depending upon the consequences of such an act as he sees them in the existing situation. This is why, for instance, so many an engineer suddenly discusses with his new supervisor complaints which have been long smoldering.



MOTIVATION IS ONE CAUSE OF BEHAVIOR
illustration no.4

When business uses the findings of motivation theory wisely, two of the most important conclusions are:

. . 1. The realization that it is now a scientifically proven fact that every individual is different by nature. We have to deal with human diversity, regardless of whether we find this administratively convenient or conceptually easy to grasp.

Everybody has a lot of motives. Nobody has quite the same mix as anyone else. Everyone will find, or at least try to find, satisfaction for some of his desires.

By not recognizing its own actions as frequent obstacles to the fulfillment of an employee's goals, management can lose many opportunities for increased productivity. Often it overpays its people and reaps additional headaches instead of rewards.

Much of the difficulty in understanding motivation stems from the fact that there is a hierarchy of motives. This structure does not remain fixed. A man's primary motive today may have lost its pulling power by tomorrow; it will, if it has been filled.

Motives are a moving target. Yet there is a basic pattern in each person. This orientation is fairly permament. There is a high degree of inertia to change the basic framework of one's needs although maturing does bring at least some shifts; so do other aspects of a man's development and his surroundings.

. . 2. The concept of "negative valence."
"Positive valence" means preference for a specific goal, say interesting work; "negative valence" is the opposite; it means: No preference for interesting work; it does not mean: Preference for uninteresting work.

Too many organizations overlook this difference. Yet it represents a fundamental fact of signal importance in every aspect of management. This is so because this concept of negative valence plays a decisive role in the differentiation between maintenance and motivating factors about which there is more below.

Too long have we limited our sights so that we still expect that most everyone has, as his foremost objective, such immediate and obvious goals as money or security. Yet these goals are often really means to other ends. Wealth, status and so many other things which we thought caused people's behavior, are frequently only means for attaining a much more significant target – to be himself. This would make the ultimate motivation for many, especially for most creative people, the desire to live and to work in such a manner as to be able to play the role we want. As long as that would bring about the accomplishments of the objectives which management strives for, executives may well consider making such a situation possible for its more creative personnel.

Maintenance and Motivating Factors

For the practice of business, it is highly important to recognize that the fulfillment of needs (including all five-level needs discussed earlier) falls into two significantly different categories, namely:

* Maintenance Factors
* Motivating Factors

In this (again simplified) summary, we draw heavily upon the research conducted by Frederick Herzberg and his associates (which is available in the literature) and upon more recent experiments (which M. Scott Myers and others have conducted on behalf of Texas Instruments, Inc.). For the latter, we are indebted to Dr. Myers and TI's top management for access to as yet unpublished material.

That such material should have originated at Texas Instruments is not surprising to anyone, who, like NASA, knows the unusual calibre of its management. Under the direction of its honorary

chairman, Mr. J. Erik Jonsson, its current chairman, Mr. Patrick E. Haggerty, and their associates, the firm has pioneered in the practical application of many of the theoretic findings incorporated in this report (and indeed well beyond its scope).

1. Maintenance Factors

These help make work more tolerable; they contribute to people being placid, though not yet fully productive, pliable but not yet fully creative. They prevent a loss of morale.

Maintenance factors are extrinsic to the work. They are peripheral to the job. They relate to work conditions and environment; they concern job context. Mainly aimed at filling lower-level needs, they are "single-edged" because they do not increase motivation.

Maintenance factors satisfy needs in six distinct although somewhat overlapping areas:

. . 1. Economics

This includes the impact from salary and supplemental benefits from leave, vacation, general bonus, general profit sharing and similar provisions.

In contrast to the remaining five categories, economic factors can also be motivators if they are related to individual work results. This situation is probably explained by the fact that our society equates too often a man's "worth" with what he earns, where he lives, which cars he drives and other matters of this type.

. . 2. Security

Here we deal with job continuity, grievance procedure, seniority rights, etc. But less tangible influences can also contribute to security; for instance the prestige which the department has within the company or the standing of the company itself (is it a recognized leader in its field?).

The individual supervisor can cater to this need in many ways, for instance by fairness, by consistency, by reassurances.

. . 3. Orientation.

Such features as getting acquainted with the company and the job as well as staying familiar with them are important. Effective orientation also fosters relationships between the man, his position and the work around him. It tells him what goes on in the firm-as-a-whole; what the company's plans are for the future; its existing and potential contracts; etc.

The individual supervisor can play again a significant role by his willingness to give necessary job and other information. This brings about a better understanding of a man's

work and the final product. How can we expect people to act intelligently if they do not have information that enables them to think intelligently. To quote Mr. Mark Shepherd, Jr., TI President: "One way to compensate people is to let them know what the problems are."

. . 4. Social Aspects

Into this category fall such basic matters as relations with associates, superiors and subordinates – through formal work groups or more informal leisure gatherings and activities. Office parties, outings, company sports programs and similar events can make a major contribution. What is actually done, is important, but it is less significant than the general atmosphere that prevails.

Using first names in contacts with higher management, for instance, is certainly one possible characteristic of a company's intent to further social aspects. Yet if such outward indicators are not supported by the general climate, by clear-cut evidence of the sincerity behind such arrangements, the end result is likely to do more harm than good.

. . 5. Status

One of the most frequent complaints of engineers, indeed not merely in the aerospace field, is the lack of recognition by management of the work which they perform. In the NASA-NYU survey,[1] we found many expressions of frustration about the demeaning status of engineering as the men saw it. Here is a brief sampling:

* "Engineers and Scientists are treated as common laborers."
* "They care nothing about us people as professionals."
* "Disassociation of management from the working morale of the people."
* "Management has a harsh, mechanistic view of the employees."

Again the supervisor can make major contributions to the satisfaction of status needs by sincere appreciation of the results which his people produce for the firm. If they did not deliver the goods, he would – should – be out of a job because his superiors judge him by their work.

Companies who are doing business with NASA, find themselves in a particularly good position to capitalize on the desire for status. Many engineers in other industries look upon their colleague in aerospace as their "reference group"; they would like their neighbors and friends to identify them with the more widely known and appreciated activities and accomplishments of the aerospace engineers.

. . 6. Physical Environment

It should not be necessary to point out that a man must have an efficient work place, with needed facilities, a useful layout and the equipment which he requires for his job. Yet too often this is not the case.

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1. Please refer to Chapter 1 for further identification of this project.

Few libraries, for example, have sufficient literature readily on hand for quick reference. Access to computer facilities, needed audio-visual equipment, dictating machines, tape recorders and many pieces of apparatus of this and other types could go a long way to facilitate the work of the engineer and scientist.

But even more mundane characteristics leave much to be desired in too many cases; to wit, poor lighting, insufficient ventilation, uncomfortable temperature and humidity, freedom from noise, a convenient spot to park, an attractive place to eat, etc.

"I cannot think in this mad house," was a typical comment in not just one of the firms we visited. "Noise, noise and more noise! The computer has more peace and quiet than I," was another remark which reflects on the physical aspects in a number of organizations.

The NASA-NYU Survey generated comments such as these:

* "Work environment is lousy. Poor housekeeping, shoddy desks, etc."
* "Overcrowded offices!"
* "Bull pens . . . for analytical personnel severely affects efficiency and morale."

Maintenance factors are important because they provide minimum tolerable conditions. They provide minimal satisfaction but they are not motivators. (They are likely to be more important at the rank and file level where work is more standardized. And in such surrounding, they are generally handled on a group basis.)

Maintenance factors are more and more taken for granted. When they exist, they may not even be noticed. However, if they do not exist or if they deteriorate, the situation can worsen quickly; the parameters just discussed could then become potentially sharp dissatisfiers. Such reactions can be expressed through

* more complaints
* greater absenteeism
* higher turnover
* increase in friction
* many other ways, including work in terms of lower quantity and quality.

Among the conditions which propel employees toward stressing maintenance factors are

* lack of company objectives and planning
* poor abilities or low aptitudes of associates, supervisors, subordinates or superiors
* improper placement

* sad experiences
* inefficient performance
* management preoccupation with "economic man" and other maintenance-oriented attitudes
* a company philosophy which sees profit as its sole purpose
* above all, too few motivational opportunities.

One of the greatest pitfalls exists for management when employees express discontent with their life at work and when business then responds with more maintenance factors instead of increasing motivational influences. Too often money is wasted on higher compensation scales, more benefit schemes or other maintenance aspects; they do not improve company operations because they cannot exert leverage when maintenance needs are satisfied. While the complaints seem to point to such items, they really refer to the scarcity of motivating factors. The same or much less money would produce significant improvements if it were applied to opportunities which nourish motivation.

Motivators

In contrast to maintenance factors, motivators are intrinsic to the work. They are characteristic of the work itself, of work content (while maintenance factors deal with work context.) Although to a lesser extent, they reflect the individual himself.

Motivators fill Maslow's higher-level needs. They aim at achievement and psychological evolution. They help a man to become a whole, a bigger person. He grows and matures because motivators have a distinctly uplifting effect on attitudes and performance.

Two words of caution are in order:

. . Motivators have to be administered on the basis of individual merit. The crucial point is their application on the strength of personal performance.

. . Even the strongest motivators cannot operate long in the absence of reasonable maintenance factors. Man has to be able to eat regularly before he can afford to stretch his ambitions to intellectual nourishment.

Motivators satisfy the four major obectives in the fulfillment of self-actualization needs which were discussed earlier:

1. Self-earned Recognition

Every healthy individual likes to have his work appreciated when it is done well. He welcomes recognition of himself as a person. This is why individual performance appraisals have been so much more successful than similar attempts on a group basis (see also chapter 7).

Other potential contributions by the supervisor are:

* discretionary merit increases
* awards for specific personal accomplishments
* individual profit sharing that is based on the individual's performance
* above all, the creation of an atmosphere of approval, encouragement and stimulation.

We cite just three comments from the NASA-NYU survey:

* "I want recognition that I am an individual worthy of consideration, especially of my ideas and judgment, which are based on education, training and experience; (I am) not just a cog in a machine"
* "Too often we are considered as being in a peon status to do only as directed"
* "Treating the individual as a single entity rather than a technical machine delegated to do 'assembly line thinking and problem solving' is extremely important to the creative engineer."

And then we found some ominous rumblings in the answers to the NASA-NYU questionnaires such as:

* "The company provides only what the engineers' association forces them to give."
* "Perhaps we have to resort to labor unions."

Happily, we also read:

* "The 'individual treatment' and 'open door policy' give the individual a strong company loyalty."

Money is of course one form of recognition. With professional personnel, it is usually neither the most nor the least important one.

2. Growth

This includes further education, participation in professional society activities and many other opportunities.

The prudent company will do well to go beyond encouragement to join a professional organization or reimbursement of its annual dues. It facilitates, for instance, the writing of papers through company support and conceivably on company time. It makes the necessary assistance available when the profession asks the individual to serve as one of its officers.

Growth includes not merely professional but personal development. If both continue throughout life, they are the best antidotes to personal obsolescence. They also increase a man's maturity.

Trends, which are representative of significant influences toward maturity, include growth

* from ignorance toward knowledge
* from irresponsibility to responsibility
* from verbal isolation into communication
* away from ego-centricity
* out of particular-seeing to whole-seeing
* out of passivity into increased activity
* out of a state of dependence to relative independence
* from short-term to longer-range perspective
* from being capable of behaving only in a few ways to conduct in many different ways
* from staying in a subordinate position to aspiring to an equal or superordinate position relative to one's peers.

These points are recorded here because they can be useful in heightening executive sensitivity to their people's state of development. The first five items are taken from writings of Overstreet, the remaining five from those of Argyris.

Both make these observations in regard to the development of children into adults. Yet this process can go on during everyone's entire life. Philosophical considerations suggest that business (or, for that matter, anyone else) has no right to stand in the way of such evolution. But even less altruistic motives are strong reminders that here is another opportunity to broaden the potential of many a person.

Again the supervisor is in a fortunate position to make positive contributions to the satisfaction of the need for growth through appropriate promotions or transfers or rotation, through advancement and similar actions – as long as each is in response to individual performance.

To illustrate the "wrong" situation, here is one response from the NASA-NYU survey:

> "There seems to be little interest . . . toward developing the engineer to more responsible work and position."

And another from a different source:

> "Advancement is either contaminated with politics and favoritism or dehumanized by undifferentiated seniority systems."

As an individual grows, his needs increase and some of them deepen. If he is to develop, we must be ready to help him find satisfaction for his wider and more pronounced needs. Allowing occasional mistakes is the price that management has to pay for such development. The proper question is not "how expensive are these errors?" But rather "how valuable is it for us that he learns?" or "how costly would it be if he does not mature, if his development is stunted and if that then causes extra losses which inevitably follow frustration."

3. Responsibility

We are using this term with heavy emphasis on its moral aspect. Responsibility means duty, a sacred trust, "the greatest gift that Fate can bestow."

Responsibility is also the response to recognizing that everyone needs a certain amount of self-reliance. A healthy individual wants to find confirmed that his job is important and that his contributions have real value. His assignments should lead him closer to the limits of his abilities. After he grows, this development must be matched with new challenges.

A good man needs the opportunity to succeed. He cherishes the situation that allows him to commit himself to work. The supervisor can accomplish much of this by delegation. But as simple as this sounds, supervisory practice seems to stumble more often when it comes to effective delegation than perhaps in most other situations. One of the questions in the NASA-NYU survey asked the respondent to rate his superior on a number of attributes listed. "Ability to establish suitable work assignments" ranked eighth out of the nine attributes listed.

Effective delegation represents tangible evidence of management's confidence. It can range from such minor things as signing one's own letters or requisitions to such major items as a justified degree of freedom for the individual

* to act on his own initiative

* to choose the method of working he prefers
* to exercise judgment and take action he believes proper (within boundaries which are reasonably well defined and agreed upon in advance).

The objective is to make the man feel that this is his responsibility: "If it is to be, it is up to me."

Of course, granting too much responsibility indiscriminately or not pulling in the reins when they have been too loose, can be as harmful as delegating too little responsibility.

Proper delegation recognizes the eternal striving for more independence. If an individual shows that he deserves such independence because he delivers the results the company wants, why should he not have more independence? This can be assured, for example, through increasing participation in goal setting and planning about which we will have more to say in Chapter 5.

When the manager delegates effectively, he accomplishes two of his most important tasks. He

* gets more and more difficult tasks accomplished
* reinforces the personal involvement of each of his men in the company and its business and in his profession.

Business will find many additional goals within reach when its creative personnel truly commit themselves to their accomplishment.

4. Achievement

The need to achieve requires the opportunity to express one's personality and interests, knowledge and skills. Especially scientists and engineers want to be identified with the result of their work. They enjoy their workmanship. They cherish achievement for achievement's sake. No other result is as profoundly satisfying as

* doing what they like and being successful at it and
* having others see what they accomplish, and acknowledge it.

The NASA-NYU survey included an open-end question in which the respondents were asked to rank, in order of importance, those factors which motivated them to do a good job. A number of items which are best summarized as "professional achievement" ranked first; they included:

* professional reputation
* pride in a job well done
* accomplishment
* need to excel.

Motivators are the catalyst – potentially the most powerful one – for substantial development of the scientist and the engineer. These individuals appear to have a tendency to increase the quality more than the quantity of work under the impact of motivators. Similarly, they seem to show frustration more in terms of calibre than volume of output. Under adverse conditions they are likely to employ less ingenuity.

Motivators are far more complex and far more subtle than maintenance factors. They are much harder to verbalize because they deal with abstracts. Complaints are often hidden behind alleged grievances which have no relationship to the real issue. For example, we are much more likely to be aggravated by noise when it occurs while we are busy with something quite boring; we may not even notice that same noise when we are engrossed in work we enjoy.

Motivators play a commanding role in a person's development. Their impact can be strengthened by repeated acknowledgements of success. What an opportunity this presents for a sensitive supervisor! Conversely, chronic lack of reward or recognition could suppress the effectiveness of motivators to a sizeable extent.

People are likely to be more affected by the absence of motivators than by their presence. And negative motivators could become dissatisfiers although they are likely to have a weaker influence than the absence of maintenance factors.

In summary, motivators cost a great deal less than maintenance factors, yet they can produce much larger results. They require a substantial change in management thinking and action in many a company. They are so powerful because they are the source of energy, drive, initiative, creativity, imagination and still other assets. They utilize latent abilities and dormant knowledge. Yet they remain too frequently unemployed.

Comparison of Maintenance Factors and Motivators

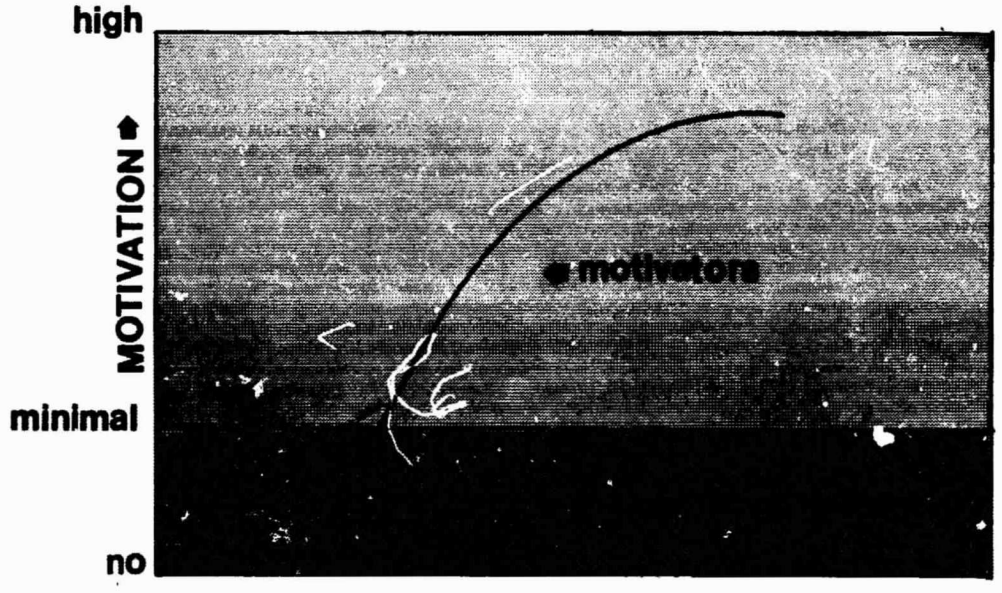
At this time, maintenance factors are almost a common way of life. Despite the economic growth of the past few years and decades, there are still many and sizable opportunities through which maintenance factors can add still more material opulence.

This could foreshadow the advent of something approaching the Millenium for a not inconsiderable number of people who have not – or cannot? – develop beyond the point where it seems sufficient for them to wait passively for events to happen.

However, this leaves unsolved an immensely more poignant problem: How can we sustain this climb to ever higher levels of good fortune while restoring a distinctly healthier balance between the economic and psychological, the sociological and spiritual components of affluence? Happily a response to this is outside the scope of this study.

Motivators are clearly easier for people who are fond of causing events to happen, who are achievement-minded and probably psychologically well-built. It seems a safe prediction that motivators will become increasingly sought after.

Maintenance- and motivation-directed influences constitute a dichotomy. But they operate in two different spheres. They have two distinctly different potentials; they produce two different types of climate. In Illustration 5, the maintenance sector runs from "no motivation" to "mini-



THE SPHERES OF MAINTENANCE AND MOTIVATION FACTORS

illustration no. 5

mal motivation." The motivating sector starts with "minimal motivation" and extends to "high motivation." Maintenance factors from the basis on which motivators can trigger higher levels of motivation.

Discontent on the job can be caused either by poor maintenance factors or by meagre motivation opportunities. The symptoms are quite similar. They include:

* negative attitude
* deteriorating performance
* frustration
* anxiety
* conflict
* hostility.

Which of these or other reactions will set in, varies with the personality of the individual concerned. The same situation (say, an overcrowded office) could make one person sullen, another furious, a third aggressive -- perhaps ready to join the union.

Management's recourse in such a situation must vary with the cause of the discontent. The same effect, for instance absenteeism, is likely to have to be dealt with in a different manner when different people are involved. Or, if the origin of dissatisfaction is the lack of meaningful work (absence of motivating influences), a new paint job in the office (maintenance factor) will not help. If a man is unhappy because of what he thinks is discrimination against him in compensation (maintenance element), assignment to more responsible duties (motivating medium), would only make things worse.

Being able to differentiate between maintenance- and motivation-directed influences requires significantly higher sensitivity and other interpersonal relations skills on the part of the manager. It also demands considerably greater flexibility in his style of operating.

The poignancy of any maintenance or motivating factor varies with the individual. However, a broad distinction can be drawn, on a continuum, between individuals who have a basic orientation toward maintenance factors and those who are more sensitive to motivators.

Maintenance seekers tend to avoid motivating opportunities. They generally show little interest in the kind and quality of work. They succeed on the job through sheer talent. It is the exception rather than the rule that they profit from experience. These people realize little satisfaction from achievement. They are therefore chronically preoccupied, and generally dissatisfied, with maintenance factors such as pay, supervision, working conditions, company policy, and so on.

Conversely, motivation seekers enjoy work and realize great satisfaction from it. They are primarily moved by the nature of work. They are likely to exhibit more creativity and to strive for excellence. They are anxious to learn from experience. They are more concerned with challenge than with comfort.

Men of this cut prefer responsibility. They have a built-in generator which is fueled by their interest in the work that has to be done. They are more indifferent to their surroundings as long as they stay caught up in the pursuit of their goals. They have a high tolerance for poor environment.

We are listing still further characteristics of motivation seekers and invite the readers to compare all of them with the comments made about engineers in Chapter 2.

Motivation seekers are usually stronger and healthier. They are more often inner-directed. They choose their beliefs quite deliberately and firmly. They are persistent and determined. They put more effort into work especially when challenged. And they take pleasure in competing in a difficult situation.

Many motivation seekers are aggressive but most are quite realistic. Each wants to know how he is doing. Such feedback has to be for each individual not merely for the group as a whole. They prefer work when knowledge of result is prompt and reliable. They spend more effort when they are told precisely what is right or wrong about their work.

In the NASA-NYU questionnaire, only a little more than one-third (37.6%) felt their superiors informed them of their progress "regularly"; 26.1% marked "infrequently"; 21.2% said, "He drops a few hints, but I have no real idea as to his opinion"; 13.4% stated that they "never" learned what their progress is.

In the words of one: "Engineers never know how they are doing as far as abilities' evaluation is concerned. If they give you a raise, they do not tell you that they appreciate your work. If they do not give you a raise, they do not bother to tell you the reason either." And another comment: "It has been eight years since any evaluation of my performance has been made or at least since the results of such evaluation . . . "

Most motivation seekers weigh their chances for success in a cool, detached manner. They are more likely to be goal- rather than task-oriented. They can pose problems for supervision because such an attitude is not necessarily conducive to smooth work flow.

Motivation seekers are prone to ask probing questions:

* "What do you mean?"
* "How do you know?"
* "Compared to what?"

On the other hand, this attitude opens up many opportunities for management. When the supervisor recognizes the area of interest of his employees, he can focus much more sharply his attempts at reinforcing motivation toward the behavior that is most appropriate under the circumstances.

Motivation and Behavior

Motivation is one of the many triggers of behavior.

Illustration 6, below, shows examples of other influences.

heredity	moods
upbringing	knowledge
interests	experience
perception	values
thinking	beliefs
learning	philosophy
character	social and moral norms
capacity	status
habits	reaction to the existing situation
abilities	and still additional aspects of man himself and
attitudes	his environment
health	

Illustration 6: Examples of Influences upon Behavior Other than Motivation

Management can exercise much more effective leverage upon behavior through motivation than most, if not any, other influences. A healthy person tries to behave as much like the kind of individual he thinks he is, as his surroundings permit. When the existing climate motivates self-

actualization, he will give his best on his own volition – and enjoy it. However, when his environment prevents him from acting that way, he will cooperate only as much as he must – and grudgingly.

In turn, behavior governs performance as it moves the individual to the goals he seeks. An individual's performance and goals are two other crucial interfaces of the supervisor and his crew. In all its thinking and action, progressive management realizes that the objectives which it sets for the business, and the performance which it needs to attain them, affect each employee and his development just as much as it influences the firm and its life.

A few exceptional leaders in management have followed this maxim for some time. Behavioral Science and Systems Analysis Research have proved that this attitude is sound; they also explain why this is so. The following nine points summarize the conclusions which affect management practices:

. . 1. Only as our needs at one level are satisfied, do those at the next higher level come into play.

. . 2. A satisfied motivator is not a motivator any more.

. . 3. Especially in an affluent society, tomorrow's maintenance elements will extend much further.

. . 4. Motivation has to be provided for the whole person, not for just a part of him. Within this general (and oversimplified) framework, each individual has his own unique and reasonably well-defined pattern of needs. So does each group and each company. For example, one key prerequisite for companies in the aerospace field to remain alive tomorrow is the need to innovate.

. . 5. For each individual (group, organization), there is a unique chain whose main links are: Needs – Motivation – Behavior-Performance.

. . 6. Group (several employees') needs are different from organizational (enterprise, community, nation) needs.

. . 7. Many individuals, most groups and all companies require both maintenance and motivation factors. Meshing the two for each person and for all groups in the organization's orbit as well as for the organization itself, without too many undue sacrifices on the part of any, is one of the manager's most fundamental, and quite possibly his single most complex, tasks. It leads to "goal connecting" (see last part of this chapter). It combines into one constellation the objectives of all the people involved. It constitutes a target whose attainment is as difficult as it is worthwhile.

The crux in the effective application of motivating influences is that combination of managerial action and thought that has been adapted most skillfully to the needs of the people in the organization, the groups they form and the company as-a-whole.

. . 8. Individuals have the urge to grow psychologically. Their efforts are often primed by the desire to expand and enrich their concept of themselves; to discover who they are as a person; to arrange life so as to reach their objectives more surely.

Some experts claim that this is the case with many, but not with every healthy individual. Regardless of this difference of opinion, all would agree that this striving does exist in the vast majority of creative people, very much including scientists, engineers and managers.

In the pursuit of their higher-level needs, these people cherish getting involved in their work. It is to the company's advantage to latch on to this force as the will to accomplish one's own aims automatically advances those of the firm.

. . 9. By far the single most important point is the realization that each individual is an individual. This simple yet so very often overlooked principle holds the key to the successful use of motivation factors which deserve management's attention to an ever-increasing degree.

Examples of Management Practices Based on Motivation Theory

1. Participation

Like so many management innovations, the idea of participation has its roots deep in the lap of history. About 2,000 years ago, Heracleites discussed what he called "Harmony in Strife" in terms which closely parallel the modern concept of participation.

The objective of this concept is the stimulation of an individual to involve himself in a group situation to the extent that

. . he will contribute to group goals more effectively than he could by working alone, and that

. . he will share responsibility for attaining these objectives.

This represents delegation in terms of a real and far-reaching partnership. It fortifies individual know-how with the knowledge, experience, talents, and other assets of his associates. The essence of the approach is to permit one (or several) individual(s) to have a meaningful hand in the management of the work. The crux is that it has to be meaningful to him; it must allow self-expression; it should promote development; it has to increase promotional potential.

The extent of participation varies widely with the existing circumstances. Among the factors which influence its degree are

* risks
* time pressure
* skills
* values
* expectations of participants
* and above all, the climate.

Illustration 7 shows the "Participation Spectrum in Contemporary Business Practice." Column (1) represents one extreme situation, a straight autocratic climate (theory X; see Chapter 10). Column (7) represents the other extreme; it includes, in our opinion, the possibility of abdication of managerial responsibility. The spectrum between columns (2) and (6) – and many possible shades in between – indicates the great variability in the degree to which participation is possible.

The disadvantages of the concept of participation are likely to be one or several of the following:

. . 1. Progress may be retarded temporarily because participation compels thinking. It eliminates unreasonable and impractical ideas before they can do harm; that takes time.

. . 2. This way of operating requires a learning period. Manager and crew alike have to get accustomed to this manner of cooperation. If time is short or if other circumstances make participation inappropriate, research appears to suggest that management-set goals are likely to be more effective than allowing the group to flounder. Thus the decision on when (and to what extent) to initiate participation requires high sensitivity, good judgment and plenty of experience on the part of the supervisor.

. . 3. Too many managers and too many employees are not yet ready to attempt participation. There are as many reasons for this as there are different personalities. Perhaps the single most frequent one is the lack of security on the part of the supervisor who, mistakenly, believes that he is surrendering through participation too significant a portion of his "prerogatives."

Among the most outstanding advantages are:

. . 1. Resistance to change is minimized. It is difficult for people to be against something

Tasks	Performed by					Manager / Subordinates	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(a) Recognition: There is a problem to be solved						■	■
(b) Identification and Analysis of the problem and its environment					■	■	■
(c) Development of Solutions			■	■	■	■	■
(d) Decision which Alternate to Adopt							■
Action results because the Manager.....	orders execution of his decision	"sells" his decision to subordinates	reveals his solutions to subordinates and invites them to suggest changes	invites subordinates to develop solutions	invites subordinates to analyze problem and develop solutions	invites subordinates to find problem, analyze it and develop solutions	invites subordinates to find problem, analyze it, develop solutions and decide which to adopt

THE "PARTICIPATION" SPECTRUM IN CONTEMPORARY BUSINESS PRACTICE

illustration no.7

which they had a hand in bringing about. A fight or frustration over acceptance of results and conclusions is avoided. Agreement is clinched because it represents a consensus of all.

. . 2. The ultimate solution is strengthened greatly. Participation adds knowledge and experience, talents and ideas – especially new ones – as no other approach can. Thus the end result is not only better but more lasting.

. . 3. The group will turn out more effective work. Where creative people are involved (such as many scientists and engineers), their activities will not only be characterized by greater quantity. There will also be higher quality, evidence of more ingenuity, wider imagination and readier assumption of responsibilities.

. . 4. The individuals involved will be more satisfied. They find more meaningful fulfillment in their work. They enjoy accelerated growth and maturity. This is so because the very motivators discussed earlier in this chapter, have gone to work in full force.

. . 5. Most importantly, and perhaps merely summarizing the preceding points, the practice of participation has a formidable impact on climate.

The areas of application are very wide, limited only by the calibre of the personnel involved, the prevailing climate and management's ultimate accountability for results.

Some examples for successful application are briefly listed below; they are discussed at greater length in the respective chapters in this report later on

. . Planning (especially goal setting in long-range planning and at any phase of a project; delegation in general, and the concept of decentralization in particular; selection of operating methods and standards); Chapter 5

. . Operations (in particular, self-follow-up); Chapter 6

. . Review (especially in connection with performance appraisals); Chapter 7

. . Control; Chapter 8

. . and most importantly on Climate which can unshackle latent motivational forces and thereby boost work results more than any other factor; Chapter 10.

The greatest pitfall for the concept of participation lies in the possibility that it could be misused by supervisors who want to manipulate their people. This is a very serious hazard. However, it is not the concept of participation as such which causes this danger; it is the manner in which it is implemented.

2. Job Enlargement

Sometimes also called "job enrichment," this practice of management aims at broadening assign-

ments by increasing the stimuli for motivation (through opportunities for learning, development, growth, recognition, responsibility, etc.). It is a reaction against excessive specialization.

Specialization is nothing new. It represents a seemingly irreversible trend over many centuries. It is caused by growing knowledge. The arts and sciences of engineering and management as well as the disciplines, which support either, have been in a state of proliferation the end of which is not in sight. This is why both fields show, perhaps at still quickening pace, increasing branches of special areas of knowledge. Just a few decades ago, five founder societies could claim to cover the entire field of engineering adequately: today we have well over 100 national societies.

The price of specialization is more dependence on a growing number of other people or other areas. As a discipline or a task increases its specialization, it occupies a shrinking sector of total knowledge. It is tied to the rest of the world through continuously shortening boundaries. This increases the need for new linkages with its environment. It is only now that we recognize that the price for specialization may have risen too steeply in some areas.

Of interest to this report is the application of the principle of specialization to job design and task assignment. A complex chore that was originally performed by one highly educated or experienced person was subdivided among several, each needing less knowledge. This won the battle of production during World War II. It could lose our position on this globe not many years from now.

The advantages of specialization in job design are

. . simpler (often more repetitive, usually more routine) work
. . need for less knowledge (or education or training)
. . consequently lower cost and higher productivity – in the short-run.

When we take a longer-range view, the disadvantages make themselves felt; they increase human cost. In some cases, this cost is small. In more instances it seems to off-set the short-run gains; frequently when it comes to creative people, there is little doubt that the human cost usually exceeds the possible gain in economic cost by significant amounts.

The reason is that overspecialization has at least these generally harmful consequences:

. . Greater monotony and boredom. Work is de-personalized. There are fewer opportunities to learn something new or to grow.

. . Generally too much control. It is harder for the employee to assume responsibility and to exercise ingenuity. The range of interpersonal relations is small because the work pace is more rigid. There is no Zeignarik effect.[2]

. . Loss of identification with the final product. There is no, or less, meaningful involvement. especially when the engineer does not see his own work completed.

. . Knowledge and experience are often underutilized.

. . Interpersonal relations are often at a minimum.

Job enlargement is beginning to put an end to overspecialization. Its main thrust has so far, however, been on less skilled (factory, and office) work. One of the companies interviewed has conducted a far-reaching job enlargement campaign. Results have been most satisfying. They also brought a change in higher-level jobs when the tasks further down the line were enriched. Two levels of jobs (assistant foreman and assistant superintendent) could be eliminated in the production departments of many divisions, thus reducing the hierarchy of levels from eight to six. Now freed of many detailed maintenance and other functions, the foreman finds more time to devote to planning; he is more readily available to his people.

Great opportunities exist for engineering management to use the principle of job enrichment more persistently. This is best accomplished by broader delegation, less compartmentalization of work, and a freer exchange of ideas. Some experts advocate more frequent job rotation, others disagree with this.

In any event, an increase in the scope of assignments will utilize more of an employee's knowledge and experience. It will enlist a larger share of his potential. It will challenge his imagination. It will motivate him to achieve still better results.

A prerequisite for sucess in deliberate job enlargement efforts is a contributory work climate (see Chapter 10). If this does not exist (because, for example, the supervisor involved is a "dictator" whose motives would be immediately suspect), people expect merely a new attempt at manipulation which they would continue to resist by just about any means at their command.

Conversely, research seems to show conclusively that in the proper working atmosphere, output is significantly improved in terms of quality, quantity and human satisfaction. In addition, job

2. Zeigarnik showed that moderately complicated work contains psychological incentives toward its completion. Oversimplified tasks lack this impulse.

enlargement represents a training opportunity toward greater readiness to accept responsibility for satisfying one's own needs without infringing on the ability of others (including the company) to fulfill theirs. Appreciation of the need for healthy interpersonal relationships is emphasized because the situation itself shows how each can advance further toward his goals as he helps others accomplish theirs.

Job enlargement is based, in part, on the principle of participation which we discussed a few pages earlier. An enriched task gives the employee added opportunities to participate in and benefit from the huge panorama of work that pervades any, even the smallest organization.

3. Goal Connecting

The principle of participation plays also a role in this third example of the usefulness of motivation theory to managerial practice. We have termed this symbiotic idea "goal connecting." It is characterized by two equally important features:

> . . The individual adjusts his goals and the organization arranges its goals until the two are not in conflict; the individual will reach his objectives through the attainment of those of the enterprise

Although reconciled

> . . each target retains its distinct identity; after the adjustments have been made, we can still clearly differentiate between what the individual is after and what the group (or organization) wants; there are two distinct sets of goals.

Goal-connecting differs from "integration," in which the partners also adjust their targets. However the purpose of this adaptation is integration, i.e., the substitution of the personal ambitions and those of the group with one set. While it would serve the employee and the company equally well, it is something new and different. Its components, the individual's and the firm's objectives, have been mixed together. Each has lost its identity.

We believe that goal connecting is superior to integration. It has the latter's huge advantage of resolving conflict on a higher plane than is possible through compromise and domination. In addition, it features one aspect which is treasured particularly by creative people. This is the preservation of the identity of one's personal wishes which does not, as is the case in integration, become lost by being alloyed, in a melting pot, with the targets of others.

Where background, education, culture or other differences are too pronounced, goal-connecting is much more difficult, perhaps impossible to accomplish right away. To use an extreme example,

let's visualize a school dropout, trained in a Job Corps camp after a period in prison and now employed as a Machinist-Helper on the engine assembly line of National Motors, Inc. It would be rather unrealistic to expect him to appreciate the need for efficiency, schedules, quality and other company objectives. It would be equally unlikely to find him interested, at this stage, in whether his fellow employees readily accept him. His mind is on his first self-earned paycheck and on what he is going to buy with it.

"Goal-connecting" has to wait for changes in his mind; they may come soon, only after some months, or not at all. During this period, it is up to his supervisor to help the man narrow the gap that separates his ambitions from those of the firm.

Although the next situation is quite different, exactly the same gulf between individual, group and company goals confronts the scientist who has just joined a corporation after a disappointing association with a university. At the latter, there was an unhealthy climate; this and persistent disappointments had made him lose confidence in his colleagues and superiors; he had withdrawn from them and the students.

Only sustained exposure to the new and favorable work atmosphere will overcome this attitude. Until that is accomplished, his goals and those of his new employment can not be connected. And again it is the supervisor's task to assist, in every possible way, in building the bridge that will bring the scientist closer to his work and the men around him.

A new avenue of research with potentially significant impact upon the practice of goal connecting by engineering management may have been opened by those scientists who are developing Game Theory. Another has been started by those who are examining "socialization" and "enculturation." The former term ("socialization") refers to the process by which individuals accept the values of the group to which they belong. We have been able to find in the literature mainly discussions in which the adoption of such group values is the result of specific training. We are not certain that this is necessarily the most advantageous approach because of its possible conflict with a favorable climate.

The second term "enculturation" refers specifically to "socialization" in R&D organizations. Avery defines it as the process through which "a researcher . . . undergoes a learning experience

wherein he connects his technical competence to the needs of the employer." Again the emphasis lies on attempts by the company "to change the basic interests and orientation of their members . . . in certain directions important to the organization." Once more our question is whether such unilateral endeavor is conducive to the maintenance or strengthening of a working atmosphere as we are discussing in these pages.

It seems to us that experimentation to date has possibly led to conflicting results. We state this, however, with a decided question mark. Much of the research is still available only in private communications. We can not be certain if we did succeed, despite extensive effort toward that end, in obtaining a truly representative cross section of pertinent findings. Our hesitation stems from the likelihood that research is being carried out without having as yet reached the stage even of unpublished conclusions.

In the light of these qualifications, we wish merely to report this: It seems likely that two factors play a decisive role, namely the science-orientation of the goals on the part of the individual researcher and of the organization. If both are either high science-oriented or low science-oriented, conflict between personal and enterprise objectives is minimal; enculturation can be easy and quickly made. The reason for this is that the depth of scientific endeavor becomes the common plane which "connects" individual and enterprise goals. Conversely, if there is a mixture of one high and one low science-orientation, greater obstacles and more expenditures of time as well as higher conflict probability appear likely.

Before this conclusion can be sustained through research results, common sense supports the proposition that management should take this matter into consideration in the selection of future engineers and scientists. It is there that the match between the degree of science-orientation of the company goals and that of each applicant should become one of the factors in the choice of individuals for employment (see also Chapter 9).

The three applications just discussed – participation, job enlargement, and goal connecting – illustrate the use of motivation theory in managerial practice. There are many additional examples. And behavioral science research has produced – or could produce – findings in fields other than motivation which are similarly significant. Because of the time and budget boundaries of this project, we had to single out just one witness to testify what psychology, sociology and

anthropology have to contribute to the practice of engineering management. Since motivation forms the foundation for many facets, we selected it to demonstrate current possibilities. Vastly more opportunities exist.

It will take the partnership of Science, Engineering and Management to develop them further. If NASA would see its way clear to provide additional leadership for such an endeavor, the results would be as valuable for the aerospace industry as for any other part of the public and private sector.

Chapter 4 -- THE SYSTEMS APPROACH TO MANAGEMENT: THE MANAGEMENT CYCLE

Management's Role in The Economy

Management[1] constitutes the leadership echelons in every organization. it builds a team to accomplish the objectives of the enterprise, and directs it toward those objectives.

The manager organizes Talent and equips it with the required Resources (facilities, space, funds, supplies, etc.). He assures the porfitable deployment and utilization of all (human and material) assets of the organization. He puts them to work for the purpose of increasing values through the work they perform in the operation of the firm.

It is -- can only be – through the exercise of management that these resources become useful to the company and thus to the nation. Management exercises therefore a powerful effect upon society just as regional, national and international life has a mighty influence upon business.

Responsible for getting results through his people, the manager is accountable for all consequences from his decisions and actions. They concern matters within the internal operations of the firm and in its environment – the market, labor supply, the economy, etc.

There is wide-spread agreement on two major internal aspects:

- . . The actual work in d o i n g (as contrasted with "managing") whatever has to be done, is performed under the direction of management by people or by machines which have been set up or programmed by human beings.
- . . The efforts expended in doing things – physical or mental ones – are meant to fulfill a pre-determined goal of the organization; management "directs" them toward that end.

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1. We are using, interchangeably throughout this report, terms such as "management" or "manager," "executive," "supervision" or "supervisor" as well as "section chief," "department head" and similar ones. In the same vein, words like "employee(s)," "engineer(s)," "scientist(s)" and comparable names are meant to be interchangeable.

To these two, progressive managers have added two external considerations which arise on the interface with society:

. . Company goals, the ways used to attain them as well as the results from such efforts must be satisfactory to those involved. They include the individuals who are doing the work, the people who buy or otherwise acquire the output of the enterprise and all others who are affected by the end-product or any other effect from the existence of the organization.

. . The end result must constitute "profitable service" (see Chapter 10).

When the attitude expressed in the last thought becomes commonplace, management will have taken a major step toward establishing for itself the prerogative of becoming a profession. Whether and when this will actually be the case, depends of course also on many other matters.

Tremendous strides have been made in recent years and decades by science, engineering and technology. At the same time, there have been major advances in the theory and practice of management. Both have had the most pronounced impact on society-in-general, including those very individuals whose work has brought these developments about.

The effects are enormous. Among them have been major changes in

* the concepts of man
* the character of leadership
* the mission of management
* the value system – or, as a minimum, the legitimate aspirations – of society. Representing, though, only one aspect, this includes the working climate in an organization.

In a way, this last one ("climate") encompasses the preceding ones, namely "man," "leadership" and "management's mission." It is therefore not surprising that climate emerges from this report as the single most influential variable in the problem areas to which this NASA project addresses itself through this and other studies; they are

. . "Technological Obsolescence" (in terms of the people involved, i.e. the scientists and engineers, technical personnel and others, as well as the subject matter with which they deal)

. . its counterpart, "Innovation"

. . and "Productivity."

The authors have added observations on the last because it strikes us as inseparable from the first. This also enables these pages, we hope, to deal with the assigned subject matter in somewhat more complete form and with perhaps more immediate applicability to the practice of engineering management in the industries with which NASA has most frequent contact.

A Model of "Management"

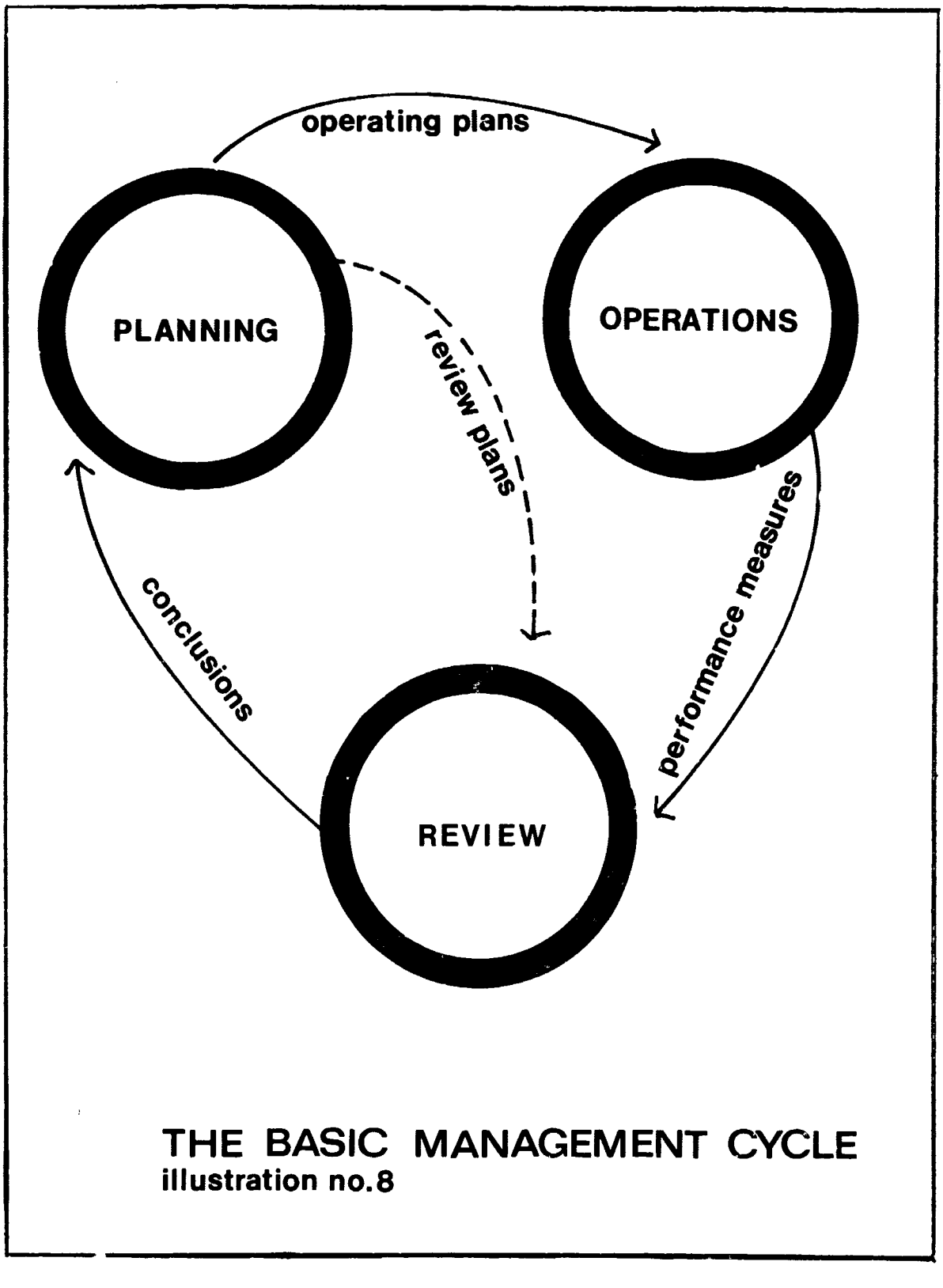
The process of managing is a cyclical one. It parallels the "cycle of learning" which strikes the authors as a fact of major practical significance because it is through learning that innovation acquires a firmer foundation.

The three most basic parts of the executive task (see Illustration 8) are

* 1. Planning
* 2. Direction of Operations
* 3. Review.

"Planning" looks ahead. It formulates goals. It determines (alternate) courses of action to reach these objectives, to monitor performance, to collect and analyze all pertinent information. Planning sets up the organization required to carry out the firm's activities. It develops criteria of action, performance and results, progress reporting and evaluation. In short, Planning includes the sum total of all the advance preparations necessary for effective work. It determines what should happen.

"Direction of Operations" is the area of action. It is here that the plans are executed; that results of every shade appear -- progress, retrogression or stagnation; that goods, ideas and money move; that men and machines produce tangible and intangible output. It is here that the purposes for which the enterprise was set up are attained. Decisions on alternate plans are made; communications take place, with their economic and managerial, social and psychological (as well as pathological, medical and still other) aspects; work is supervised; the myriad relations are caused between the manager-in-charge and each of his subordinates, with his crew in part and in full, and with others within and outside the organization.



THE BASIC MANAGEMENT CYCLE
illustration no.8

"Review" looks back. It provides the opportunity for observing what is taking place and for analyzing the results. It thinks about operations and the lessons they contain; collects pertinent information on internal activities and external influences; analyzes it to elicit its meaning in terms of conclusions which will affect future plans.

The literature abounds with discussions of the process of management. In some cases the constituent parts carry different names. The model, which forms the basis of this report, agrees with all the more authoritative varieties although our terminology is somewhat simplified.

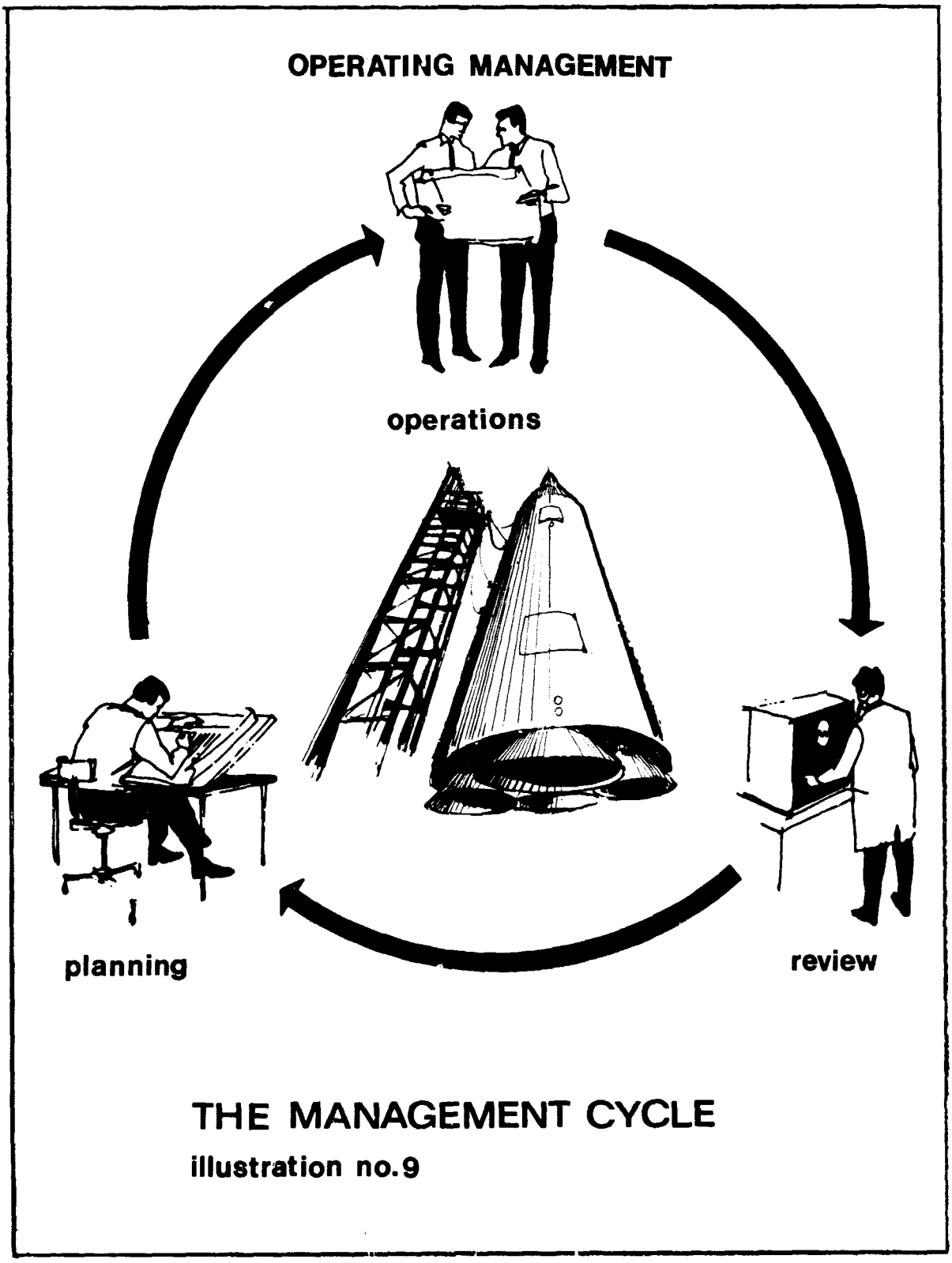
Management is a continuing (cyclical) process. This provides opportunities for a conscious and conscientious build-up of experience through the systematic observation of results and their feed-back into future plans. The model we use here, portrays management in action, i.e., in its dynamic aspects. It opens up all the advantages of systems analysis to the process and problems of management. Utilizing this systems approach one step further, the planning-operations-review cycle does not merely apply to the task of managing (and many, if not all human activity). It is equally valid for each of the parts of the executive task. For example, planning is done in the same three-part-sequence, i.e., it is first planned, then executed and finally reviewed; so are "operations" and "review." The management cycle has the same relation to its planning, operations and review epi-cycles as a system has to its subsystems.

Management Research and Development

Illustration 9 shows the most basic form of the management cycle in its three most fundamental tasks and therefore in its most simplified version. Illustration 10 represents the first possible extension of tasks by adding Management Research and Development.

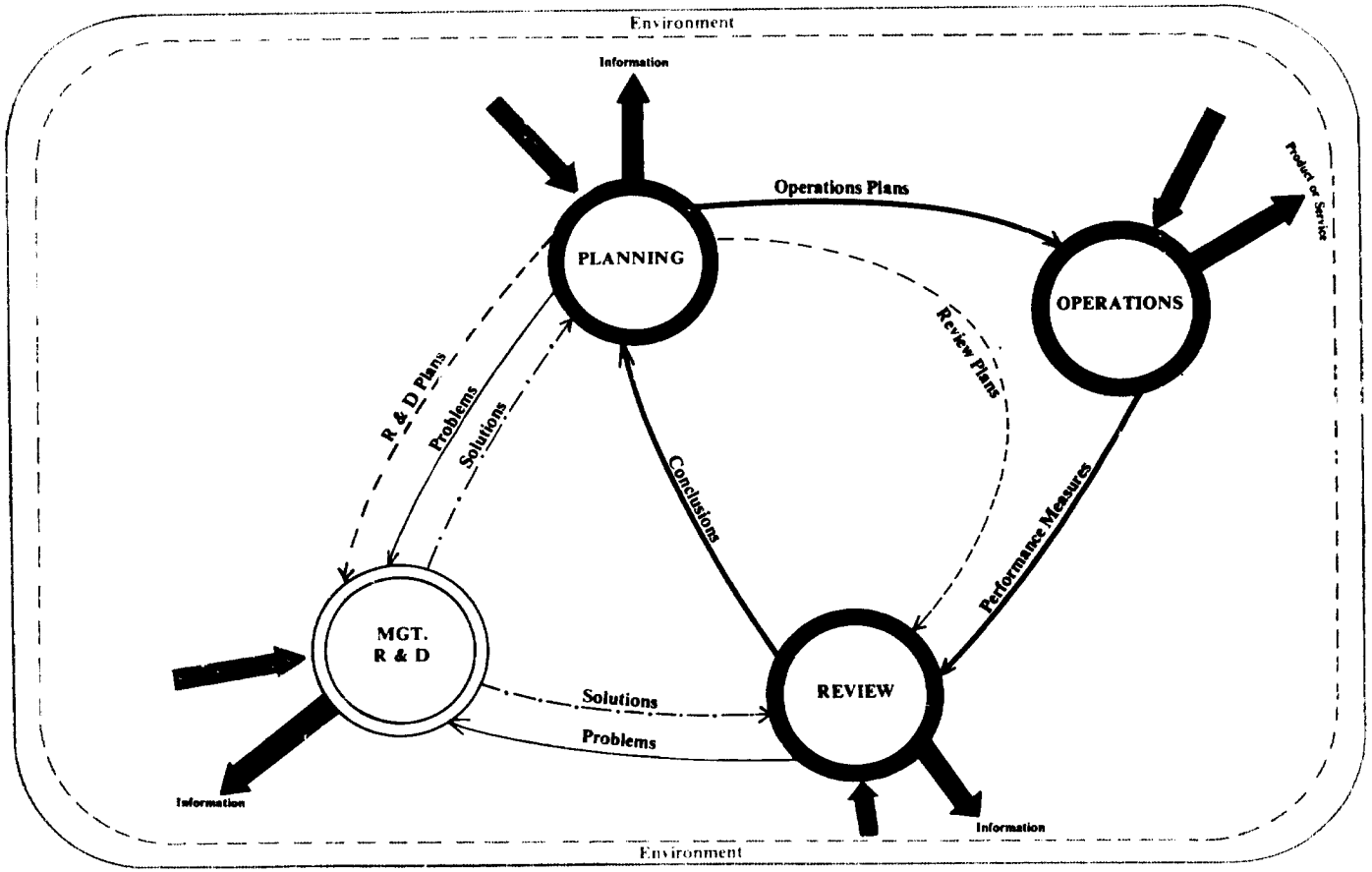
Problems appear in every phase of managerial work. In some instances they can be solved within the normal planning-operations-review cycle. In others this would be either impractical or impossible, too time-consuming or too costly.

Unresolved matters readily accumulate, especially when they have predominantly unfavorable consequences. A wait-and-see attitude makes their ultimate conquest progressively more difficult. The answer lies in the management R & D area. Its two main contributions are:



THE MANAGEMENT CYCLE

illustration no.9



THE PROCESS OF MANAGEMENT

illustration no. 10

INFORMATION FLOW THROUGH
- Main Loop
- Planning Input to Review and R & D
- Planning or Review Problems to R & D
- R & D Solutions to Planning or Review

RESOURCES

OUTPUT

. . the processing of existing and the procurement of additional information

. . investigation, study and, if possible, solution of existing or future management problems.

The discussion of desirable information for management, under "review" (Chapter 7) outlines the scope for the first of these two tasks of management R & D. The second could be performed for two different purposes. The objective might be, first, the solution of operating difficulties or the attempt to improve managerial performance. This represents the vast majority of current management "research" projects. It is in essence a straight "development" task.

We really get into the "research" sector when the purpose becomes, secondly, to increase management knowledge. Very little basic research has been done so far in the field of management. The picture is somewhat more encouraging in contributory areas such as

* economic research
* behavioral science research
* operations research
* management science research.

The repertory of the management researcher comprises statistical, mathematical and computational techniques. It contains also the methodologies of the disciplines cited in the preceding paragraph as well as of others, to the extent that potential benefits (in terms of further knowledge about management) might be obtained.

The organizational location of the management R & D function depends upon the basic organization. For example, in a heavily centralized arrangement, management R & D is likely to report at a very high level, possibly directly to the President. In more decentralized operations, management R & D areas are likely to be strewn across the crucial areas of managerial responsibility at top and middle as well as, progressively more, supervisory levels.

Regardless of where the management R & D function is organizationally situated, it can render service to the executive in any area of his responsibilities. It could assist in

* long-range and other planning aspects
* organizational strategy
* decision-making, problem-solving, communications and other supervisory tasks which arise in the direction of operations

* measurement and analytical problems
* and indeed in advancing the management R & D sector itself.

When what is sufficiently good today becomes inadequate tomorrow, Research and Development often provide the clues or solutions for improvements or innovation. This is widely accepted with regard to products. R & D serve equally well when the problem is improvement or innovation in management.

Thus one of our recommendations is the consideration by engineering management of the advisability of an expanded Management R & D capability. The proper first step would be the strengthening of the ability to solve present or potential problem areas. This might be especially worthwhile if there were reason for engineering supervisors and executives to believe that perhaps just occasional difficulties may exist, or could develop, in regard to matters such as

* communications upward, downward and crosswise
* readiness to assume responsibility
* organizational arrangement of work groups
* relationships between different but complementary sectors of scientific and engineering work (such as analytical and design engineering)
* criteria for employment of professional personnel
* manpower skill inventories
* performance appraisals
* development of (scientific, engineering and managerial) personnel
* specific aspects of company climate which deserve further development
* and, readily, dozens of other considerations which have shown themselves as sources for potentially significant advances in many a company.

General and Engineering Management

The executive whose responsibility extends over a variety of major areas (say research, engineering, manufacturing and customer liaison) is considered to exercise "general" management. Conversely, the executive whose realm covers only one major function is usually regarded as a "functional" manager. The Chief Engineer, Vice-President of Engineering, the Manager of Analysis or the Director of Research are examples of functional managers.

All points made about management in these pages apply to general as well as to functional management. They are valid with regard to all executive levels in the organization hierarchy. The main difference between the two areas of executive responsibility just cited is the portion of the total scope of company activity involved in each case. Thus all comments on management which are not specifically identified as applicable to engineering management, are nevertheless just as significant for that particular functional sector as those especially labelled that way.

Chapter 5 – THE MANAGEMENT OF ENGINEERS: PLANNING

How Management Plans

Planning determines what should happen in an enterprise. It encompasses all possible preparations for the future. It matches the company's capabilities (which is a variable) with the opportunities in its environment (another variable). It resolves when each of these becomes the dependent or the independent variable. Its scope is the full range of executive responsibility, i.e., operations, review as well as planning itself.

Planning gets the firm, or any part of it, ready to do the right things and to do them right. In two inter-weaving steps (see Illustration 11),

. . 1. it establishes goals; this includes the formulation of objectives as well as long- and short-term planning

. . 2. it designs the best possible approach to these goals: this involves organizational policy-procedural planning.

Its greatest challenge is to balance tradition and innovation. Tradition is proven in its v .. has shown itself to be fundamentally sound. It is familiar, customary. Its sameness provides security and stability but also the possibility of slipping into a rut.

In contrast, innovation (please refer also to Chapter 10) is something new, something different, unproven and unfamiliar. Quite often it represents a leap forward for society which may, in total or in part, not be ready for such a step. Innovation provides opportunities and risks. Above all, however, it opens the portals wide for progress. The pace of technological progress has accelerated in our lifetime as never before in history. Yet technology, like any other body of potential energy, must be used before it can be effective. The task of utilizing it (as well as any other necessary asset) is that of management.

More systematic attention to basic research could multiply results in the years and decades ahead. Existing barriers have already been pushed back by the fund of knowledge mined through NASA projects. An expansion of the efforts and potentially of the scope of that Agency could

Planning					
Step		Tasks	Type	Theme	Answers Question
1	a	Formulate objectives	Objectives	Goal – Purpose Meaning – Significance	what? why?
	b	Determine long-range and short-term course of action needed to reach the objectives, monitor performance, collect and analyze all pertinent information	Long-Range and Short-Term Planning (including Operating Programs)	Specific Action	what? where? when?
2		Design best possible approach to these goals			
	a	Set up organization to carry out required activities	Organizational Planning	Responsibility	who?
	b	Develop criteria of action, performance and results, progress reporting and evaluation	Policy and Procedural Planning (incl. Policies Methods Procedures Systems)	Best way	how?
			Standards Schedules Budgets	Expected Results Time Table Funds	how much?

Illustration 11: A Two-Step Approach to Planning

significantly accelerate these developments, with benefits again spilling over from aerospace into many other fields of endeavor. In conjunction with research carried on elsewhere, it could make opportunities for the future virtually unlimited.

The importance of innovation has perhaps been best expressed when Mr. P. Haggerty, Chairman of the Board, Texas Instruments, Inc., modified Schumpeter's famous theorem by stating that "profitability above the bare fee for the use of assets results only from the advantage of innovation. It disappears as soon as innovation becomes routine."

Mr. Haggerty went on to emphasize that innovation is by no means limited to the area of research. Equally important is innovation in manufacturing, marketing and in most, if not all, other areas of activity of a modern corporation. A growing number of authorities believes that a company with insufficient attention to innovation is headed for potentially severe penalties. They might appear in the form of a shrinking market, of outright threats to continued existence or of many other serious effects. Balance between tradition and innovation is planning's most important task. And balance between individual and organizational goals is its most complex goal. Attaining equilibrium on both fronts affects planning from the very outset, that is, it begins with the formulation of objectives.

Objectives

The pages on motivation (Chapter 3) consider, among other items, the action-reaction (stimulus-response) sequence that relates individual needs to objectives. People's motives determine the goals they go after. This, in turn, influences behavior and performance of their job. This is why many, especially creative people, cherish getting involved more deeply in the formulation of work objectives and then in more and more of the other aspects of corporate planning. To do this effectively, they need to be familiar with the way their group's work is planned and with the manner in which company-wide planning goes on.

The individual has to be involved meaningfully in the organizational goal-setting process because that reinforces the need-to-achieve. Having had a hand in setting objectives and knowing why he is after them, he makes an extra effort to accomplish them: Their attainment brings fulfillment of his own ambitions ("goal-connecting," see also Chapter 3).

Objectives reflect the philosophy of the enterprise most tangibly. They need to be formulated for the company-as-a-whole, for each of its parts, or projects and – some believe – for every task of importance. They have a dual character. First they predetermine the aims, the goals which we wish to pursue. They need to answer these questions: "What are we after?" "what is our purpose?" "what is our raison d'être?" This sets forth the values and conditions which will be attained when these ends will have been reached.

Corporate objectives thus may express the firm's profit goals in comparison to those of other firms in the industry. They may spell out the resolve "to remain a leader in research" or many other ends and purposes. It is a rare exception when the objectives of even the smallest group could be stated in one single goal. There is usually a well-rounded complex of targets. "Profitable operation" is one of them. It is not the only one that has to be met. Customer satisfaction, development of individuals, advances in organizational capability are merely three out of a potential plethora of additional aims which need to be pinpointed.

Most objectives of the more advanced firms fulfill their first task quite well, i.e., the designation of goals and purposes. This is generally not the case with regard to their second mission: Objectives should also contain an explanation of why these aims, conditions and values are proper and desirable. This clarifies their significance or meaning.

It is in this area that engineering management can find special opportunities to use its inventiveness in the development of decidedly more meaningful or more clearly thought-through statements. As a by-product, their formulation could constitute a big step toward the involvement of creative individuals in these work goals by ascertaining that the latter reinforce or trigger interest in the tasks involved.

Illustration 12 reproduces an example of the objectives of the Research Division of a well-known aerospace company. It would be difficult for a dedicated person to be indifferent to the last two points even if the first one should leave him cool.

Purposes

To aim, with reasonable probability for success, at generating effective, industrial technology, which represents

- . . a dominating force in the scientific and engineering community or
- . . an activity which the company has to be aware of, and understand (f.i., a technology which is not unique to our industry, but common to several) or
- . . a listening post through which the company learns what is going on in the scientific community-at-large.

Significance

To underpin developments of new products, new product ideas and ideas for product improvements so as to be better able to

- . . sustain company operations and insure its technical future
- . . make an impact on the firm's technical personnel
- . . maintain an eminent position within the scientific community.

Illustration 12: Objectives of a Research Division

A realistic appreciation of the kind of business we are or would like to be in, is one of the most basic considerations that should underlie the formulation of corporate objectives. Many difficulties in quite a few railroad companies today stem from their view that their objective was the provision of r a i l r o a d service. As the favorable position of most leaders in this sector of the economy clearly shows, those firms who saw as their goal the provision of t r a n s p o r t a t i o n (rather than merely of railroad) services, are far ahead of their competitors. One of the most demanding of all top management activities thus becomes the continuous process of decisions about the nature of their company.

It is the "market," if this term is used in its widest possible sense, which exercises the most exacting influence. Illustration 13[1] recaps twenty selected key features of the market which includes NASA's purchases of major aerospace items, and compares them with their counterparts in markets with non-government customers who buy non-aeropsace products. The right-hand column of the illustration does not distinguish either between types of customers (business, consumers, export, etc.) or the wide variety of products (such as durables, non-durables). This simplification appeared justified since the comparisons are meant for illustrative purposes only.

Markets differ because of the customer (items 1.1 to 1.4 in illustration 13) and the product (items 2.1 to 2.6) they involve as well as the distribution system between the two (items 3.1 to 3.10). They exist not merely in the two forms which this illustration shows, or in three or ten shapes. There are so many that they could be viewed as a continuum. At one end, there are the millions of customers of "consumer" goods (toothpaste, food, etc.) in which the features of the product and the service reputation of the manufacturer establish the corporation's position. NASA is at the other end of the spectrum at which the nature and character of the product are such as to assign the decisive role to the company's capability for technological developments. This capability varies with the customer's demands which, in turn, are influenced by the needs of the end product.[2]

Managers of any business are continually faced with decisions on what the main strengths of their firm should be in the light of the demands of the market(s) they wish to serve. For example, consumer goods generally require distinct marketing ability; the aerospace contractor's capability has to be the development of technology. In any event, further analysis i.e., review and planning, are needed to recognize the specifics of the necessary competence in realistic fashion.

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1. The authors acknowledge the valuable assistance of Drs. Arnold Corbin and Harold W. McDowell, of the Graduate School of Business Administration, New York University, in the formulation of this illustration. They wish to express their thanks to Dr. Herman E. Krooss, of the same institution, for his helpful comments upon the conclusions on the next several pages.

2. It is possible that this capability which exists or has been established in order to develop (and make) one system with quite specific performance and other characteristics, could perform in some cases also on behalf of another with somewhat different specifications and perhaps even mission.

	Markets	NASA Purchases of Major Aerospace Systems	Non-Government Customers buying Non-Aerospace Products(*)
1.0	Customer		
1.1	demand	one, or at most, a few customers; a complex composite of many views by (geographically dispersed) prime contractors, other companies and government agencies, not easily reconciled on product requirements	a few millions of individual customers; generally each with his own views and requirements
1.1			
1.2	changes	subject to sudden changes	fewer or similar changes
1.3	influences	varying (including political, economic, domestic and international (U.S. foreign policy and still other) factors	mainly economic factors and impact from marketing appeals
1.4	relations with company	involves few "company representatives" but also a large number of other personnel in company activities other than marketing; scientists and engineers play major role	fewer if any company personnel outside marketing; scientists and engineers play (usually much) lesser or no role
2.0	Product		
2.1	nature	original, highly complex systems	varying but generally (much) simpler
2.2	technology involved	highly sophisticated	varying from minor to high
2.3	development of product and its requirements functions	long lead time; requirements specified by customer deep customer involvement in research, design and manufacturing phases	varying but usually shorter lead time; based on composite of customer requirements or company's analysis of what it perceives as market needs; active customer involvement only occasionally
2.4	performance	highest reliability, safety and overall quality specs; more limited life time; price is important but secondary	(much) lower reliability, safety and overall quality requirements; longer life time; price is often decisive
2.5	life cycle	short	generally (much) longer although comparable for fashion goods
2.6	obsolescence	rapid because of advances in technology in U.S. or abroad	(much) slower although obsolescence can be accelerated by more frequent model changes

(Continued on Page 80)

(*) This column does not differentiate between types of customers and goods; please refer to text for further comments.

Illustration 13: Comparison of Twenty Selected Market Features

	Markets	NASA Purchases of Major Aerospace Systems	Non-Government Customers buying Non-Aerospace Products(*)
3.0	Distribution		
3.1	introduction of product	little flexibility because long-term period involved; no special problems of introduction because product is "custom-made"	(much) more flexibility because (much) shorter time spans are involved; frequently considerable effort is needed to effect customer acceptance
3.2	delivery period	usually long	at times negotiated; more often affected by competitive pressures
3.3	price of product	negotiated or through competitive bidding; company (financial) records available to customer	mainly through open market; less through bidding, negotiation or administered prices; not available
3.4	credit	not important	often very important; frequently provided by other companies; also growing opportunities for leasing arrangements
3.5	terms	contract established by customer; negotiated; R&D facilities & equipment needed are usually financed by customer	contract usually established by supplier; negotiated, set by industry custom or individual supplier; rarely, if ever
3.6	promotion	no product promotion; some institutional advertising	much heavier promotion and advertising; often great emphasis on merchandising
3.7	service	by customer	at times by manufacturer, more often by outside companies, rarely by customer; in many cases, not applicable
3.8	company inventory of product and spare parts	no product inventory; parts inventory is small in quantity but very wide in parts covered; speedy delivery needed and available	(large) product inventory, often stretching over complex distribution system pipeline; parts inventory less certain and less long available; delivery time is generally slower
3.9	distribution system	direct to customer	some direct to customer; often quite extensive with (several, often independent) middlemen; long-range trend to systems selling may bring changes
3.10	competition	focussed; competitive product or parts rarely if ever available; little flexibility after contract award; contract represents long-term commitment	generally (much) more diverse; product substitutes readily available, often also from international sources

(*) This column does not differentiate between types of customers and goods; please refer to text for further comments.

Illustration 13: Comparison of Twenty Selected Market Features (Continued)

Should the company be "a leader in providing scientific, engineering, managerial and other competence for turnkey jobs, from conception to delivery of the finished product, on complex satellite systems," or should it build up "research, design, manufacturing or some other (specific) ability."

These questions are typical of those which confront engineering management of current and future NASA contractors just as much as their organization's top management. This is so because it is scientific and engineering (as well as systems management) capability which enables the enterprise to offer NASA attractive opportunities.

The nature of a firm's business and its corresponding strengths affect the relationship of engineering planning on the one hand and of other functional (especially marketing) and corporate planning on the other. In the vast majority of instances, marketing considerations give rise to engineering activities and thus engineering planning. While a dichotomy disregards the continuum character of the markets and simplifies matters too much, it is mostly the other way around in the aerospace industry. Here scientific and engineering capability is the trigger for the planning elsewhere in the company although the former remains subordinate to basic long-range objectives of the firm. A NASA contractor's planning base is technological planning.

Long-Range and Short-Term Planning

Once objectives are set, long-range and short-term planning are needed to implement them. Both spell out action. Long-range plans propose a general course to attain the company's objectives. They outline the action needed to reach long-range goals. They reflect management's examination of long-range potential and problems in pursuit of the enterprise's goals, and of opportunities and obstacles on the road to their fulfillment.

Incorporating conclusions from examinations of the basic factors and crucial questions which confront the organization as it embarks upon making its objectives a reality, long-range planning does not yet physically commit resources but guides the direction of this commitment. Progressive companies seem to agree that its needs cover only major, not all, activities.

Often considered to represent (or require) a full-fledged business strategy, long-range plans are the link between the objectives (which, with occasional refinement or modification, normally guide the organization for several decades) and the month-by-month operating programs. Representing short-term planning, the latter fix immediate action, with specific goals, for all company activities. They fit current (usually next year's or the next twelve to eighteen months') operations in with the overall strategy. If long-range planning is viewed as strategy, then operating programs represent tactics.

Constituting a look through a magnifying glass at a smaller sector of the total picture, short-term plans implement long-range intentions. At the same time, they trigger the review and possible revision of strategy just as strategic changes can cause alterations in operating programs. Either is likely when there have been changes in assumptions or opportunities, capability or when other events have taken place since the long-range plans were drawn up or studied last.

Four conclusions from successful aerospace practice deserve engineering management's special consideration:

- . . Operating programs spell out the general course of action not merely to reach short-term goals. They should also lay down what is required to monitor developments; to record and report progress; to analyze and evaluate these findings; and to carry out their own planning tasks.
- . . Alternative operating programs are often developed on the basis of several different approaches or assumptions. This is particularly useful when planning premises are liable to change quickly (as can be the case in the aerospace business) and when speedy reaction to the altered circumstances is needed.
- . . Short-term without, or out of context with, long range plans lack their single most potent support. A thorough look at the (existing?) linkage of short-term and long-range planning is therefore especially in order when a manager experiences unforeseen obstacles in following his programs.
- . . The efforts invested in planning have made some managements reluctant to contemplate changes. Whenever they should be, but are not made, operational difficulties are certain. In many cases, firms who were guided by obsolete programs, were worse off than those who had none at all.

A variance in this approach to effective planning discussed so far, has been successfully used at Texas Instruments, Inc. It was described to us as follows:

> "Objectives are formal statements of ten-year goals for business areas such as materials, exploration, electronic components or for intra-company 'staff' functions such as person-

nel or facilities. These objectives are pursued through one or more supporting strategies (f.i., for the evolution of integrated circuits); in turn, the latter are implemented through detailed 12 to 18 months' tactical-action programs or TAPs in the areas of R&D, manufacturing and marketing."

TI refers to this complex of planning activity as its "OST system" (objectives, strategy, tactics). We were told that, for example, "personnel supports a strategy for locating and developing the company's managerial talent," TAPs supporting this strategy could include

* development of a personnel information retrieval system
* identification of criteria and predictors of managerial effectiveness
* refinement of performance measurements, individual merit compensation procedures, and so on.

A strategy manager is in charge of one strategy, a TAP manager is responsible for one or several related tactical-action programs.

Perhaps the most significant part of the OST system is that any individual who suggests, to his supervisor or if need be to higher management, projects or activities of potential usefulness is likely to be designated the strategy or TAP manager for his very idea. This arrangement makes it possible, while remaining an employee, to be set up in one's own business on behalf of one's own notion, without the risks of entrepreneurship. On top of this he is backed up by all the resources necessary for the project as they are available in a large company.

Naturally this situation involves the man deeply in his work. Texas Instruments is pleased with the increasing calibre of the results which men have produced under this arrangement for the company. Here we have one exemplary way in which the theory of motivation (and other research findings) is being used to make the work of people, especially of creative personnel and specifically of scientists and engineers, more effective for the business and more satisfying for the individuals involved.

Organizational Planning

The first of the two intertwined steps of planning sets goals. As just described briefly in terms of conclusions which are of interest to engineering management, it firms up what we wish to do, why, where and when. The second step adds answers to the questions of how the work should

best be performed and who does it. The last named is the domain of organizational planning. Put in abbreviated form, it establishes who is to do what. It puts specific people to work on specified tasks. It sets up the organization to carry out the activities required by the long-range and short-term plans.

It is a field that has benefitted substantially from the findings of behavioral science research in areas other than motivation (to which this report had to confine itself).

The spotlight is on relationships because the success of an individual's work is dependent on meaningful cooperation with (many) others. For example, interaction between analytical engineers, on the one hand, and hardware engineers as well as research personnel, on the other, is not always easily possible. This is so, at least in some cases, because their respective roles are still evolving. However more careful organizational arrangements can remove some of the existing barriers in a number of instances.

Toward that end, organizational planning should

- . . facilitate the accomplishment of enterprise objectives through the design of the most appropriate network of communication channels
- . . provide the individuals with opportunities for necessary, constructive relationships
- . . give each person the opportunity to perform as best as possible in the interest of the organization-as-a-whole and to reach his own aspirations through his work as far as possible.

The one consideration of overriding importance for the points under discussion is Communication. To enable each work group to be effective, competent organizational planning gives special consideration to a minimum of three areas of particular concern in communication, namely:

- . . provision of effective (formal, but not necessarily stuffy) channels of communication; they need to reach into every nook and corner of the organization; they have to encompass internal and pertinent external events; and they have to form an integrated communication network (see also Chapter 7)
- . . minimizing "filters" in this network which would impede information flow horizontally and vertically in the enterprise
- . . arrangement of the organizational design so that informal communication will neither be hampered nor distorted unnecessarily.

The pages which follow comment upon a few key problems of communication and other aspects of organizational planning by discussing, first, "traditional" and then newer forms of organizing team work.

"Traditional" Organizations

"Going through channels" has been such a frequent admonition in most "traditional" organizations that it is often regarded as typical of this type of construction. Yet it is much more characteristic of an impersonal, perhaps even an authoritarian atmosphere than of the structure itself. While size tends to promote "steep" organizations (i.e., more levels in the management hierarchy, with possibly fewer subordinates for each supervisor), this need not be the best solution. In contrast, a "flat" design has fewer levels but generally a larger crew per manager. Because of the number of people who have to be covered, horizontal communications are harder in such a setup; but the vertical ones are easier to establish and to maintain.

Although it is not yet done in too many firms, it is entirely possible to combine the communication advantages of both types of structure. It is accomplished by choosing a flat organization (which assures shorter lines upward and downward) and by reducing the size of each executive's "span of control" (which facilitates interaction within each group). This requires more supervisors; but it also provides more opportunities for more meaningful contacts.

The size of an organization is at the bottom of another communications problem. In order to meet the vast and diversified demands, business is following more and more an already existing trend of large-scale organizations. Decades earlier, business had created large organizations in order to cope with the opportunities of technology. By their very existence they have been generating new problems of their own.

One solution to counter the difficulties which stem from the variability, the instability and the unpredictability of human behavior, has been the attempt to formalize and institutionalize many work aspects in the large-scale organization. It exists of course not merely on the business scene but in the field of political, the military, educational and in many other segments of our society.

In his classic observations on large-scale organizations, Max Weber proposes that it, and it alone, can assure maximum organizational efficiency. Toward that end he proposes.

. . 1. An administrative hierarchy, with each lower level strictly accountable to the next higher one, and each office staffed by a specialist.

. . 2. An atmosphere of impersonality (responsibilities and authority reside in the office not in its holder, according to Weber).

. . 3. Stress on rationality. The hierarchy is governed by generally applicable rules which

preclude the need for specific instructions in each specific case. These rules assure stability. They have to be learned thoroughly and applied faithfully. They are intended also as constraints on individual decisions and actions. They compel people to behave in a more readily predictable fashion.

Some of the more fundamental consequences seemingly inevitable in such structures were summarized by Warren Bennis in his much-discussed paper entitled, "Evolutionary Trends in Organizational Development." Compressing his findings, we quote ten of his main points:

. . 1. "Large-scale organizations do not adequately allow for personal growth and for the development of mature personalities.

. . 2. "They develop conformity and 'group-think.'

. . 3. "They do not take the 'informal organization' into account.

. . 4. "The systems of control and authority are outdated.

. . 5. "There is no adequate juridicial process.

. . 6. "They do not possess adequate means for resolving differences and conflicts.

. . 7. "Communication (including innovative ideas) are thwarted or distorted.

. . 8. "Because of mistrust, fear of reprisals and other reasons, the full human resources in such an organization are not likely to be utilized.

. . 9. "They modify the personality of the individual so that he becomes the dull, grey, conditioned 'organization man.'

. . 10. "They cannot assimilate the influx of new technology."

The authors go along with the proposition that the basic points cited are likely to prevail in a large organization (this does not necessarily indicate agreement with other statements from the same source). However, we believe that it is not the organizational arrangement but usually the working climate that hampers creativity (although climate is influenced by the organizational structure). Observations on the climate occur in every chapter of this report because of the overriding influence of the subject. Potential improvements in organizational design are discussed in the comments under the next heading "Organizing for Team Work."

The great variety of demands on scientists, engineers and other technical personnel has spawned a variety of organizational arrangements in the practice of industry in general and of the aerospace sector in particular. It is an oversimplification when we attempt to compare them on the basis of just three categories. One research report which has enjoyed particular attention by progressive management, has done just this. We are not aware of any other and similarly compre-

hensive investigation although our search has unearthed a veritable plethora of piece-meal studies, often with contradictory findings.

In order to include the findings of the Stanley-White research, see Illustration 14,[3] we briefly recap its delineation of the three groupings used there:

. . 1. Subject/Discipline:
This brings together all the specialists in one subject area, for instance Hydraulics. This pattern has proved itself especially where needed investigations fall neatly into one field. It is favorable for multidisciplinary work only when its scope can be realistically divided into parts which can be effectively studied within the confines of one of the constituent branches of knowledge. As a rule, this organizational form is used when emphasis is on research.

. . 2. Product:
Where development needs predominate and a cross section of different specialists is required on behalf of one product, personnel from all the disciplines involved is brought together. For example, work on fuel cells may require experts in special branches of metals, plastics, chemistry and physics. The "product" type of organization has proved itself where the product is not too complex.

. . 3. Problem/Project:
This third category is suitable for a more complicated system. It is characterized by the formation of temporary teams whose members' different know-how comes from the various fields of knowledge involved. The project (management) concept is on the borderline of "traditional" organizations which are discussed briefly in this part and more recent concepts which are scanned starting with the next paragraph.

Organizing for Teamwork

Too much structure as often featured in "traditional" organization design is disliked by many, especially by most, if not all, creative people. Research findings have shown time and again that less structured and more flexible arrangements are superior in cases where emphasis is, or should be, on the role and contribution of the individual.

Here are some of the more measured reactions we encountered:

> "My job description tells me to do some things which are outside the jurisdiction assigned to my section; it omits others without which I cannot work effectively."

3. Reprinted by permission of the publisher from AMA Research Study No. 72, Organizing the R & D Function, by A.O. Stanley and K. K. White.

SUBJECT	PRODUCT	PROBLEM	Effects	Key: F signifies "Fosters" H denotes "Hampers"
H	F	F	1.	Relating specific targets to broad R&D objectives and goals.
H	F	F	2.	Maintaining unity of leadership or command over all involved in project.
H	F	F	3.	Planning to reach specific project targets.
H	F	F	4.	Achieving teamwork on multidisciplinary problem.
H	F	F	5.	Maintaining concentration on main research target.
H	F	H	6(a).	Communicating appropriate product problems and instructions to each group or person.
F	H	H	6(b).	Communicating appropriate science problems and instructions to each group or person.
H	F	F	7.	Providing ability to shift approaches or steps as results develop.
F	H	H	8.	Rearranging manpower in order to start a new project.
F	H	H	9.	Maintaining satisfaction and low turnover of scientists and engineers.
H	F	F	10.	Maintaining momentum and vigor of thrust toward objectives.
H	F	F	11.	Avoiding preoccupation with short-term "fire-fighting" matters.
H	H	H	12.	Providing year-to-year continuity in the overall research approach.
H	F	F	13.	Controlling expenditures.
F	H	H	14.	Obtaining efficient utilization of physical facilities.
F	H	H	15.	Obtaining efficient utilization of equipment to avoid duplication.
H	F	F	16(a).	Securing project or product progress reports.
F	H	H	16(b).	Securing progress reports on scientific developments.
F	H	H	17.	Avoiding unintentional duplication of technical effort.
F	H	H	18.	Securing use of standard materials or parts.
F	H	H	19.	Increasing manpower to accelerate lagging work.
H	F	F	20.	Maintaining established schedules.
H	F	F	21.	Coordinating efforts on massive problems or long projects.
H	F	F	22.	Securing the right priorities for all necessary steps in project.
F	H	H	23.	Equalizing workload among persons on project.
F	H	H	24(a).	Bringing to bear the most advanced knowledge of one discipline.
H	F	F	24(b).	Bringing to bear the most advanced knowledge from several disciplines.
F	H	H	25.	Encouraging each man to keep up to date in his science or discipline.
H	F	F	26.	Communicating with specialists in needed disciplines.
H	F	F	27.	Encouraging each man to keep up to date on pertinent product knowledge.
H	F	F	28.	Obtaining interaction of ideas among disciplines.
H	F	F	29.	Aiding each man to keep up to date on findings in the overall project.
H	F	H	30(a).	Applying experience from related products or processes.
F	–	F	30(b).	Applying experience from related experimental designs.
F	H	H	31(a).	Maintaining development and upward mobility of individuals in sciences.
H	F	F	31(b).	Developing managers.
F	H	H	32.	Increasing the capability to attract and employ noted researchers.
F	H	H	33.	Achieving an advance or breakthrough in science.
H	F	F	34.	Translating new findings into commercially useful results or products.
H	F	F	35.	Protecting research results against theft.

Illustration 14: How Organization Affects Management Aims

"Sometimes I wonder if our beautiful organization chart serves any purpose other than to look nice and to impress visitors. Those who work here know it gums up the works."

"Stratification results in limited ability to be creative or to make decisions."

One solution that takes these facts of business life into consideration is the addition of an Administrative Engineer (or Engineering Administrator – a much more proper designation) to the departmental or project organization. His task is primarily that of taking care of all planning and of some review tasks, such as manpower, budget, schedules and similar responsibilities. The section chief, thus relieved of some of his work, has more time to devote to supervisory duties.

Views on the success of this arrangement differ. It has the obvious disadvantage of splitting, between two people, attention to managerial matters within a relatively smaller group. The manner in which both men work together becomes often the decisive influence on whether or not this setup is effective.

Another more widely used organizational arrangement is based on the concept of the Project Manager. It lays stress on the project in its totality, in preference to allowing possible dilution of the responsibility focus among the various functional areas involved.

Opinions and experiences about the project management arrangement vary, too. Here are three samples from the NASA-NYU survey:

". . each person works for two bosses – the one closest to his performance (the project leader) is not the one responsible for his merit review (the department manager)";

"a basic division of loyalty between the project (technical) and the department (administrative) has created in the employees a confusion as to purpose and goals";

"The double supervisor situation causes many . . . questions as to who has cognizance, the section or the project. Further, performance evaluation of the individual is in many instances compromised; the supervisor who makes the evaluation is not the one most knowledgeable about the man's activity."

NASA is not alone in finding the project manager idea operative at many of its contractors. There is more or less wider agreement on several points, to wit:

. . The project involved should be a one-time undertaking; it should represent a unique or unfamiliar picture to the organization. It should have clearly definable goals although it deals with a complex of many interdependent tasks

. . The merging into one hand – that of project manager – of all requisite responsibility and authority is facilitated. He can make trade-offs between tasks or components in attempts

to assure optimal total results for the system, without the burden of exclusive loyalty to one of its parts.

Future practice will undoubtedly bring new insights into the concept of project management and into possibilities of refining it further.

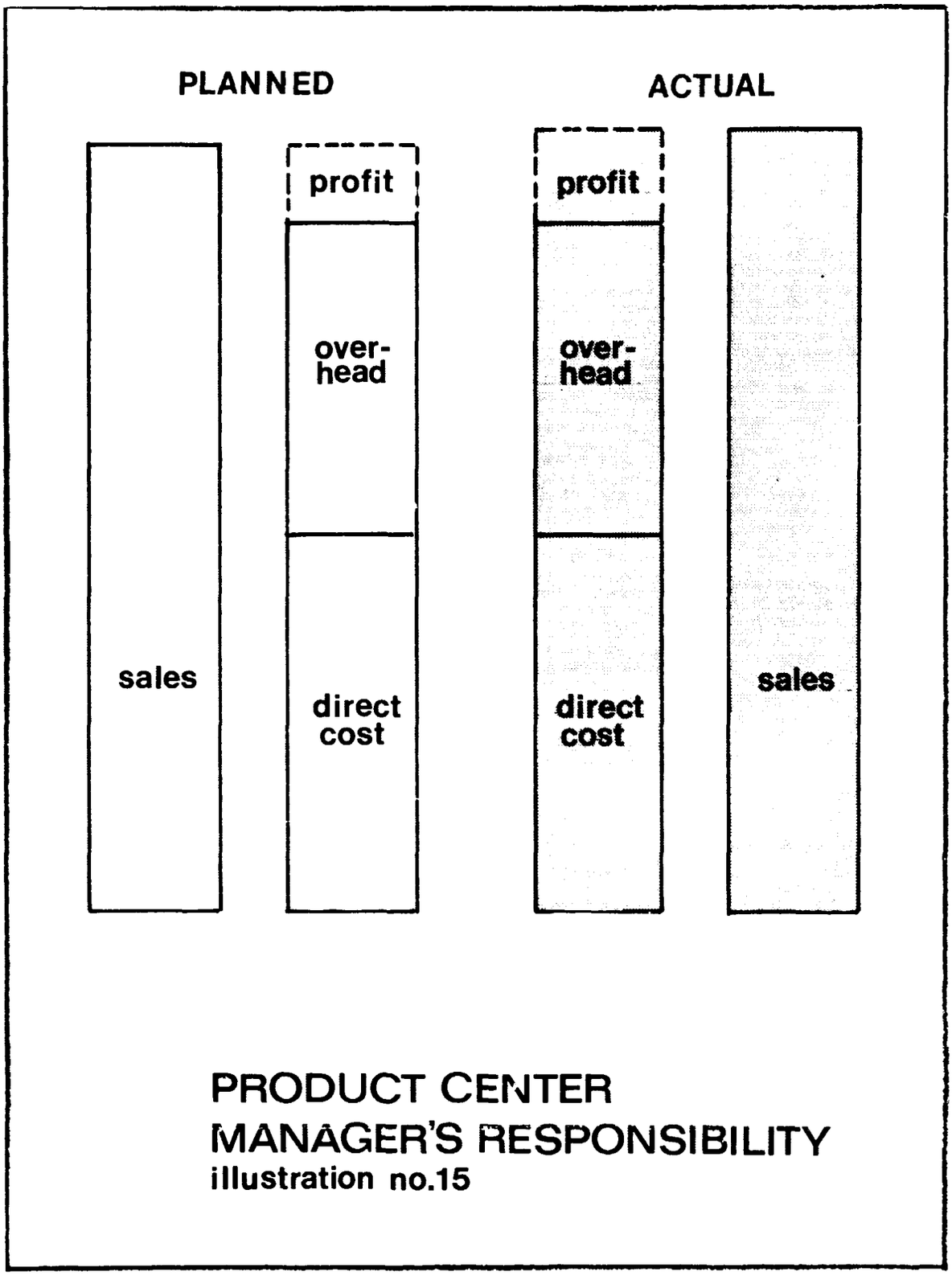
The OST system of Texas Instruments discussed earlier, needs to be mentioned also in this connection here. The strategy and TAP managers as well as their crews who are responsible for the work, also form a "project" group as a temporary overlay on the permanent company organization.

Another TI concept is the "Product-Customer Center." This involves the creation of one product manager for each of the various groups of products in a division. He is in charge of all functions necessary to create, make and sell his line, i.e., engineering, manufacturing, marketing and others which may be needed.

Some functions, such as R & D or accounting, may be set up at a higher, perhaps the division, level so that they can serve several product-customer centers if economic or other considerations make such an arrangement preferable to leaving these tasks with each of the centers. The product manager is responsible for the profit performance of his center on the basis of plans which were (1) developed by him and his associates, (2) coordinated by the division and (3) approved by top management (see Illustration 15).

These three arrangements – the Project Manager, OST and Product-Customer Centers – as well as all other useful means for organizing teamwork in a business setting known to us, are based on the concept of decentralization. This is a topic which has been discussed widely in the literature. There exist quite a few divergent opinions. We are advocating this organizational pattern as long as it signifies, strictly, the transfer of decision-making responsibility and authority from one ("central") spot at the summit to several self-sufficient lower levels.

In practice, this means, on the corporate level, the division of one large organization into several smaller autonomous and self-sufficient entities within the larger system. Each functions in the operational scope it has assumed, as an integral component of the total organization. Advantages and disadvantages are well documented in the literature. Thus we can safely limit ourselves to four comments:



PRODUCT CENTER
MANAGER'S RESPONSIBILITY
illustration no.15

. . The success of decentralization (and, for that matter, of any managerial set-up) depends upon the calibre of the executives and of the professional and other contributors whom each manages. Without any question, decentralization requires more competent managers.

With all the conviction we can muster, we suggest to aerospace management who consider decentralization to any major degree, to ascertain or to assure the availability of the required number of truly qualified executives b e f o r e the organization is changed.

"Decentralization" has taken place too often in the absence of a cadre of suitably equipped executives. This weakness has been compounded, not too infrequently, by insufficient orientation of managers and others in the organization to the opportunities, risks and problems of decentralized operations. The result has been loss of effectiveness, as a minimum; sometimes near-chaos and often recentralization.

. . There is ample evidence that enlarged opportunities for innovation is one of the many advantages of a decentralized arrangement.

. . There are many shades of decentralization. The term actually refers not to one specific extent but to a spectrum of possibilities. Even in the most widely decentralized design, however, there will remain some tasks which need to be retained at the headquarters level. We term them "corporate reserve responsibilities" because they deal with the organization-as-a-whole, such as

* stockholder relations
* (many) legal matters
* usually finance and credit
* company-wide planning
* and, depending upon the situation, other functions (such as potentially R & D, some aspects of labor relations, etc.)

. . A decentralized organization pattern can be applied profitably not merely to a major corporate division. While its design is more difficult, it is equally useful on a smaller scale. To take an extreme case, it is possible for just one group with a handful of people to operate on a decentralized basis within itself although all its neighbors in a company remain in a more centralized pattern. As a result, the supervisor is likely to find that his dealings with associates and superiors outside his group will become (much) more difficult while his relationships with his subordinates are improving, becoming easier and more effective.

It is therefore preferable that the degree of decentralization upon which management decides is reasonably uniform throughout each (or, as a minimum, most) major units of a corporation. When we visualize the impact which decentralization has upon climate, this stipulation becomes even more logical.

The key for the success of decentralization lies in its greatly increased personal involvement of a larger number of people. The discussions on motivation indicated the strong leverage which individual commitment has on achievement.

Philosophical considerations also underline the potential superiority of decentralization. Its essence is its climate, a true "contributory climate" (Chapter 10). Mr. Ralph J. Cordiner, retired Chairman of the Board, General Electric Company, phrased it this way:

> "Decentralization requires the realization that the natural aggregate of many individually sound decisions will be better for the business and for the public than centrally planned and controlled decisions."

The success of GE testifies with greater strength than any comments we could make, to the soundness of organizational planning in a decentralized pattern where the necessary managerial capability exists. The crux of the concept lies in the natural supremacy of multiple in the place of single judgment; of self discipline instead of imposed restraints; and of ready access to necessary and timely information. These are all hallmarks of a democratic society and of the contributory work climate such as these pages espouse as the single most crucial point in engineering management.

Dr. A. N. Sanford included the following comment in his presidential address at the annual meeting of the American Psychological Association in Washington, D.C., ten years ago:

> "Science flourishes under that type of democracy that accents freedom of opinions and dissent, in respect for the individual. It is against all forms of totalitarianism, of mechanization and regimentation. . . . Men have asked for freedom, justice and respect precisely as science has spread among them."

Decentralized organizational design represents a more refined way of managing and operating. It reflects evolution of society. If properly designed – a very big "if" – decentralization offers the most effective concept for improving teamwork and results through organizational arrangements.

Illustration 16 assembles some major points which successful executives told us they reflected upon b e f o r e deciding on decentralization. The same items can serve also those managers who h a v e a (somewhat) decentralized setup and wish to evaluate the way it really works.

BEFORE decentralization:

Are managers, engineers and scientists capable and ready to work in such a way . . . .

. . . . that . . .

AFTER decentralization:

What evidence exists . . . . . .

. . associates in decentralized positions have – or can develop – the competence to make sound decisions in the majority of cases and are willing to assume the personal responsibility involved?

. . higher executives recognize that authority genuinely delegated to lower echelons cannot, in fact, also be retained by them?

. . officer and managers do not believe in decentralization down to themselves but no further?

. . it is not just lip service which is paid to decentralization while work is reviewed in great detail by superiors who continually "second-guess" those who report to them, or withhold needed information?

. . initiative and creativity are encouraged in their own work and for team effort, outlets for self-expression are provided and participation fostered?

. . communications are adequate and reasonably devoid of vertical and horizontal roadblocks?

. . two-way exchange of ideas is frank and free?

. . there is effective interaction among employees in the company who need to consult or work with one another?

. . managers and their people are strongly committed to their work, their company and its philosophy as the result of individual and voluntary decision?

. . teamwork and team spirit exist and expand?

. . voluntary agreement and the rule of reason are emphasized rather than compromise, conformity or coercion?

. . there exists a "court of appeals" to which action may be referred, without fear of reprisals, when, in the firm conviction of the individual involved, his superior's decision works contrary to the company's best interests although this was indeed never intended?

. . accountability for results remains clearly with the person who accepted the responsibility for the work involved?

Illustration 16: Some key questions on Decentralization

The first four items were adapted from Mr. Cordiner's summary on decentralization in his lecture series and book New Frontiers for Professional Managers.[4] The authors owe a unique debt to Mr. Harold F. Smiddy, retired Vice President of General Electric Company. We have learned more about decentralization and its essential nature from his speeches and papers and through personal discussions than from all other sources combined.

Subject to availability of sufficient managerial competence, the essence of successful organizational design is a climate in which managers and their co-workers can and will improve necessary interaction as long as results are satisfactory. Especially when creativity and innovation are among the objectives, we need an arrangement that helps the uncommitted to commit themselves. To again quote Warren Bennis' previously mentioned paper:

> "The old, the learned, the powerful, the wealthy, those in authority – these are the ones who are committed. They have learned a pattern and have succeeded in it. But when change comes, it is often the uncommitted who can best take advantage of it."

The Marketing Function

Marketing is the prime mover of any company. Its task is to establish and maintain contact with the customer. In turn, it is the customer who holds the future of the firm in his hands. If he is satisfied with the product or services, he will channel further business to this corporation; if he is not, the competitor will be the gainer.

When NASA is the customer, marketing – or its equivalent by one of the many other names which are used – is possibly even more important. For many reasons, much more generally rides on one NASA contract than is the case with one order in other non-government business. For instance, the failure to land one key contract can make that firm fall behind in the development of technology while its competitor who became the NASA contractor, pushes ahead.

4. J.J. Servan-Schreiber credits in his book The American Challenge the various points in Mr. Cordiner's formulation of General Electric's philosophy of decentralization with the major influence which U.S. corporations are exercising in Europe in comparison to indigenous companies there.

The basic mission of the marketing function of a NASA supplier of aerospace systems[5] is pretty much the same as that of a company which serves non-governmental buyers of other products. But that is where the similarity stops. Differences are quite pronounced. To wit:

. . The scope of the work of the marketing people; the tasks involved; the approach to, and the cooperation with, the customer are markedly different. A mere listing of some samples of the tasks concerned illustrates this point when we visualize what each entails:

* market analysis (including collection of market "intelligence," early identification of potential business, etc.)

* marketing strategy (including trade-off of bid opportunities - in an atmosphere of special uncertainty: the company might not win enough business or it might find itself suddenly with too much; missionary sales; field support activities; etc.)

* home office support (including preparation of proposals; assignment of priorities in the compilation of such documents; special investigations, studies and research in support of bids; availability of company personnel in matters of science and technology, contract administration, budgets, planning, law, facilities, personnel, etc.); assistance in the development of specifications and in technical interaction during development; etc.)

* and finally the actual liaison between NASA and its contractor.

. . "Company representatives" should have the usual experience in the marketing field, i.e., they have to be familiar with the ways in which the customer prefers to conduct his business and the requirements which he wants to fill. This is a big order. But it is only the beginning. To be able to be of proper service to the Agency, the marketing people would need the same profound technical knowledge as their colleagues in scientific and engineering work back at the home office. It constitutes a second demand of such size that it cannot simply be added to the first.

This is why the marketing task has been shared, for some years now, between marketing and technical personnel. The former usually continue in their market analysis work and in being responsible for marketing strategy and for managing the relationship between the customer and the company. However the scientists and engineers have become the ones who (have to) make the major technical decisions, which gives them a dominant role in the relations with NASA.

It is obvious that this division of marketing responsibilities is somewhat unequal. Divita points out that. "While the marketing department is 'responsible' for marketing, it lacks the authority to carry out its responsibility . . . ; the engineering department, on the other hand, is not respon-

5. We are indebted to Mr. Sal F. Divita of IBM (Founder and Director, Defense and Government Marketing, American Marketing Association), for extraordinarily helpful comments and assistance in connection with these observations.

sible for marketing; but it appears to have assumed the sales responsibility and, perhaps, more of the marketing function than meets the eye."

Marketing is a part-time job for engineers and scientists. This is quite proper from their point of view because their primary mission is the performance of the contract as such. This represents another big order in its own right, one that makes it hard to assume the other two tremendous jobs mentioned earlier, namely relationships and technical discourses with the customer.

Divita advances an interesting solution; he proposes the concept of what he calls a "Capability Manager." His role would be that of a technically oriented business manager. He would manage the marketing capability of the project group (including market analysis, strategy, programs and so on, with all their manifold tasks). The company organizational pattern has to decide the precise location of this function. Divita suggests that the capability manager might best work on the same level as the key technical subordinates of the project manager. Such an arrangement would give the capability manager the opportunity

- . . to assure for a technically top notch proposal the added strength of a sound presentation
- . . to influence engineers and scientists to undertake the technological investigations which are needed to make, and then to keep, his area competitive in the years ahead
- . . to have a voice in the assignment of personnel after the proposal has become a contract; (this would hopefully reduce, f.i., the number of instances when the best people are called to solve a sudden crisis; while this generally solves the short-term problem, it too often inflicts damage upon the fire fighter's long-range work).

Divita's proposal would eliminate a central sales department. Although possibly caused by different reasoning, this conclusion is fully in line with our comments on the advantages of decentralization. In the case of the marketing function, such a set-up might conceivably be structured on the basis of market applications rather than on the technologies involved. Texas Instruments' product-customer centers are an example of this type of thinking, in the establishment, for instance, of one group for airborne and of another for ground-based communications. Because of the emphasis on objectives, such result-oriented arrangements have the added advantage, in comparison with function-oriented systems, of preventing means from becoming ends in themselves.

These (and other) organizational provisions lay special stress on the need for coordination between the various individuals and groups involved. Chapter 6 deals with this aspect further.

No one structural pattern serves the marketing responsibilities of all NASA contractors equally well. On the contrary, organizational design represents perhaps the area which has to be most sensitive to personal and personnel considerations. It must be custom-tailored to the needs of the situation and to the capacities of the people. This suggests also the desirability of reviewing the existing organization, whatever it may be, is reviewed periodically to see if it still fits the circumstances after some people have left, while others, with different abilities, have joined the firm.

Policy and Procedural Planning

Organizational planning constitutes the first of two parts in the second planning step, that of designing the best approach to the goals established. We have labelled the second part "Policy and Procedural Planning" because it outlines criteria of behavior or action, performance or results, progress reporting and evaluation. Some of the more frequently used tools are

* policies
* methods, procedures and systems
* standards
* schedules
* budgets.

All have the characteristic in common that they implement objectives in varying degree of detail. They testify to the feasibility of the organization's intentions. They continue the allocation of resources. Engineering management generally considers them important; and scientists and engineers talk about them a lot. All are widely discussed in the literature. This is why we take up just one point which applies to all of these techniques. It is the matter of participation in the establishment of these planning instruments. Often set by "staff" groups, they become the rules under which managers and their people work.

The availability of well-designed guides such as those cited, has many and weighty advantages. Capitalizing upon the experiences of the past, they record those which have proved themselves "best." They show how potential pitfalls can be overcome. They provide indicators, to the employee and his supervisor alike, on how he should be progressing, etc.

The strength of these planning tools is not infrequently diluted by disadvantages which stem from the approach used, not from the nature of the techniques involved. For instance, a work method that should be good for many people is likely to be based on averages. It is probable that it will be much more effective for some than for others. Individuals, who are to follow this method on the job, have different experiences and different working habits.

Insistence on uniform or standard operating procedures offers, at best, pitifully little incentive for motivation-seekers to improve methods, to exceed standards or to find better ways to do their work. When used indiscriminately, they can injure or immobilize inherent interest and imagination, intelligence and ingenuity.

Similar damage results when the salary administration system makes incentives available only in monetary form. While financial recognition is unquestionably important, other forms of appreciation are equally, perhaps more urgently, needed. This remains the case even after salaries have reached an appropriate or high magnitude for the job demands involved.

Depending upon the supervisor, these planning tools can remain or become maintenance factors, sources of dissatisfaction or, at most, of no satisfaction. He could, though, forge them into powerful motivators when he gives his people an opportunity to participate in (at least some parts of) the development of these guides.

Such involvement does not imply, for example, that the employees alone should be responsible for developing their individual methods or for setting their own standards. The supervisor must, of course, provide necessary assistance or see to it that it is furnished. Certain tools and techniques have to be available, such as methods analysis, work-simplification training, work measurement, process flow, quality control and other items. Moreover there are likely to be certain organizational constraints which the supervisor must explain. And last but indeed not least, the section chief has to be satisfied with the methods and standards; he needs to approve them, or, as a minimum, go along with them.

Many employees within the jurisdiction of every research and engineering executive (as well as indeed elsewhere) have jobs in which they could set some of these planning aids if they were helped to do so and if they understood the goals of their work in terms of the crucial parameters of success. As they express the extent to which operational, performance or other action

benchmarks must be reached, standards in particular can free engineers and scientists from some of the shackles they complain about so often so vigorously.

The practice seems to be increasing where supervisors discuss with their people such key points as

. . the objective of the project, investigation, study or whatever the task may be

. . anticipated results

. . time, budget and other limitations.

This takes place in necessary detail until there is a reasonably realistic consensus. Particulars on how to proceed are left to the individual. The manager remains close by to be able to guide or help if either is needed, and to judge performance.

To sum up this brief comment, we wish to report that greater success seems assured to the extent to which planning becomes more creative and more flexible. The more successful the manager is in enlisting individual knowledge and skills, interests and goals, the greater does the probability become that the work objectives are met more effectively for the company and more satisfyingly for the employees.

The best way to accomplish this is to increase those aspects of planning which the individual can develop himself as long as they still fit the larger picture. This reduces the instances of imposed provisions and rules. It simultaneously weakens resistance and mitigates hostility. It opens the doors to improvement and innovation. It fosters responsibility and growth. This approach also does away with the proverbial situation in which "planners make plans and managers make decisions, and never the twain shall meet" – or at least, not very often.

The Supervisor as a Planner

What can the manager do in the planning phases of his responsibility to apply the findings which this report endeavors to cover? Planning affords him the opportunity to set the stage for effective operations in the most profitable form when he puts into effect, unceasingly, management's (and life's) most basic axiom: The recognition of the individual as an individual. That is, he deals with each of his men according to that person's specific needs and ambitions, capacity and personality.

One formidable question has baffled the authors when it comes to putting this principle into practice. The evidence we have seen, suggests that a large majority of scientists and engineers work on "formatted" tasks. They do routinized work. In the main, if not exclusively, it involves problems whose solution requires not much more than a good handbook. It is only a small number who are truly creative. The limitations of this project did not make it possible for us to delve into this situation to the extent necessary for firm conclusions. This is why we cannot be certain if this situation is caused by the nature of the individuals involved or by experiences in their current or in previous positions. If it were the former, then some of the comments which follow, can apply, for the time being, primarily to the more imaginative individuals. However if the latter is the case, such a restriction would have to be dropped.

Universal applicability of the comments below would also be in order even if the "formatted engineers and scientists" were happy in their work in consequence of a naturally divined pattern rather than as the result of managerial or other action. However this would demand of their superiors an imagination and inventiveness as yet not witnessed too often. These supervisors would have to find ways and means by which to enliven pedestrian work with some of the excitement normally associated only with non-routine tasks.

To be an effective planner, the executive arranges for farthest-reaching delegation. He selects the best qualified and most interested men for the work that has to be done. In doing this, he tries to recognize his prejudices; he attempts to shield himself and his people against such bias when making assignments.

He gives every one of his people the opportunity to show what he can do on his own – to the extent that the man's experience and knowledge permit and that he is ready to apply them. This may include pertinent decisions about the employee's work and the operating methods which he, the engineer, prefers because of his natural style or abilities.

The supervisor sees merit in the ideas of others even when they are in conflict with his own until they are proven useless. A real leader of men, he knows that motivational forces are strongest when an individual is involved in his work. Thus the able department head makes certain that, as often as possible, each of his men realizes his potential or at least his picture of what he is or what he would like to be or to do – as long as all this benefits the organization too.

The progressive engineering manager does not merely delegate responsibility for doing a certain job but rather for clinching needed results. He increases the scope of each man's work in tune with that person's development. He attempts to strengthen in his people the sense of working for themselves.

He acquaints himself with the work of each of his men. But he does not attempt to top their technical know-how. If the supervisor's engineering knowledge, for instance, were greater than that of his crew, he might be misplaced in a managerial position. In many cases, the company would lose in such a situation a good engineer and gain a bad manager.

The supervisor of engineers and scientists – and of others as well – is discontent with the status quo. He is an opportunity-sleuth. He finds or creates opportunities, weighs their risks, analyzes the potential return from blazing new paths. He evaluates the advantages and disadvantages that he and his company would reap should they not venture forward. He balances short-term with long-range results.

He is a change-agent, perhaps the potentially most influential one in society because his resources are the material and human assets of his work group. He knows that change demands advance preparations (development of needed skills, for instance, for a new method of analysis; de-bugging of equipment; education of higher management echelons; an atmosphere of acceptance; etc.).

When new operations dominate the schedule, planning enables the department head to abolish that wasteful "first round of trial-and-error" in ever-increasing degree. Rather than rely on mistakes to provide clues for later improvement, he plans how to prevent such errors in the first place. He has pledged himself to find an ever-better way of getting work done because this adds another achievement to his record.

He is aware of the fact that planning affords opportunities for creative thinking to a wider extent than any other managerial task except research and development. He welcomes the intellectual challenge to study, in advance of actual operations, their potential, their problems and their consequences.

In harmony with each man's performance and capacity, competent managers enlarge opportunities for each of their men to participate purposefully in the planning of their own work. If they do

really well there, the supervisor will bring them in on planning the work of the group, and later on a still broader scope. He helps in the reciprocal adjustment of individual, group and organizational goals so that their pursuit becomes a matter of joint concern, of common interest and of mutual advantage.

Planning: Prelude to Operations

Finally, planning affects the company climate. Its major influences on the working atmosphere stems from the fact that the objectives, which are being formulated, transform the substance of management philosophy into tangible goals. A feature that should be common to all objectives is the dichotomy of management's concern with both economic and social aspects. The former stems from the need for profitable operations; the latter is caused by the fact that business is also a social system in which it is the people who bring success or failure.

Here are four examples of the effect which philosophy and climate have upon planning and vice versa:

. . 1. The recognition of the individual as an individ al. He is a citizen in his country but at times merely a subject in his company. In return for proper recognition, of course, the employee has the obligation to show through his performance that he deserves this status.

. . 2. The freedom of the company to separate itself from any person who does not want to fit himself into its work environment; just as such a man has the right not to be forced to conform.

. . 3. The opportunity to reconcile our technological potential with our social needs and to balance the desires of the group with the wishes and ambitions of each individual who helps form it.

. . 4. Continually to advance the frontiers of company technology so as to increase its capacity for leadership in and toward new projects.

. . 5. Above all, to mirror in its philosophy, that of the country in which it is located. Business, the most powerful sector of the United States economy, should lead the way in helping make more of the legitimate ambitions of all society a living reality. Management, business' spokesman and director, has the prerogative to plan company activities toward this goal.

Planning has been firmly established as one of the hallmarks of progressive management. Its key characteristics have been "law" and "order" long before this term had any political meaning.

In management, "Order" connotes harmony and continuity, systematic organization, the rule of reason and justice. "Law" implies that "the Force of Law" is always superior to "the Law of Force." Its majesty is manifested when we reflect that the Law is the one restraint which a free society has placed upon Freedom. In business, more "laws" should be drafted by more of those employees who deserve such a status as a reward for the results they have accomplished.

Planning makes a weighty contribution to the effectiveness of management. It is, however, only a means to an end; the end is better operations, better results. Planning is successful only when it facilitates both. Planning makes it possible for us to prepare for the future; if we do not plan, we may not have one.

Chapter 6 – THE MANAGEMENT OF ENGINEERS: DIRECTION OF OPERATIONS

Its Anatomy

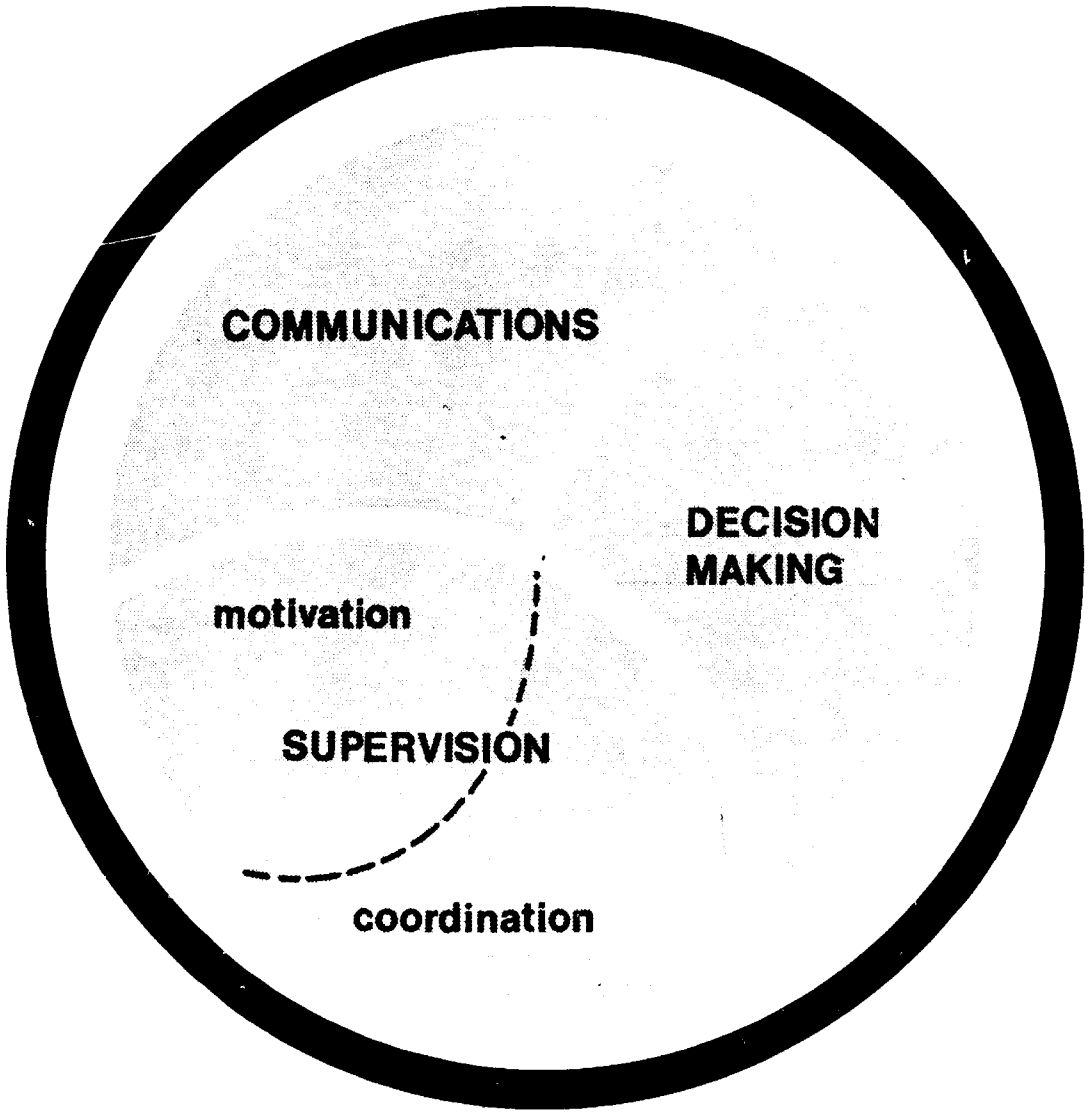
As in the case of planning (and again of review, see Chapter 7), the scope of this project permits a discussion only of selected major aspects of the subject matter. We are limiting ourselves to those segments in which the most recent, authenticated research findings and our own analyses cover points which, to the best of our knowledge, have not yet been reported upon in print.

In addition, we agreed early in the planning of our research work to eliminate two of the three major sectors of "operations," namely "decision-making," and "communications." Both are represented in the literature rather generously. Each deserves further study. We have ascertained to our satisfaction that our conclusions would not be contradicted by the demands of these two managerial tasks which were left outside the contents of this report.

The third key segment in the direction of operations is "supervision" (see Illustration 17). Surprisingly, this particular area is treated much less frequently than its two companions in the operations sector through research, publications and executive development programs.

Supervision is that part of the total managerial task in which the executive directs his people when they put accepted plans into action. He guides the transformation of these plans into reality. He helps breathe life into their intentions. This enables thought and effort to become output. They appear as action (of any kind). They produce movement of goods, ideas, money, and other tangible and intangible output.

In the case of engineering management, this means the creation of "the design," in the broadest possible sense of this term as discussed in Chapter 2. It encompasses all effort spent on analyses and calculations; perception and conceptualization of ideas; their development, redevelopment or rejection; etc. – in the form of mathematical equations and models; design sketches and drawings; correlations and all the other varied forms in which scientific and engineering minds express their creations.



DIRECTION OF OPERATIONS

illustration no.17

The Many-Sided Talents of the Supervisor

The supervisor is a man of thought. He has confidence in himself and in others. He needs few of the traditional trappings of authority. His vision, judgment and interpersonal relations skills are the key ingredients for success – his own and that of his company. He is a formidable foe of imposed conformity. Reflecting his personality and philosophy, he has a firm value system which is consistent in itself and with that of his organization.

Here are two comments on this last point, consistency. One comes from the questionnaires of the NASA-NYU survey; the other was made in conversations we had with scientists and engineers:

> "He plays favorites all the time. One of my associates is always right in his eyes even when he makes a bad mistake. Another can never satisfy him. Personally, I do not have any complaint about the way he deals with me but I don't like this inconsistency."
>
> "One day he compliments you highly on a simple task; the next day he bawls you out when a very difficult analysis is not done in two hours."

The manager's thoughts and action are rooted in integrity. This assures that the Talent around him can count on candor, conscience, and character to provide the respectable platform which Competence deserves. He realizes that the integrity of his group starts with his own. For instance, when he makes a mistake, he admits it; he does not try to alibi it away or saddle someone else with it.

Also a man of purpose and action, the executive knows that the essence of his job is the effective performance of his organization. Thus he is decisive. He makes decisions readily and commits himself to their successful execution in terms of planned results.

He is a good communicator. He gives his people the information each needs (what each should do; why; how he stands; the plans of others which affect his work; etc.). He reports on developments in the department and beyond. He publicizes outstanding work of his men.

Listening patiently and with understanding, the capable supervisor knows how each of his people feels. He is aware of what each thinks. He keeps tabs on what is going on in his group and elsewhere in the company and the community. He gives evidence that he wants to know how each of his people is doing. He is quick to praise and give recognition whenever it is deserved.

If executives, also in higher echelons, manifest their interest in word and action, the boost to morale is great. Mr. Charles F. McCollum, Chairman of Continental Oil Company, told us of the lasting impression which his president made on him when he was a young geologist: "Invariably, he would ask my views on some broad matter. Imagine, the great W. S. Farish asking for my opinion!"

Most importantly, the executive is a leader. He is genuinely interested in each man in his group as a person. He is readily accessible. He is easy to speak with, even under pressure. He is prompt to discuss things and to help.

He sharpens his insights as he endeavors to understand his people, their feelings, habits and talents – good or not so good. He is responsive, not aloof. He is ready to go to bat for everyone in his crew.

He respects each member of his group. He recognizes the dignity of every man as a human being, of his work and abilities, ambitions and values. In turn, he has the right to expect others to respect the dignity of himself, of his company, its profit motive and its other goals. He continues this attitude as long as each also respects the others.

All people in a work group and the manager are dependent upon one another. The executive needs his men to help produce the results for which he is accountable. Conversely, his crew has to turn to their boss not merely for direction or guidance or help but also for opportunities through which they can assume responsibilities and grow.

The manager adapts his approach to the personality and stature of every one of his people. For example, some extracurricular activities are good for, say, well-established authorities in their field, while they would handicap novices. Service as chairman of an important committee of a trade association or professional society is one of many possible illustrations.

Or, to take another case, some need supervisory pressure to produce under certain conditions; others do not. Here are two opinions from the NASA-NYU questionnaire:

> "I don't mind if my section chief puts pressure on to get the work done. It helps me – if he doesn't push too much too often."
>
> "If he would only stop his constant needling!"

The competent section chief patterns his approach also to the situation. He acts one way on a project which is just starting and a different way after it is well established. He goes easy when introducing something new.

The supervisor recognizes the undulating character in the flow of new ideas. He appreciates that occasional periods of sterility are inevitable on the part of every, even the best, man. They may merely be the time needed for incubation of ideas.

He recognizes the need for unlearning old habits before new ones can be mastered. Just as he expects his people to grow, so does he endeavor to increase the scope, variety and flexibility of his repertoire of supervisory approaches. This is one of the never-completed objects for further improvement.

This man is the main architect of the atmosphere in his shop, office or laboratory. He cannot create it all by himself. But as the manager, he takes the first and often the most decisive step toward establishing a contributory climate (see Chapter 10) which facilitates that each person, his group and the company reach their goals. This invigorates the self-conception that everyone has of himself. It makes work less drudgery. It produces more and better results all around.

Of course, things do not always work out this way. Perhaps the single most frequent reason for difficulties, especially on the first and second rungs of the managerial echelons, lies in weaknesses (or absence) of (1) defining the supervisor's role and the relations with his people, as well as of (2) appropriate status in the management hierarchy. Too often this makes him the "forgotten man" in management who is stuck in an ambiguous position: He can identify neither with the "brass up there" nor with those who report to him. Suspended in limbo, his effectiveness is seriously handicapped.

The solution generally lies in the need for thinking through the existing relationships between technical and executive leadership and in spelling them out clearly for each specific situation. Rarely combined in one person, both aspects are nevertheless needed if the group is to succeed. The crux is the working climate, i.e., again contributory leadership (see Chapter 10): it unambiguously assigns the managerial phases to the section chief; simultaneously it assures the technical side a proper berth within the expertise of the engineers and scientists with whom he works.

Even in the most favorable circumstances, it takes a lot to be a good supervisor. When one's crew are highly educated, competent and creative individuals, the task of managing them in their work is even more formidable. For those properly equipped for executive responsibilities, the fact that supervision brings the most direct face-to-face contacts, makes matters easier. They excel in interpersonal skills. And in the field of supervision, there are the most frequent opportunities for such contacts. Three quite distinct types are involved, namely the relationships between the supervisor and

. . each individual subordinate

. . the group of his people (in part or as a whole)

. . associates and superiors within the firm and a large variety of others outside the company.

The first resolves itself mainly into motivating tasks. The second is primarily a matter of coordination. And the third involves both motivation and coordination.

The Practice of Supervision: 1. Relations with Subordinates as Individuals (Motivation)

One of the authors has been conducting a survey of successful managerial practices for a number of years. One of the questions asked the respondents to single out the one most important aspect which has brought them the best results in supervising engineering, scientific or other creative personnel. A recap of the replies shows two main forces at work.

* Guidance
* Rewards

Together with the areas not covered in this report, they add up to giving motivation the opportunity to exercise its powerful influence.

Guidance

The approach to guidance varies widely because it is so intimately dependent upon the people and the situation at hand. However, the same three (somewhat intertwined) steps appear to be dominant under a large variety of circumstances. Effective guidance should

. . stimulate the individual: this causes deeper commitment to responsibility

. . lead to more challenging work assignments, with its opportunities for increased scope and complexity in the tasks involved

. . develop the engineer, scientist or whoever may be on the scene; as a result, he becomes capable of coping successfully with these more difficult assignments.

1. Stimulation

"Get his attention," was the advice given by many executives in response to our question: How to start the process of stimulation. It is interesting to note that this counsel came most frequently from marketing and general managers, least often from engineering and research executives.

There are many more successful ways to make people take notice than there are people. This study has stressed repeatedly the concept of goal-connecting (Chapter 3) which brings personal and work objectives together and thus makes the individuals involved sit up and listen. To give just one other example, we refer to the experience of many salesmen who capture the customer's attention by showing how their proposition helps him solve problems of long standing. Similarly, imagination, creativity and other powerhouses in a scientist's mind, are triggered when the successful attainment of the objectives of a new task is shown to bring, as a by-product, the disappearance (or mitigation) of old headaches, or the appearance of something valued by him.

The next goal should probably be to arouse the individual's interest and stir his enthusiasm. There is a thin line between enthusiasm and excitement. The latter can be helpful in the conquest of difficult tasks. Under such circumstances, it is even more important that the superior himself stays calm, unruffled, even when the going is really tough. He must have learned how to "sweat out the mission." All this is more evident the higher up in management we are and the more difficult the job concerned is.

Then there is encouragement; it is not a one-shot affair. Boosters are often needed when time pales earlier stimuli because the hurdles to be overcome seem to mount steadily. One of the questions in the NASA-NYU survey asked: How frequently each respondent felt encouraged by his supervisor. On a scale on which one signified "never" and five "nearly all the time," the composite mean score was 2.95. This means that in four out of ten cases, the section chief did not provide the encouragement which his people were looking for.

Such failure is as regrettable as it is unnecessary. Guidance without encouragement can deteriorate into slave-driving, with all its damaging consequences upon motivation. Yet the antidote, stimulation, requires nothing beyond sensitivity to needs and the manager's ability to act accordingly – two indispensable ingredients in the supervisory profile. The wide-awake supervisor sees many opportunities to spur his men on to reach out further; to help each think out (and through) new ideas and concepts; to move in new directions; promote innovation. Yet not all engineering managers act this way, witness the many comments along the (perhaps slightly exaggerated) lines of this one:

> "He (the section chief) is the worst bottleneck for new ideas; he just won't listen since one suggestion of mine went wrong – ten months ago!"

One of the most effective ways to assure stimulation is for the executive involved to set an example himself. This shows everyone that the boss does not ask for anything he is not ready to do or give himself. He demonstrates what can be done; and he does it through action which accomplishes so much more than words. People do what they see their superior do – a delightful corroboration of the existence of effective guidance.

The crux of stimulation lies in the establishment and maintenance of an invigorating work atmosphere. This is one of the components of the contributory climate (Chapter 10) to which reference has been made earlier. As long as it is persistent and sincere, encouragement increases the incentive for each person to activate more motives on behalf of the company and of himself. He becomes more deeply involved in his work, more firmly committed to results needed.

There is a world of difference between individuals who can see in their productivity the fruits of their own ingenuity and those who are restricted to contribute nothing of themselves but mere obedience to orders and instructions. Man must involve himself before he can have a proprietary interest in his work.

2. Assignment to a Challenging Work Situation

The next major step is to put stimulation to work effectively. We discussed the preliminary draft of this section with Mr. C. J. Thomsen, Senior Vice President of Texas Instruments, who had been so extraordinarily helpful at our earlier visit to this company. Asked what he thought TI's highly successful experience with engineers and scientists suggested as the single most im-

portant aspect of guidance (after stimulation has been achieved), he singled out a challenging work situation."

This view was echoed by many others, especially by just about all those who have enjoyed, like Mr. Thomsen and his associates, consistent and consistently outstanding results in their direction of professional personnel.

Before a supervisor can be sure that his assignments are challenging, he has to focus on the strength of each individual. He has to admit and use greater knowledge which others have. He has to build up their loyalty to the group, the proj , the company. Translated into the framework of motivation theory, delegation of difficult tasks represents a motivator of highest power because of its direct appeal to "achievement." Giving a scientist or engineer a truly difficult task is a compliment. Providing less demanding work can be interpreted as an insult or, at least, as lack of appreciation, understanding or confidence.

Delegation offers a challenge to a man's capacity even before the work starts; this should continue while the work goes on. According to the NASA-NYU survey, reality looks quite different. One question inquired what percentage of the engineer's time was spent on non-engineering tasks which did not require the individual's level of ability. A fairly large number (11.8%) said they spent over 50% of their time on performing such tasks; an equally great group (11.7%) believed it was 41 to 50%, but 41.9% gave 11 to 30% as their estimate; 27.7% were convinced that such assignments were not justified. When asked if these non-engineering tasks could be performed by others with less education or ability, 58.1% agreed.[1]

Putting these figures into some perspective, under the most conservative assumptions,[2] we find:

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1. The NASA-NYU questionnaire provided additional data and information which are not analyzed in these pages because this is the prerogative of the companion study to this project (see Chapter 1).

2. Assumptions:
   (1) use of midpoint of the "11 to 30%" and "41 to 50%" estimates;
   (2) use of 50% in the "over 50%" estimates;
   (3) application of the percentage shares of engineers (11.8, 11.7 and 41.9%) across-the-board to a total of 1,000,000 practitioners;
   (4) an annual salary for engineers of $12,000, for their substitutes in the performance of non-engineering tasks of $8,000.

A 50% improvement in the current use of engineers on non-engineering work would result in

. . the addition of something like 40,000 engineers to the profession (we graduate at present somewhat more than 50,000 per year)

. . savings of the magnitude of $150,000,000.

With less conservative yet still quite realistic assumptions, these data (additions to engineering labor force, savings) could easily double and come close to trebling. Moreover, all these (admittedly rough) calculations deal solely with the regular bookkeeping cost elements. They do not include the human costs which are incurred through lagging morale, sagging motivation, deterioration of initiative, lost opportunities to counter professional obsolescence and many other potentially heavy expense items.

To get back to emphasis on the assignment of challenging work, another means is the choice of criteria of excellence in performance. Experience seems almost unanimous that tough but realistic standards of what an individual should do are likely to be most effective with creative people. As before, the manager should start out by setting high standards for his own work. For others, he views these benchmarks in terms of what each man can expect of himself, not in terms of what the company expects of him.

A single standard can not apply to all. Standards vary – should vary – with the individual (see Chapter 5). Yet there is need for consistency in demands, tempered of course by recognition of different capabilities, experiences and knowledge on the part of different persons.

In many cases, a good way to bring out the best in a man is to expect it from him. People will rise to high expectations in the proper climate. Such faith has often to precede justification for it.

Providing difficult work assignments has some aspects of snowballing. Each subsequent task reinforces its predecessor; advance becomes commonplace; it steepens to maintain its power and with that, capacity grows into a more open-ended phenomenon. Where this cannot be achieved, the cause is likely to lie either in improper recruitment or in shortcomings of management.

Furthermore, wider use of technicians, engineering aides, and other support personnel could relieve the professionals of many routine type tasks. This is a topic beyond the scope of this project.

3. Opportunity for Personal and Professional Development

A challenging work situation has as its logical consequence the third aspect of guidance: personal and professional development. Here is another opportunity for the supervisor to act as a catalyst for the release of initiative and knowledge in each member of his group.

The managers we surveyed named information or communication as prime contributors to growth. "People do a better job if they know why it has to be done," or "a job that is understood is half done," were much-recurring themes. This imposes upon the executive the task of explanations, demonstrations, illustrations, discussions and whatever else can help to make clear what the situation is; to pinpoint the problems which are likely to be encountered; to show why certain arrangements are necessary and others not likely to be successful; to deliberate how to overcome obstacles; and so on.

All this goes well beyond the provision of necessary data and the various other forms in which information comes to aerospace engineers and scientists. The Vice President of Engineering of one of the firms we visited put it this way: "Knowledge conquers fear; ignorance fans it."

We are fully aware of the fact that it is easier for us to stipulate such actions than it is for the engineering supervisor to carry these suggestions out under some circumstances. "I don't know what I'm supposed to do," was the plaintive observation heard on a number of occasions even from rather outstanding engineers or scientists.

When the field of endeavor includes so much virgin territory as many aerospace tasks, this readily represents a statement of fact. But it is also an admission of limitations in imagination and understanding. It could be an indication of lagging motivation, unsuitable placement or assignment of work.

When the cause for the comment is the difficulty clearly to define the start and the end of one specific assignment, the solution is easier. Overlaps of efforts are generally better than omissions. Under other circumstances, though, it is a good bet that more encouragement, more information and more assistance from the superior will help conquer difficulties which seem overpowering without such a boost.

Paper studies, often necessary in seeming profusion, add another element of potential confusion. And occasionally, even the most conscientious statement of what the customer expects has to be somewhat less than complete, especially in the early stages of a project.

The basic remedy of all these situations still lies in the hands of the section chief. He exists for many reasons; one is, unquestionably, to obtain the information and cooperation that his people need, even if that is at times quite difficult.

It is precisely under such conditions that the manager has an opportunity to grow himself until the "impossible" comes within his reach. He has at his disposal by far more opportunities to accomplish this than anyone else; after all, he can – and should – call on whatever additional resources may be required to fill the vacuum.

Management should show each employee his role in the overall picture. Every healthy individual enjoys a sense of importance. He welcomes evidence of the effects of his efforts. He is happy at the opportunity to make new contributions. Creativity, in particular, thrives on useful guidance. And it is the supervisor's task to help each of his men along these and related tracks.

The problem-solving loop used to have the technical expert as the sole dispenser of decisions. Now programmers, coders, key punch and other machine operators as well as the computer add layers before a decision can be made. As a minimum, this increases communication and information difficulties. Moreover, it may seem to some engineers or scientists that a part of the decision-making responsibility has been taken away from them.

This is just what happens at times. But it can take place only with the consent of the individual. As long as his own knowledge expands with his extension of the problem-solving circuit, he stays right on top of it. Only when he resigns from the opportunity to call the shots can others take (a part of) his work over. There is no reason why he should give up his share unless, of course, his judgment or his capability is not up to the increased demands anymore, while they may well have been more than sufficient a short while ago.

The computer eliminates a lot of drudgery from scientific and engineering work. But some remains inevitably pedestrian. In such situations, the manager, and only he, can make dull tasks exciting. He is going to be more effective if he succeeds in doing this in terms of the engineer's

interests and ambitions. It is the executive who must make certain that there is always ample occasion for him to help his people by giving them an opening to ask for it.

Most, especially creative individuals, want to know how they are doing. Even a champion can run a four-minute mile only when he knows how far he has come after sixty seconds. This knowledge has real pulling power. He knows he has reached an important milestone on the road to his objective. He is that much closer to his goal. Prompt feedback (not only on past performance but also on current ideas, on proposals for work to come and so on) exercises a great influence on future results.

May we sum up these paragraphs on communication by suggesting the need for frank and free exchange of views and opinions, data and experiences. Perhaps its foremost barrier is the labelling of somebody's idea as "obvious" or other forms of shutting off debate just when it may be on the track of quite unexpected discoveries. This obstacle is best eliminated by the realization that superior results are produced by "consulting" rather than directing people.

The engineer has to learn. Management must enable him to do so. This may initially consume more time. But it is an investment which will bring dividends later on.

There are several ways to accomplish this. Their common denominator is the creation of a work situation in which learning occurs naturally supervisor can help his men over hurdles. He can assist them in burying their doubts, particularly after a failure. He gives them a chance to blow off steam and to rationalize themselves into the clear again. He accentuates the positive by showing how negative aspects can be overcome. He does not merely try to argue that they are not there.

And he pays special attention to members of the group whom others may neglect. Let's take a new employee as an example, perhaps one fresh out of engineering school, on his first job. He needs special encouragement, special avenues for development because this is an entirely new experience for him. He has not yet won a place in his group.

Too often, his first run-in is with his boss. The new man would like to show how much he can do. Many a supervisor wants to "put him in his place." From here on, each is likely to do precisely what will stymie the other. The section chief will ignore ideas of the new engineer. In

turn, the young man tries harder. The superior now sees his worst misgivings confirmed: "This guy is overambitious; he wants my job," is how one of the respondents to the survey phrased it. The newcomer sees his suspicions come true: "I am being relegated to meaningless work." He begins to wonder how good the things are which he learned in school.

The up-shot is too often frustration on both sides as a minimum. Not infrequently, the young man quits or is fired. All this could have been avoided if the supervisor would have helped the fellow to learn how to put his knowledge to work within the context of the project.

This case shows, by using a more extreme situation, what can easily happen also under more frequent conditions when management is loath to help its people learn how to help themselves. When he was Chairman of the Jewel Tea Company, Frank Lunding told one of the authors: "The manager should consider himself as the assistant-to-all who report to him."

Individual growth can also be furthered by placing a man on a committee, a task force or some other temporary assignment which brings him into touch with new situations. More important of course is the choice of the full-time tasks in such a manner that the engineer or scientist will be exposed to new ideas, different problems, other people or circumstances.

Development often requires systematic schooling – through books, seminars, courses, conferences, degree or non-degree programs – provided by professional and other societies, consultants, the firm itself, universities, government and still other agencies.

The consequence of development along personal as well as professional lines is the expansion of the capability of the individual and, through him, of his group and the firm as a whole. It produces increased work results, greater personal stature and satisfaction; it is good all around.

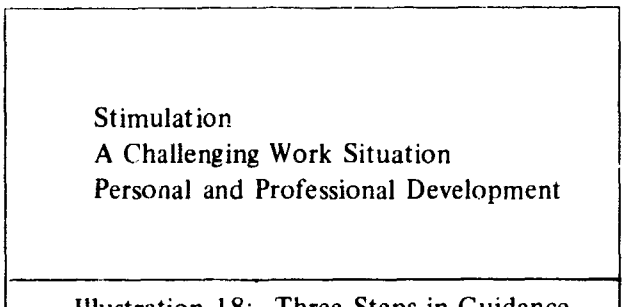


Illustration 18: Three Steps in Guidance

When the manager is successful in his three-step efforts at guidance (see Illustration 18), the result is that his people resolve: what has to be done, will be done. And it will be done more willingly and more effectively.

Rewards

1. Recognition

Each individual wants to be known for what he is, what he could become, and what he is doing. Only management can confirm each man's mark of excellence at work.

Money is one form of recognition. Straddling maintenance and motivating influences (see Chapter 3), financial rewards represent, as a minimum, a much-needed foundation of individual satisfaction. Base salaries and bonuses which are fixed on the basis of individual merit have much stronger pulling power than general, across-the-board provisions. But even the finest monetary arrangement needs to be supported by other forms of recognition. For professional personnel, in particular, acknowledgement of work well done and respect for it as well as for the man who did it, are absolutely necessary companions.

Showing appreciation provides the supervisor with the opportunity to shift from meagre maintenance to powerful motivating forces. It requires individual recognition of individual achievement over and beyond normal compensation measures. Its influence upon the general work climate is remarkable.

This means to give credit when credit is due, on an individual basis. "I want to feel useful." "I am not sure they really need me here." These two examples from the NASA-NYU survey show what can easily happen when the manager does not succeed in instilling pride in a man's work, when he withholds the ego-satisfaction that every healthy individual likes. The complaint heard elsewhere more than once, "I gave him a wonderful idea; and that is the last I ever heard of it," casts shadows of even greater doubt on the supervisor.

Engineers and scientists cherish recognition also as tangible evidence of the respect they believe they deserve. They believe it reflects the type of supervision that is proper for their abilities and

for the complexity of their work. It expresses support and trust on the part of their superior and his chief(s).

2. Status, Not Just Symbols

We have to differentiate between status symbols and status. A profession – and indeed other sectors of society – recognizes merit through honors. Business does the same but too often limits itself to titles and the traditional adornments of the executive office: wall-to-wall carpeting; draperies; or perhaps an electric typewriter for the secretary; reserved parking space; the privilege of first-class air travel; or just a key to the washroom or finding one's name on several routing lists. These are all symbols. Some people treasure them. Others would live and work happily without them.

The best situation seems to exist when a contributory climate (Chapter 10) places status within reach of everybody who, without undue sacrifice of himself, contributes significantly to the success of the organization. This has proved itself to be one of the most effective means for improving scientific and engineering accomplishments. Increased status is a major stimulus for most (especially for professional) personnel. It is a powerful reward. It represents an incentive for continuing improvement of performance.

Progressive companies are beginning to pay less attention to status symbols and more to individual work needs. For example, eating and similar facilities are shared by all employees. Identification badges are color-coded by job responsibilities, not by status. Parking privileges and parking space are assigned on the basis of job requirements. At the headquarters of one of the firms we visited, for instance, parking spots close to the entrance are reserved only for the physically handicapped, for people who use their cars on company business more than three times a week, and for employees who have been with the firm for 20 years or longer.

In the climate which we are advocating in this report, the mode of attire is not standardized. A hierarchy of office furnishings does not exist except as required by work. First names are much more widespread through all echelons; so are informal communications.

Firms who have successfully tried this approach recommend that recognition of individual status should be reinforced by general status symbols for all employees. Among those most frequently

mentioned are attractive buildings and grounds, the reputation of the company as-a-whole and especially that of its engineering department.

It is hard to overemphasize the potential influence of rewards. The satisfaction they cause plays a powerful part when a person decides how to behave, what to do or what not to do.

Of course, poor performance cannot be accepted under any circumstances. Failures have to be pointed out and shortcomings corrected. This is the unquestioned responsibility of supervision. But it has to take mistakes in stride.

The important thing is the spirit in which all this is done. The purpose must be to prevent errors from recurring, not to punish for them. There are only the rarest exceptions to this principle; they may apply, for example, to an employee who has shown repeatedly that he really does not fit into the organization; his original employment may have been a mistake; he is likely to leave, or be requested to leave, very soon.

The approach suggested here demands in return that the engineer shows clearly he is learning from his error. With the help of his supervisor, he has to demonstrate that he knows how to turn damage from shortcomings in the past into investments for the future. We shall have more to say on this subject under "Control" (Chapter 8).

The manager's relations with his subordinates on an individual basis has been discussed in terms of emphasis, first, on guidance (with its 3 major steps of stimulation, challenging work and development), then on rewards (recognition and status) and its resultant satisfaction. Properly handled, this sequence can produce a chain reaction (see Illustration 19):

. . Satisfaction with the rewards (recognition and status) of good performance reinforces existing and causes further stimulation

. . In turn, this brings yearning for more challenging work

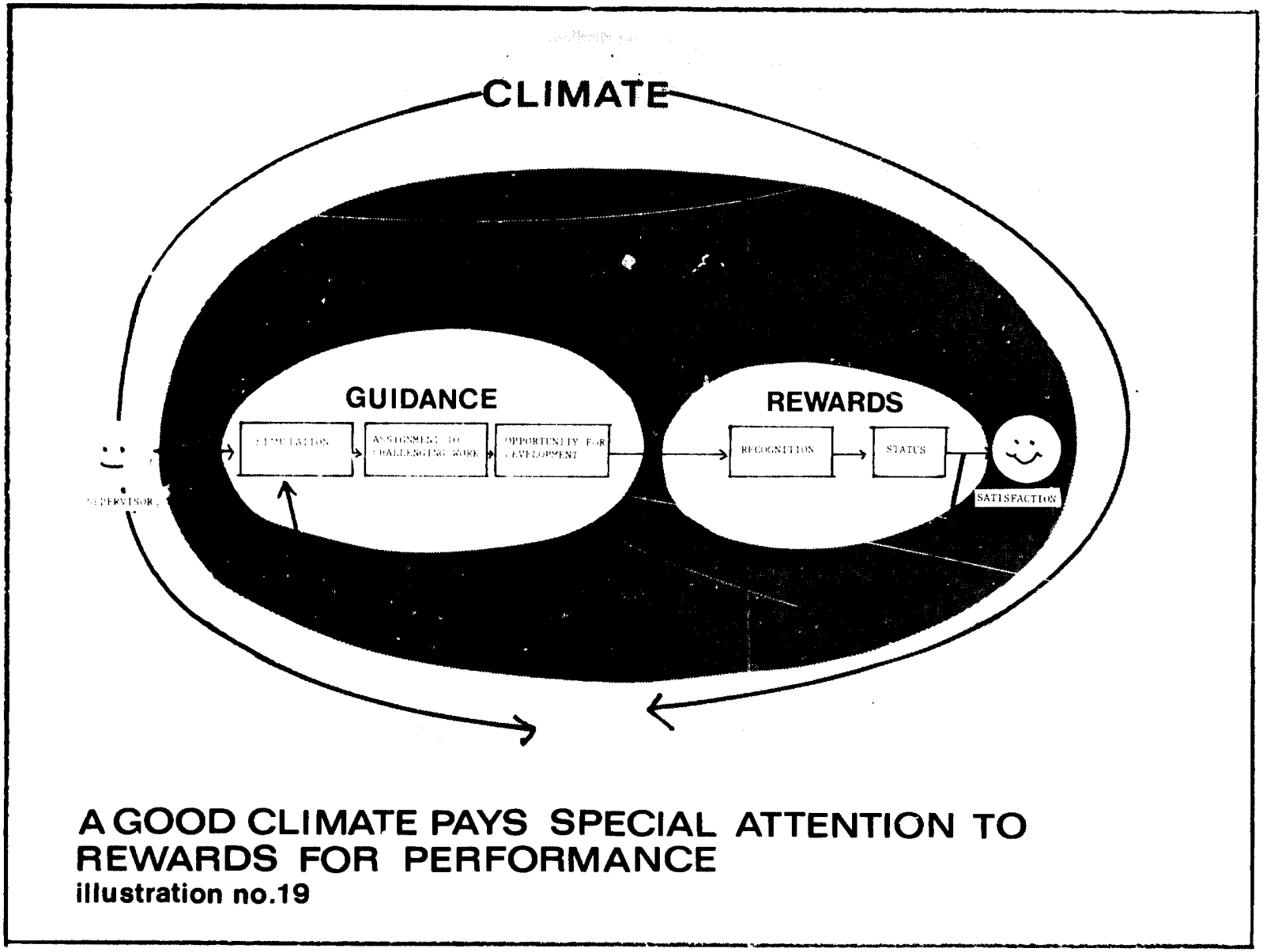
. . That sets the scene for further development

. . Such growth requires new rewards for results achieved, producing even greater satisfaction

. . And so on.

Summarizing, then, the manager's interaction with each of the members of his crew:

. . he guides and rewards performance



A GOOD CLIMATE PAYS SPECIAL ATTENTION TO REWARDS FOR PERFORMANCE

illustration no.19

. . he does this by supervising work so that it serves organizational and individual goals; energizes; widens responsibility; furthers personal development; promotes achievement.

. . that is, he m o t i v a t e s every one of his people.

As a result, common men achieve uncommon things.

The Practice of Supervision: 2. Relations with Subordinates as a Group (Coordination)

The immediately preceding pages looked briefly at the executive in his relations with each man in his group individually. The following thoughts concern his interaction with his group-as-a-whole or in part. With this, the spotlight shifts from Motivation to Coordination.

The engineering manager knows how to differentiate between matters which should be handled on a personal basis and those that require group thought or action. Basically the choice depends upon recognition of who has a legitimate interest in the problems at hand.

. . Individual attention is reserved for questions which are of concern only to the supervisor and the o n e person involved. Into this group fall, for instance,

* personal counseling
* individual merit raises
* disciplinary measures for individual performance
* items which truly deserve or demand "confidential" treatment.

. . The supervisor should deal with his subordinates as a group when the subject needs to be discussed with, or acted upon, by some or all of them. This might include

* base salary scale
* company plans
* policies
* etc.

To find the proper dividing line between these two is not always easy. When a decision on whether to solve a problem on an individual or a group basis is hard to make, one thing is certain: The answer is not to keep it under wraps.

This would only feed the rumor mill which, contrary to some opinion, is not just a characteristic of a less desirable working climate. On the contrary, it is a firm fact of human life anywhere.

It is influenced by climate only in the content and frequency, form and scope of distribution in which gossip presents itself. The grapevine flows mightily in any surrounding. Under favorable conditions, it will be known much more quickly and can be countered much more readily where it is wrong.

Another proposal is accepted more widely these days. It is that the more information can be disseminated, the more limited will be the generation of rumors, the less vicious are they likely to be and the less fantastic will be the difference between their contents and the real facts.

Rumors will diminish also when the supervisor encourages frequent (preferably informal) discussions. He is clearly and firmly in favor of frank and open exploration of problems and difficulties. He will help bring them to the fore because they are solved much more effectively in their early stages.

Office parties, sport groups, review meetings with or without outsiders and many other similar efforts on the part of the company as a whole, of one of its divisions or departments help interaction. But each manager has to go much further. The able supervisor realizes that the greater the differences in individual makeup or knowledge, the less likely will there be easy interaction. Where that is the case, he will have to create or rekindle opportunities for useful exchanges more often. His most reliable anchor is to latch on to common interests or similarities as catalysts for cooperation.

He knows that working together is based only in part on rational considerations (each needs others to make his own work fully effective; collaboration is especially necessary in many phases of engineering work; even more cooperation will be required in the future as the complexity of the problems increases which engineers have to solve). It is also based on emotional grounds (sentiments toward one another; the affiliation motive, i.e., the need to be part of the group, etc.).

As healthy as it is to foster interaction, it is even more important to assure its effectiveness. This is where Coordination comes in. It makes certain that individual efforts are dovetailed so that their effect becomes cumulative. It avoids the neutralizing or smothering of some efforts by others because of lack of such alignment.

How has coordination been achieved by the more outstandingly successful executives surveyed? They contribute results primarily to two specific aspects, namely

* balancing capabilities
* linking resources

Balancing Capabilities

The goal is to preserve individual motivation and to reinforce it through motivating the group-as-a-whole. This involves exactly the same approaches and it brings precisely the same results as just discussed, a few pages ago, with regard to the individual member of the group.

"Synergy" is the theme that best summarizes successful handling of this problem. Different people have different views, different ambitions, and different personalities. Every organization knows who is the deliberate, who is the aggressive man; who is the risk-taker and who prefers to play it safe; who is the theorist, who is the experimenter.

Rather than submerge one for the other and force conformity, it is management's duty to place each where he, with all his particular features, can do the most good – for the organization and for himself. The enterprise is entitled to the full benefit from the experience, talents, attitudes, etc. of each of its people.

We hired them in the first place because we wanted their individual experience, talents, attitudes, This is also why more and more among the wiser executives choose as their right-hand man someone with complementary knowledge, reactions and personality, not an individual who merely compliments him. This is the way we can multiply ourselves. This is how people who work well together, can accomplish much more than the sum of their individual efforts would be if each had operated alone. This is synergy.

The point is not to suppress conflict but to have it act as breeding ground for a better solution. Friction as such is not necessarily something bad. It can become one of the most valuable events in a group's life as long as the friction is utilized in constructive fashion. As Mary Parker Follett pointed out almost four decades ago, a pulley would not work if there were no friction.

There should be cross-fertilization of ideas, not as a rare occasion but as a common, day-by-day habit. The supervisor's skill in coordination proves itself when he succeeds in helping his people pull together.

Disagreements and differences in opinion are added opportunities for the competent executive to help new ideas to be born and to come to the fore. Again there are many ways by which this can be done, each depending upon the individuals involved. Among the more generally useful ones are brainstorming, hitchhiking of ideas and just about any arrangement for informal discussions as long as the result contributes to the successful solution of the problem at hand.

Many functions in an organization have opposite views or somewhat conflicting objectives by their very nature. This is not infrequently evidenced in the relations between the design and the analytical engineer, the production and the quality control-reliability supervisor, headquarters and the field and in many other instances. The supervisor has his work cut out to prevent these – often traditional – differences from hugging the spotlight and, instead, to point them toward common interests and common objectives.

Achieving and maintaining balance is a continuous task because there are continuing changes. The situation can alter overnight; some people grow; others leave; customer requirements shift; etc. Yet balance is a conditio sine qua non for the effective operation of a group. The results must of course be measured in terms of their value to the progress of the company-as-a-whole, not just to one of its parts or a few persons.

This maxim can cause difficulties with engineers and scientists. From the firm's and the customer's points of view, the solution just reached may be fully acceptable while its author, in his quest for even better arrangements, might oppose its appplication with all the force of his strong motivation. It is therefore just another fact of life – but one that is often hard to swallow – that the "best" engineering solution may not also constitute the optimum for the project, for NASA or the company.

Coordination includes the task of trying to find a reconciliation of views in such, as in any other, situations. Successful coordination increases the effectiveness of individual and group efforts just as it strengthens personal achievement and satisfaction.

Linking Resources

This adds one more ingredient to the blend of results from coordination discussed so far, namely "voluntary cooperation." When the supervisor succeeds in linking individuals and the material resources they need in their work, the effect is a coalition of human and material components. He has created a united organism.

This enhances further the employee's commitment to, and involvement in, his assignment. His job is the bridge between himself and the organization. His membership in his work group invigorates the coupling of his own aspirations with the company's goals. The supervisor's role is to assist the members of the group as they assimilate themselves – with their individualities intact, voluntarily and reasonably happily – into one whole, smoothly functioning system.

Efficient coordination gives each individual the opportunity to make a small sacrifice when it is warranted; if he makes it on his own volition, he is likely to avoid a larger one which would probably have to be imposed whether he likes it or not.

One immediate result of successful linking of resources is the strengthening of mutual confidence among the members and the reinforcement of trust between them and the manager. Just about all executives whom we asked about the best approach to accomplish this cohesion agreed: It means helping everyone involved recognize how far-reachingly his self-interest coincides with the interest of others, including the work group and thus the company. Goal-connecting which we discussed from various theoretical points of view in Chapter 3, thus reappears as the natural conclusion from decades of especially successful executive experience.

Because each is dependent on others, we must pull together. For example, even the most ingenious programmer would be unemployed if he did not have support from the engineers who use his tapes; from the maintenance mechanic who keeps his computer running; from the company treasurer who sees to it that the necessary finances are on hand; from the personnel office who hires the keypunch operators he needs; and so on.

Where full coordination is not possible, it is the leader's inexorable duty to protect the greater Good from encroachment of lesser interest. This proposition, still too often honored by disregard, makes it incumbent upon the supervisor, for instance, to reject improper demands on his crew or on one or several of its members.

Coordination requires the synchronization of efforts. It is not enough for people merely to cooperate. They have to do so at the right time. To choose that is another one of the many supervisory tasks.

Recapping then the manager's relations with his group, his major aims are

. . to balance things and people

. . to link and unify his resources into a cohesive whole

. . that is, to c o o r d i n a t e.

Effective coordination remains a target which many organizations still have to reach. The problem is not new. Management's lack of full success in it may be helped in the future by further insights into the concept of interface.

A group within which coordination has been achieved, testifies to its leader's authority. As one functional whole, it has cohesion. It is an activated system, an energized community. It represents a real team in action.

Our discussion of the practice of supervision has been built around four themes, namely: guidance and rewards, balance of capabilities and linkage of resources. All foster the formation of effectual groups. Because of the overriding significance of the individual, it is not yet possible to discuss the subject in more specific terms. To do this, the state of the arts and of the sciences must advance a good bit further. We hope that the points made in these pages may be useful. They represent a more specific insight into supervisory practice than we could find in the literature.

The combined effect from all aspects of supervision is the strengthening of a climate which assures the success of the company to a greater extent. Competent supervision strengthens motivation and achieves coordination at the most crucial stage of activities, namely the entire area of operations whose success is the most powerful safeguard for the continued profitable existence of the organization.

The Practice of Supervision: 3. Relations with Others

The contacts which the executive has with others in the organization give him the opportunity to fit his group into the larger picture. It is a two-way effort:

. . Upward: The supervisor keeps higher echelons acquainted with progress in his area, development of his men, their plans and capabilities for the future. He informs higher management about the viewpoints, opinions and wishes of his men and does his best to "sell" them. He protects his group against non-essential pressure or assignments. An example is the "Instant Engineer Syndrome." It is not entirely unusual that "they" want an answer "immediately." This leaves the man no chance for proper preparations, even if he should have been given a bit of time for the work itself, probably a fraction of what he feels he should have.

In these as in all other circumatances, the section chief represents the interests of his men. He is their spokesman.

. . Downward: The manager brings to his people the story of the needs and developments elsewhere, of problems and opportunities in the company-as-a-whole. Of special importance is information about the organization's long-range plans and expectations, ambitions and difficulties. He protects the enterprise against perhaps unintentional exploitation by too narrow specialized interests.

He explains the requirements of the company to enable his group better to understand their collective and individual work roles, their relations and obligations to others. This provides the perspective which can become so quickly so distorted when viewed from too close a range. And it is never more important than when it involves sacrifices which his people are called upon to make at times in the interest of greater success of the organization-as-a-whole.

The supervisor acts as a "link-pin"[3]: He heads up his group and he is, simultaneously, a member of a larger team (see Illustration 20).

In his relations with associates and superiors, he faces basically the same tasks as with his own crew. They were dealt with on the immediately preceding pages, namely

. . motivation (of other sectors of the organization toward the potential of his area),

. . coordination (of the efforts of his group with those of the rest of the organization).

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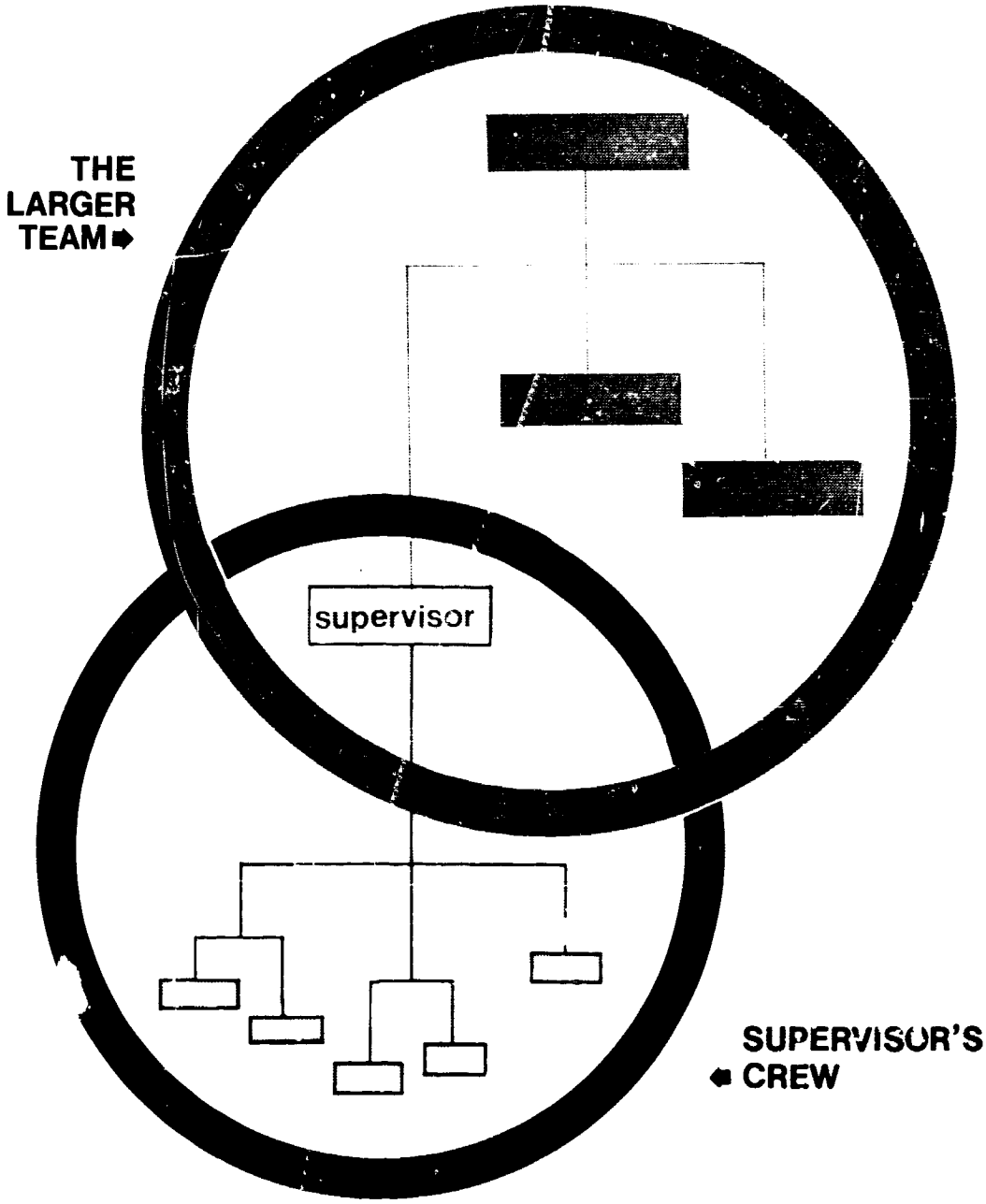
3. To the best of our knowledge, the term "link-pin" was first used by M.R. Lohmann (Dean of Engineering, State University of Oklahoma and currently President of the American Society for Engineering Education) in his doctoral dissertation in 1953.



THE SUPERVISOR'S "LINK PIN" ROLE

illustration no. 20

Since these two tasks have been covered in the preceding pages, we can now move on to another aspect of supervision.

The manager has to deal also with people outside his own organization. This could include quite a wide variety of constellations; to wit

* customers
* vendors, suppliers, subcontractors
* job applicants, employment agencies
* outside accountants, auditors, lawyers, economists
* consultants in engineering, management, etc.
* advertising, market research, public relations and others
* union stewards, delegates and other officials
* newspaper, radio or TV reporters, writers for magazines, journals and other publications
* students, educators, representatives of professional societies, of trade and other associations
* "thought leaders" and others in the community
* various regulatory and other government agencies
* visitors
* etc.

Within the purview of this report, we briefly cite just one, though, which is of paramount importance in the aerospace industry, the relationships with NASA.

Because of the nature of the work, the customer is often deeply involved in the contractor's activities, not merely from the start of the project to its conclusion but also beyond and possibly prior to it. This presence exercises a not entirely negligible influence. It is already recognized by most managements in the basic company organization which generally provides a separate division (or other unit) for activities on behalf of NASA, DOD and related kinds of government business. Day-by-day operations reflect this situation as well. There are extra meetings, work task justification, documentation and other aspects which are hard to schedule in advance.

In the main, the task of conducting these relationships falls squarely on supervision. He calls in engineers and others quite properly on many, probably most occasions. While the crux of a number of discussions is apt to fall on these, it remains the manager's responsibility to keep on top of what is going on. This task is really still another phase of coordination, admittedly a difficult one because it extends beyond the plant gates of the firm. But it differs from other features of coordination mainly in the manner in which it is accomplished, not in the substance involved which was discussed before.

When the authors discussed this project on several occasions with Dr. Peter F. Drucker, our colleague in the Graduate School of Business Administration, New York University, he added the thought that special communication problems can arise at times. His reasoning was that the latter are more prone to express themselves in concepts, the former through perceptions (anecdotal), he felt.

This situation is of course not unique. It exists in similar fashion between practicing executives and some academicians and indeed elsewhere. Whenever it makes its appearance, the solution lies in some sort of "translating organ." To provide it is another supervisory duty, that of facilitating communications wherever they affect the work of his people.

Excellence in Executive Leadership

Possibly the most sensitive of all the areas of executive concern, supervision, deserves a summary. Perhaps the answers of the executives surveyed provide the best synopsis. Taken together, they add up to a formidable roster of traits which these men believe constitute "excellence in executive leadership" (see Illustration 21). In general we have to wait for the future to find many individuals – perhaps just the first – who have all of these attributes.

A Composite of Traits Which Have Brought People to the Top, in the Opinion of People at the Top.		
Health	Firmness	Sensitivity
Interest	Decisiveness	Empathy
Intelligence	Flexibility	Understanding
Creativeness	Dependability	Self-reliance
Ambition	Loyalty	Self-discipline
Sense of Achievement	Honesty	Emotional stability
Enthusiasm	Integrity	Maturity
Initiative	Character	Judgment
Courage	Perception	Consistency in value system
Sense of urgency	Vision	Demand for excellence
Readiness to take prudent risks	Reflectiveness	Competence

Illustration 21: Excellence in Executive Leadership

Progress toward that date has accelerated in recent times. This is manifested by four highly encouraging trends. Each is being pursued by a larger number of executives every year:

. . The crux of managerial responsibility is Dedication to Achievement. It is the manager's task to get the job completed. He realizes that to accomplish this, he needs a crew who is characterized by competitive but constructive cooperation of the highest technical and moral calibre. The initiation of such contributory climate is the duty of each manager within his realm of responsibility. Its maintenance and growth is a joint obligation of the executives and all members of the organization.

. . The motivating power of self-actualized team effort is vastly superior in comparison to the retarding force of involuntary or hesitating followership. Getting things done, through others, remains the acid test of executive ability. But such results are counted not merely in technical or material but also in human, social, moral and cultural terms.

. . It is the totality of a leader's behavior that counts. As an engineering manager, he has to have technical know-how. But he also needs skills in dealing with people. They are affected not just by his words, his facial expressions or vocal inflections; they are activated – or deactivated – by everything in his makeup and behavior.

. . A leadership position is not an invitation to enter a popularity contest. Mature executives are aware of the fact that (occasional) antagonism of the led is a natural burden of their role. The manager is the nomal target of, at times, inevitable dissatisfaction. Occasionally, they prevent him from achieving all his goals; he cannot take action to suppress them without jeopardizing those very goals in the long run. What pulls him through in such a situation is his people's confidence in him. which he has built up and nourished through persistent excellence in executive leadership.

The heart of supervision is perhaps best reflected in the motto of La Societé des Jeuns Patrons, France's YPO (Young Presidents Organization) which suggests that

"To be boss means to command; to command means to serve."

Chapter 7– The Management of Engineers: REVIEW and FEEDBACK

Its Mission

Review is management's observation post. Its function is scorekeeping. It determines what is happening; its records what did take place in the past. In time-reversed parallel to planning, review looks back; it thinks about operations and the lessons they contain.

The mission of review is to obtain pertinent information on the operations of the organizations, in all its parts, and on its environment. The significance of review is growing steeply because it depends on information and analysis. These are two areas which have made astounding contributions in recent years and will probably make even larger strides in the future.

The Supervisor's Role in Review

First and foremost the manager is responsible for results. It would be a terrible waste of effort (on preparations, decisions, instructions, etc.) if there should be no results. But even with the most careful arrangements and with the most capable crew, there are times when things do not work out.

This means the need for follow-up. The supervisor has to make sure that what was supposed to happen, does happen. For example, he has to ascertain that needed information is available. He checks if equipment is on hand as planned, if people are properly instructed, if the job progresses as anticipated, etc.

Follow-up is the price for delegation. The knack is to find lapses early when there is still a chance to remedy things. Here is where the significance of real-time information is perhaps most obvious that the manager can help the engineer or scientist to correct shortcomings and find opportunities for improvement before it is too late or too difficult for either.

One of the major problems in practice is to keep a balance between following up too closely and too loosely. If the former is one of the characteristics of the supervisor, he is likely to look over the shoulders of his people all the time, to "breathe down their necks" or to "climb on their backs." He may even take the job away and do it himself because "Joe won't ever get it done." This has all the earmarks of a dictatorial situation; if not that, it certainly makes it impossible for the engineer to learn by doing.

On the other hand there is the temptation to check matters too infrequently. This is especially so when the work involved is in its on-going, repetitive phases. Here the manager may hold back on guidance although the man needs it (for instance, when his knowledge of a particular aspect is scanty). Many executives hesitate to inquire of their people how things are going, perhaps out of tact that this may injure the man's pride.

One of the questions in the NASA-NYU survey asked how frequently each engineer felt annoyed by thirteen specified situations. One of these dealt with the extent of follow-up. On a scale on which 1 signified "never" and 5 "nearly all the time," the composite mean score was 2.65 for "too little guidance" and 2.23 for "too much supervision." Our interpretation is that in just about half of the cases, the managers had not (yet?) hit upon a "happy medium."

To find that equilibrium is one of the many instances in which the supervisor's sensitivity and judgment are put to an acid test. When arrangements include provisions for self-follow-up by the people themselves, matters are greatly facilitated.

To be fully effective in review, the manager also has to be perceptive and comfortably at home with the techniques of analysis (including statistical, mathematical, and computational methodology). If he is fortunate, he is gifted with an extra portion of analytical skills, common sense and judgment. He can conceptualize isolated facts or ideas into a meaningful and realistic model. In his thinking, he "undepartmentalizes" the situation so as to be able to see the fuller picture. This is a very real potential hazard for the specialist who may be prone to visualize the life of others in the image of his own.

It is this situation which is many times at the bottom of difficulties between engineers and

managers. More often than is healthy for him and his work, each sees the others operating in his own framework. For example, the executive must lay stress not merely on the technical calibre of the project but also on economic performance. The engineer is likely to strive for more technical "perfection" even at the expense of economic considerations. A meeting of the minds is not probable when one imposes his thinking upon the other by force or direction. The principle of participation – joint deliberation and exploration – provides an answer if the existing climate has accustomed both to the advantages (but also to the difficulties) of such an approach.

The competent manager knows how to ask the right questions. This enlarges his awareness of the situation, including the interests of his men so that he can cut through the fog of "masking" (in many discussions, the employee may camouflage the crux of the issue because its direct discussion would be too embarrassing). He is sensitive to the reactions of his people whenever possible, especially after experiments or other results are disappointing despite energetic and skillful efforts.

He is scrupulous in his professional integrity, impartial, fair and consistent. He has no axe to grind but understands the sentiments and the bias of himself and others. He keeps his temper and does not pound the desk at the slightest deviation of actual results from plans. Review should not be a hiding place for procedure-riders or psychopaths.

Not every individual welcomes facts, particularly if they are in conflict with his "estimate of the situation." The effective executive knows that the company can lose some of the most useful ideas when the perceptions and accuracy of the experienced nose on a qualified scientist or engineer are disregarded "in the presence of undeniable facts." A collision between his proven "sixth sense" and "somebody else's facts causes frustration, resistance or outright hostility. If repeated too frequently, it could shake the scientist's security.

The supervisor avoids the pitfalls of the man who is a statistician first and a salesman second; this could bring the temptation to bend men to what figures say. But he also steers clear of the hazards of the individual who is a salesman by choice and an analyst by necessity; it could produce a tendency to compromise and to seek accommodations when firmness is called for.

If review is carried out by an executive other than the one who is also responsible for supervision of scientific or engineering – or for that matter, any other – work, he should have a broad and diversified background in the fields concerned and in the principles, practice and philosophy of management and engineering. He must be familiar with the problems of the work involved. This does not mean, however, that he is the best qualified man to solve them. But his crew should not have reason to complain: "We can't talk with him intelligently; he does not understand our (technical, physics or whatever) problems!"

How Review is Performed

Review is carried out in two quite distinctly different steps:

. . Pertinent information on internal activities and external influences is collected.

. . This information is analyzed to elicit its meaning and to evaluate it so as to extract lessons of the past and the present for use in the future.

We found a little sheet on the desk of the Vice-President in charge of Engineering and Research of a large and successful aerospace company. One of the most eminent colleagues in the engineering profession, he told us that his "why-sheet" has been a companion for years and possibly a major contributor to his success. Illustration 22 reproduces this page whose original has as its first line Shakespeare's "Judgment - oh most lame and impotent Conclusion!"

Collecting Information

The following observations on the character and scope of effective review information are the result of quite extensive studies of contemporary practice.

. . 1. Checking and double-checking on the reliability of data is a "must." This can be done in many ways: to cite just one example of how the calibre of information can be improved, experienced supervisors have found that "to plug in early" – that is, to get information firsthand – improves the probability of obtaining undistorted information (for instance, direct from specifications in the files, not through a telephone call to somebody who thinks he has full information but does not).

. . 2. More information is coming in quantified form. This assures all the advantages which facts have over opinions. "Gentlemen cannot disagree on facts; they can only be ignorant of them." Of course, something is not necessarily factual if it is – can be – expressed numerically.

We also like to stress that in our opinion the important dichotomy is not between "qualitative and quantitative data." All information is qualitative; some can, other cannot (yet) be measured.

Raw Data:

* where did the data come from?
* have they been checked? for what? by whom?
* which are contaminated with unsubstantiated opinions?
* which are based on rumors? or "unimpeachable" but unidentifiable sources?
* which represent value judgments of specialists? whose?
* which are self-serving?
* where is the information meagre or non-existing?

Analysis:

* which data have been discarded?
* where are the loopholes?
* has balance been restored to over/under emphasis? to unfair claims?
* which factors are crucial? negligible?
* which represent inside, which outside influences?
* which are controllable, which uncontrollable by us?
* whose views have not yet been heard?
* are conclusions different from those reached in a comparable situation?
* what reasoning was changed the next day?

Illustration 22: The "Why?" Sheet

. . 3. Information needs should change with the individual on the job. Different people have different experiences, different knowledge, and different working habits. Thus they need different information.

. . 4. It is also desirable to build information "from the bottom up." This means that details go to lower levels and only their totals to the next higher echelon. If the supervisor needs more particulars, he gets them from his subordinates. The main reasons for this are:

* The higher we go in management, the fewer details are generally needed (and the longer-range should be the viewpoint of the information).

* Data for all levels have to be comparable. It introduces unnecessary inaccuracies when we have to put on a common denominator some which are based, for instance, on the number of hours spent on a project and others (say, salary figures) which are collected on a monthly basis.

. . 5. Illustration 23, a summary of desirable indicator characteristics, is self-explanatory:

* Numerosity	* Simplicity
* Validity	* Economy
* Accuracy	* Speedy Availability
* Precision	* Operationally Meaningful Units
* Reliability	* Fit into Total Information Grid
* Adaptability/Reconciliability	

Illustration 23: Indicator Characteristics

. . 6. Often the problem is not to establish mathematically incontestable accuracy and precision but to find practically useful measures. An imperfect yardstick for an important item has much more value than a precise concept for doing something insignificant.

Designing measures and measuring systems is a traditional (industrial) engineering task. It has been discharged rather satisfactorily just about wherever performed. However the segment of information covered so far is on the narrow side. Progressive management is ready for new contributions. If engineers should not provide them, others will.

. . 7. As far as internal operations are concerned, managers always need information on quality-reliability, quantity, cost, time and personnel aspects of work. They usually require additional data as well. Basically each man's realm of responsibility should be covered, in addition to needed background, so that he can relate current events to the fuller panorama of the company and its surroundings.

More than one set of data is generally necessary for the same object when the information is used for different purposes. For example, figures on equipment depreciation are likely to be recorded in the accounting ledgers on the basis of pertinent tax legislation. For decisions on modernization, such amounts may be mis-

leading so that operationally more meaningful information is preferable over that compiled to comply with IRS provisions.

On the strength of a comprehensive review, over many years, of the most advanced practices, we propose that the scope of desirable information for engineering management can be classified in this way: Information on

. . Human and material resources and their utilization
Illustration 24 summarizes the data which general managers usually require. When this list was carefully checked by engineering executives against their needs, every single item remained on it with the sole exception of "capital structure."

RESOURCES		
Human		Material
such as	vested in	
actions and ideas	individuals	product
experience and knowledge	owners and stockholders	raw materials and energy
skills and abilities	other investors	machines and equipment
attitudes	employees and unions	processes, tools, facilities
motivation	customers	real estate and buildings
health	other business establishments	finances, capital structure
habits	educational and other	credit and insurance
capacity	institutions	contracts and patents
understanding	the community	research
character	government	services
	management	

Illustration 24: Management Information Needs on Resources

. . Input-transfer-output conditions
For example, information on inventory of instruments represents "input" when quantities in stock are counted; it reflects "transfer" when the number in temporary use on experiments is recorded; it becomes "output" when the total of instruments which were built into customer orders is stated.

. . Performance of individuals, groups and the organization-as-a-whole
An example of "individual performance" might be the number of patents granted to a specific engineer; an illustration of a typical performance indicator of the organization-as-a-whole might be the ratio of Net Sales Billed/Total Number of Employees – or, the most classic of all, profit.

. . Environment

Even one solitary person or the smallest work group is influenced by many factors – people, procedures, the climate around it, forces from the outside, etc. There is a great variety of possible external influences. Here are a few illustrations:

* economic conditions (actual and forecast GNP, money rates, etc.)
* social aspects (unemployment rates, contract coverage of distressed areas, etc.)
* legal factors (security and renegotiation provisions, Taft-Hartley provisions, etc.)
* etc.

Illustration 25 gives a more complete list of the more important categories:

economic	personal	legal
financial	social	political
technological	cultural	ethical
time	geographic	philosophical

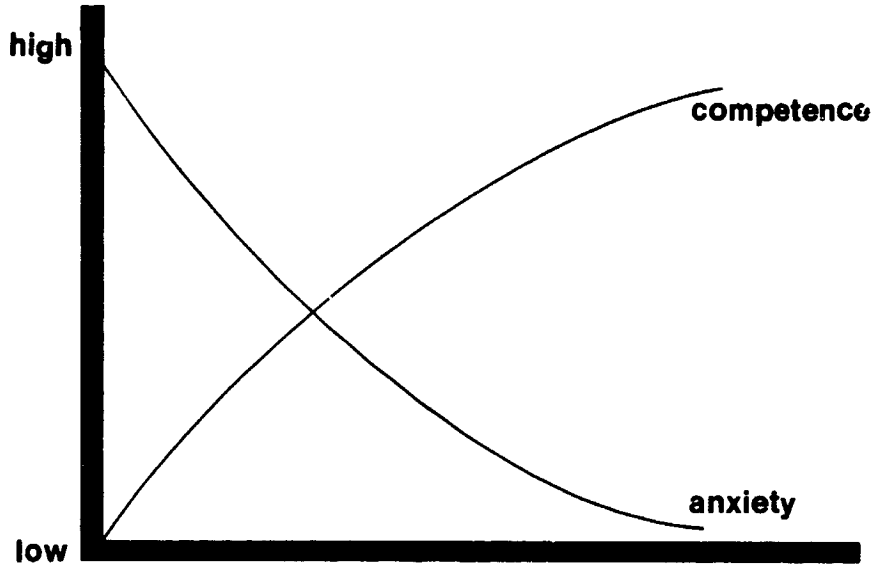
Illustration 25: Outside Influences

Information on the environment is as vital to the executive as data on internal events. One further word: Too much available information relates effects. Yet only after we come to grips with the cause(s) can effects be meaningfully tackled. Most data, for instance, from accounting, represent "effect information"; they have the magnitude shown on the books because we have operated the way we did.

Here is an example of the significance of causes (see Illustration 26). Recent research showed that anxiety was a cause for, rather than an effect of, learning. Only after this had been ascertained, did it become possible to take effective steps to mitigate the situation, which had been a bottleneck with new employees for a long time (through appropriate planning, improved supervision, use of learning curves and so on).

Analysis

The second part of review is by far more difficult. It begins with the processing of data. This represents a crucial step. However, in the final analysis it is human judgment that supplies the decisive element to arrive at conclusions as to what action is called for in the light of the information at hand.



EXAMPLE OF "CAUSE INDICATOR"
illustration no. 26

Judgment is – and will remain, in our opinion – one of the most critical, most valuable and most brittle contributions which an individual can make. This is also the case in the most highly programmed decisions because it is judgment which formulates the problem; selects the analytical approach; sets the numerical values for many coefficients in the algorithms; chooses the computer programs; and so on.

Much to our surprise we found that the literature sheds but little light on the nature of judgment. Even more immediately significant, still less is known about the ways to sharpen this ability. We know that judgment is a curious complex of contrasting characteristics; it entails

* insight and perspective
* proven intuition and factual analysis
* subjective views and objective evaluations
* technical and philosophical, economic, ethical and still other factors.

Information is the catalyst through which judgment, vision and other attributes go to work to make the right decisions which will produce the desired solution, action, results, or whatever the end product may be.

Judgment can be furthered in a number of ways. To wit:

. . 1. Too much information can be as harmful as too little information. Thus judicious culling of data – a judgmental process in itself – is one means to improve the probability of good judgment.

More effective access to more clearly identified information (through skillful library reference and other information services) is another. A third is the recognition that each individual has an apparently quite distinct ability to retain data in his mind for cross-comparisons and other analyses. Some can readily handle twelve, even fifteen items; others find themselves already struggling with only six or eight.

. . 2. The selection of bases of comparison can also help or hamper the exercise of judgment. Trends over time enjoy, in many cases perhaps exaggerated, popularity:

Last week Last month Last season Cumulative results to date Percentage changeover . . . Previous high Previous low
Illustration 27: Bases of Comparison Over Time

A project's development flows continuously, like a mighty river; the calendar is just a milestone along its path.

Correlations with other projects, offices, companies or industries, and with local, regional, national (in some cases, even international) bases offer frequently more significant clues.

In terms of managerial review information on internal events, there are two classes of equal significance:

. . Data on the soundness of the plans as such
When results are disappointing, the cause could be either in faulty plans which prevented success despite heroic efforts at making them work; or it might be the other way around; the plans could have been splendid but their implementation lagging.

The remedy is radically different in each instance. In the former, plans need adjustment while operations should stay as they are. In the latter situation, it is the exact opposite; plans need to be conserved but operations changed. In order to be able to decide which is the proper action to take, information must be available on the calibre of planning, as just stated.

. . Data on operations

These are likely to appear often in form of actual results and comparisons with existing "plans," such as specific targets or programs: forecasts or budgets; quotas or quality-reliability levels; delivery dates; standards; etc.

When planning has been successful in stating the real parameters of success numerically (such as 5 nano seconds reaction time at temperatures between 120 degrees above and 20 degrees below zero and 10 to 80% humidity in the atmosphere), review is immensely facilitated. We met some managers who stated that the main purpose of planning is to establish the proper datum line for evaluation. It seems that such a view restricts planning much too severely in its potential contributions. But the essence of the thought – planning's usefulness as a basis of comparison – is proper. It also suggests clues for the manager on how to match his review to his planning work and vice versa.

Once conclusions from the interpretation of information seem to be reasonably firm, the device of a "Devil's Advocate" has been used somewhat more frequently in business in recent years. Some of the most successful engineers, scientists and managers we talked with have been full of praise for such an arrangement. Many assign their most competent men to prepare the best possible case against the conclusions. Others utilize role-playing to test the results.

Personnel Evaluation, Performance Appraisals and Management Audits

These three review techniques throw further light on some of the points which this study emphasizes. Strictly speaking, "personnel evaluation" should refer to an individual; "performance appraisal" or "management audit" ought to concern itself with the work involved. However, the three terms are often used interchangeably in many businesses and in the literature. Practice shows some happy and some disgruntled customers.

True, it is difficult to distinguish a man's performance as such from his personal characteristics. To correlate one properly with the other requires psychological, frequently psycho-analytical, knowledge and experience; few, if any managers have – and, in our opinion, should possess – these.

This puts stress on the need for using as evaluation parameters those significant factors of success in performance in which executives are experts. We deal with their proper sphere, when we focus attention on work. The company is interested in the results of the work. It is not directly

concerned with the complex interplay within the worker's mind, body and heart, which brings these results about.

"Performance review" at Texas Instruments serves the dual purpose of

* setting future goals and reviewing past accomplishments
* determining salary.

It is started by the employee who fills out a form on which he states his accomplishments during the past year, his short-term (up to six months) and his long-range (one year or more) goals. He discusses these items with his supervisor and records on the review blank the consensus of their conversation regarding priorities, planned future action and a time table. This enables the man himself, rather than his supervisor, to become the initiator of corrective action.

(For "blue collar" personnel – at the start of 1968, TI placed all employees on salary – the company uses the traditional "report card" with comments on quality, quantity, reliability and other job-related factors).

The reasons which prompted Texas Instruments to take this approach, were similar to the experiences of the General Electric Company with its performance appraisals. GE summarized the situation this way:[1]

> "Most people think the idea of performance appraisals is good. They feel an individual should know where he stands. Therefore the manager should periodically discuss with each of his men an appraisal of his performance.
>
> "In actual practice, however, it is the extremely rare operating manager who will employ such a program on his own initiative. Personnel specialists report that most managers carry out performance appraisal interviews only when strong control procedures are established to ensure that they do so.
>
> "We also found from interviews with employees who have had a good deal of experience with traditional appraisals, that few indeed can cite examples where they have taken constructive action – or achieved significant improvements – which came from suggestions received by their boss in an appraisal interview."

Faced with such contradictory evidence, a study was made by GE over several years. Special attention was devoted to the appraisal interview between the subordinate and his manager because it was supposed to motivate the man to improve his performance. Here are some of the findings of the General Electric study:

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1. See Bibliography – Articles: Meyer, Herbert H. et al.

. . 1. "Criticisms have a negative effect on goal-achievement. Praise has little effect one way or the other.[2]

. . 2. "Perforance improves most when specific goals are established. Defensiveness resulting from critical appraisal produces inferior performance. Coaching should be a day-to-day, not a once-a-year, activity.

. . 3. "Mutual goal setting, not criticism, improves performance. Participation by the employee in the goal-setting procedure helps produce favorable results.

. . 4. "Interviews designed primarily to improve a man's performance should not at the same time consider his salary or his promotion."

These following findings are also significant because of their wide applicability to creative personnel:

. . 1. "An employee seems to accept suggestions for improved performance more readily if they are given in a less concentrated form than is the case in comprehensive annual appraisals.

. . 2. "Each individual seems to have a tolerance level toward the amount of criticism he can take. As this level is approached or passed, it becomes increasingly more difficult for him to accept responsibility for the shortcomings involved.

. . 3. "Some managers reported that the traditional performance appraisal program tends to cause them to save up items where improvement is needed. This enables them to have enough material to conduct a comprehensive discussion of performance in the annual review. But this short circuits one of the primary purposes of appraisals, that of giving speedy feedback on performance. Studies of the learning process have shown that feedback is less effective if much time is allowed to elapse since the performance involved.

. . 4. "Far superior results were observed when the manager and the man together set specific goals rather than merely talked about needed improvements. Frequent reviews of progress provide natural opportunities for discussing means of better performance. They are also far less threatening than the so much more foreboding annual appraisal and salary review.

. . 5. "It is unrealistic to expect a single appraisal program to achieve every conceivable need. Furthermore, it seems foolish to have a manager serve in the conflicting roles as a counsellor (helping a man improve his performance) and, at the same time, as a judge (who decides what his future salary will be)."

---

2. Some other studies disagree with this last point. So do we. This difference in views stems less from the fact that praise was given but rather from the way in which it had been forthcoming, we believe. As in all communications, their effect depends not only on their contents but also on the manner in which the information is presented.

After performance appraisals were adjusted in line with these findings, General Electric's new version, called WP&R (work planning and review) program, was tested for attitude changes in comparison with another group which continued on the old performance appraisal approach. In contrast to the latter, the WP&R group expressed significantly more favorable attitudes in general and specifically with regard to

. . 1. "the amount of help the manager was giving them in improving performance on the job

. . 2. "the degree to which the manager was receptive to new ideas and suggestions

. . 3. "the ability of the manager to plan

. . 4. "the extent to which he made use of the abilities and experiences of his men

. . 5. "the degree to which they felt that the goals for which they were shooting, were what they should be

. . 6. "the extent to which they received help from the manager in planning future job opportunities

. . 7. "the value of performance discussions with the manager."

General Electric comments further that "in addition to these changes in attitudes, evidence was often found that the members of the WP&R group were much more likely to have taken specific actions to improve performance than were those who continued with the traditional performance appraisal approach."

Back at TI, reviews of selected strategies and TAPs (tactical action programs; see Chapter 5) are presented monthly to the President by the strategy and TAP managers concerned; they are, in most cases, several organizational levels below him. This presentation directly to company officers serves several purposes:

. . It circumvents the traditional upward-screening process through several organizational layers and thus presents the top echelon with first-hand progress reports on important projects.

. . It keeps the officers posted on developing technology.

. . It gives the project head immediate feedback, without distortions which are inevitable when a number of levels in management hierarchies become involved.

. . The recognition of the individual by this process increases his incentive and involvement and thereby multiplies the occasions for improved performance It also presents a learning opportunity of not inconsiderable significance.

One comment, in response to an open-end question about motivation in the NASA-NYU survey, may serve here as just one witness although there were a number of similar reactions to the opportunity of "rubbing elbows with the top brass":

> "I especially appreciate being asked to attend conferences with some of the 'Big Wheels.' It gives the young engineers a chance to see them operate as well as being made to feel important."

Attitude surveys are another way by which problem areas can be brought to the fore. At one company they are administered annually as a system for helping managers monitor their own effectiveness. They provide a basis for diagnosing problems and a planning remedial actions. Supervisors compare attitude survey results for their department against the current total company profile and their own profile for the previous year. They appoint committees and work through them to review survey results and to formulate recommendations for improvement. This enables the employees better to understand organizational problems and to make more meaningful contributions to their solution.

At the same time, the company attempts to identify and evaluate key managers through its annual Key Personnel Analysis program. For each salaried person, including company officers, the president and chairman establish a relative "Index of Contribution" to company objectives for the coming year. Department heads then examine and select the top 20% of all their personnel. The performance of these selected managers is reviewed with the division head who in turn boils the list down further to the top 5%.

Finally, the president and chairman rank these key men. The chairman says: "The relative index of contribution is compared against income, job grade, length of service and recommended salary change so that proper adjustments can be made." The president adds: "This gives us a mechanism for deciding who gets what part of the kitty; it helps us identify guys for the future."

Alan Wood Steel Company has a "Personnel Review Board." It is headed by the chairman of the board and president and has as its members two directors, the executive vice president, and the vice president of personnel. A combination record of data with comments on performance and promotability is discussed by this group in detail for each key employee.

These more recent forms of performance review differ from their predecessors mainly in that they incorporate conclusions from behavioral science research, especially in the fields of motiva-

tion and socialization (enculturation). The two focal points are again: Attention to the individual as an individual, and employment of "critique" as a helpful and motivating, not as a disturbing, element.

Impact of Climate

There are three major areas in which the manager can improve the results from his review efforts by enlisting the potential influence that is inherent in the climate he establishes.

Foremost is the degree of dissemination of information that is customary in the organization. The manager of course needs information himself. It puts his decisions on a firmer basis before he can bring to bear upon the situation which the information describes, the full powers of his judgment and conscience.

And he realizes that his employees have 'the right to know,' too. As a minimum, they and he need information so that each can plan and act properly in the areas of their respective responsibilities. More important from a motivating point of view is the opportunity for each to learn how the project is doing; how things came out which he had a hand in setting up; what reactions have been triggered in the environment by the activities of his firm; etc. Similarly significant is knowledge of future plans for the group and the company; both affect the supervisor and his men. The authors believe that access to information of this type may be as important as, if not more than, freedom in operating. What good is it to be free to act when ignorance of the situation prevents us from determining the right course.

Barriers to information are shrinking. Yet ready access to all desirable data is so far characteristic of the more progressive companies only. Within the limits demanded by reasons of security, a supervisor can materially improve the climate in his group by being more generous in the distribution of information which his people need and want.

A second example of the impact of management philosophy is the mission which management assigns to the review function: Is it used primarily to prevent future mistakes or to punish past errors? If the latter is the case, there will be lots of defensive statistics, hiding of facts, if not downright hostility. In contrast, if information is intended to foster learning from experience, then fears to the contrary have to be allayed in advance. Management has to banish the last vestiges of review as a sort of Gestapo or as an operation in a vigilante spirit.

The best-known approach today is through the concept of participation on which we have commented in every preceding chapter. Applied to review, this principle is probably implemented most often through managerial action which shows the employee that review of his work assists rather than attacks him. This is another reason why appraisals should concentrate on performance, not on personal characteristics.

The best way to handle this responsibility is through a gradual increase of the degree of self-appraisal which rests with the individual engineer and scientist. To the extent to which his superior has proof of its effectiveness, he can stay out of the review process. The proportion of such self-audit of one's work within the total review task is a measure of the combination of three eminently significant features

* maturity and judgment of the employee
* sophistication and skill of his supervisor
* contributory character of the prevailing work climate.

Finally, review should serve the future, not the past. Only as a by-product, not as their major mission, should operating records – as contrasted from books required for tax, legal and other reasons – serve as archives for historians. Experience pays dividends only when it is used. Mount Everest would never have been conquered had it not been for the accumulated experience of previous efforts.

Feedback

Feedback is the channel through which we capitalize on lessons learned. Since only one brief comment on feedback is in order within the confines of this study, we are discussing this subject in conjunction with "review" for simplicity's sake. It actually represents a topic in its own right since it represents the link from the review component of one cycle to the planning sector of the next. Feedback enables the executive to put past experience to work on behalf of future action. It keeps the enterprise dynamic and responsive to new conditions. It represents one special aspect of the broader problem of managerial communications.

Perhaps because of the occasional reluctance to use experience to the fullest, feedback is generally the weakest link in the management cycle. Putting this another way, strengthening feedback is one of the most ready and potentially most auspicious influences through which an executive can make his planning, his supervisory and his review duties pay higher dividends.

To summarize, review is the organization's information center. It measures the effects of all operations and the influences of their surroundings. It digs out, analyzes and evaluates their causes within the context of the environment in which we operate and vice versa. Through feedback it passes accumulating experiences on for use in future planning and thereby permits us to benefit even from errors. While we cannot repair yesterday, we do not have to copy it tomorrow.

Chapter 8 – THE MANAGEMENT OF ENGINEERS: A NEW CONCEPT OF "CONTROL"

What is it?

There is a good bit of "control" in business, to wit:

budgetary control	process control
cost control	production control
internal control	profit control
inventory control	quality control
labor control	safety control
mission control	and still more.

And there is plenty of "control" elsewhere in life, too:

air pollution control	government control
arms control	heat control
audio control	industrial theft control
birth control	land control
climate control	narcotics control
credit control	noise control
crime control	numerical control
curl control	parking control
currency control	pest control
damage control	remote control
dandruff control	shock control
delinquency control	traffic control
disease control	visual control
energy control	weight control
federal control	and others.

The first problem that stems from the use of the term is the great diversity in the precise meaning of what action each "control" entails. For example, does a Controller really have "control"? That depends upon the meaning of the word. The abbreviated dictionary shows these explanations:

account	influence	query
act	inhibit	question
administer	join	regulate
boss	judge	reprehend
check	know	reprove
command	lead	restrain
compare	manage	rule
correct	manipulate	shackle
curb	measure	supervise
direct	negotiate	suppress
dominate	number	sway
drive	object	test
enforce	observe	undertake
expose	overpower	unite
fit	overrule	uphold
forestall	persuade	verify
govern	prevail	warn
guide	prohibit	watch
hinder	quantify	weigh

Illustration 28: 57 Varieties in the Connotations of "Control."

Some are quite contradictory, such as

* compare/correct
* expose/influence
* prohibit/question
* restrain/know
* suppress/watch.

In addition, more and more executives deplore the unfortunate connotation of force that too often accompanies the exercise of control. It happens not too infrequently that we are over-controlling our activities to the point where initiative and ingenuity are driven to seek outlets elsewhere. Under such conditions, control cannot have any motivating impact; on the contrary, instead of helping, it hinders. Organizations cannot survive without talent; and talent will not tolerate (sub)systems which prevent it from exercising itself.

Yet the crux of controlling is the obligation to keep things on the beam, to hold the reins. While presenting here a new concept of control in management, we agree that controlling means assuring planned performance of planned results. It sees if original plans are being accomplished and takes appropriate action if they are not. This requires:

. . 1. Plans on what should happen.

. . 2. Operations in harmony with these plans.

. . 3. Review;

If what actually happens is what was supposed to, we have control;
if not, we have to do something to get control: We have to go on to steps 4 through 7.

. . 4. Continued review of information until we locate the reasons for our failure to accomplish what we set out to do, and draw conclusions about possible remedies.

. . 5. Incorporation of these findings into the Plans for the future (including provisions to continue those past arrangements which worked well).

. . 6. Operations in accordance with these revised plans.

. . 7. Again Review of results;
if this now shows that what actually took place this time is what we planned for, we have gained control;
if not, the same cycle of further review-revision of plans-operations-review continues until results are in harmony with our expectations, i.e., with our plans.

Do Managers Control or Controllers Manage?

Therefore control is possible only when we plan-operate-and-review, that is after we follow through the sequence of the management cycle. Control, the result of controlling, exists when review shows that operations bring the results we expect; it is the state that has been achieved as a consequence of controlling (or "managing") effectively.

This reasoning permits three conclusions, each of which is of special significance in engineering management:

. . 1. Control is not a means but an end. It is o n e result of the management process because it is accomplished through the pursuit of all the tasks which make up "managing."

. . 2. The cause for a failure in seeking or maintaining control could come from shortcomings in planning, in operations or in review or in any two or in all three of the elements of the management cycle.

Typical examples of the reasons for such difficulties could be

* in planning through unrealistic scheduling of overtime,
* in operations because a policy is not known, disregarded or implemented wrongly,
* in review on account of misleading information on time sheets.

Control can be attained only when all three parts of the executive task are performed effectively.

. . 3. There can not be any responsibility for any task without the obligation and the right to control it. Conversely, any control of work carries with it the responsibility for results.

This conclusion lays down a clear-cut fiat: When management assigns to one person the responsibility for getting a certain job done, it can not give "control" to someone else without seriously jeopardizing the entire undertaking. Yet in practice this has happened on more than one occasion. According to a number of executives with whom we talked, some arrangements of the project manager concept are flirting with just such a constellation. So are many others.

Depriving a manager of the delegation of even a fraction of one of the elements he needs to manage his area, is likely to cause difficulties in controlling. It can be done only through closest cooperation of the (two or more) executives among whom the various executive tasks have been distributed.

Obviously, such an arrangement is liable to slow up control action, if conclusive results could indeed be obtained in this manner. At the very least there can be potentially severe extra cost in one form or another (financial or human costs, short-term or long-range effects, etc.).

In centralized organizations, either planning or review or both has been moved from the level of the supervisor of operations to a higher probably the top echelon. When the operations head tries to keep his activities under control, he finds he cannot do so by himself alone because he lacks the planning of the review sector or both. On the other hand, the manager higher up, to whom planning review or both has been shifted, can gain control on the operational level only by directing or overriding the actions of the man in charge there. This reduces the latter to a rubberstamp, which is hardly an appropriate role for a responsible individual.

This adds corroboration, now also from a control point of view, of the superiority of the newer forms in organizing team effort over the more traditional ones (see Chapter 5).

Concentration in the hands of one man of all elements necessary to control is also the clue to harmonious cooperation between "line" and "staff." We propose that there can only be one locus of control: The man who is charged with clinching results. This same principle holds true also of relationships between the scientist or engineer who has responsibility for one task, and all other – reliability, analysis, computer, functional, schedule, budget, etc. experts whose special knowledge can help him.

Of course, it takes a good bit less effort to make these statements than to live up to them under the pressures of operations. We believe the opportunity to facilitate the smooth functioning of such collaboration lies with the supervisor; as discussed in Chapter 6, one of his two crucial responsibilities in face-to-face relations is the coordination of the various resources which are needed to accomplish the work involved.

We started our discussions of control with some comments on its semantic aspects. We can now follow this with some additional observations on the peculiarities inherent in the terminology that surrounds control. They are important because of the confusion which they cause so often in day-to-day activities.

For example, we stated that "control" is synonymous with one of the consequences of the process of management. But "controls" is not its plural; it rather indicates the means by which control is reached. It is not an entirely rare exception that an executive who has established lots of "controls," still does not have "control." One reason for this may be that for control to be firm, controls have to be flexible.

Conflict or Cooperation

Finally, we wish to reiterate that control is neither one of the parts of the management process (as it is pictured almost always throughout the literature); nor is it something separate from it (as some management practice has it). It is o n e product of managing effectively. As much as effective operations demand the existence of control, we could paradoxically do away with the t e r m "control" as such – as long as we substitute "management" for it.

This is a conclusion which is eminently proper not only in theory but in practice as well. It would be a particularly happy outcome in the face of repeated complaints from scientists, engineers and just about every creative individual, in addition to a growing number of others.

Their, at times, deep-seated dislike of control does not refer (so much) to management's obvious need to keep things on the beam as such. It is the manner in which control is often exercised, that disturbs them. This is the case, for instance, when potentially useful arrangements are bent into obstacles to progress. Opposition is also likely to arise when an approach is chosen which, in the name of "control," diverts interest and creativity into conscious or unconscious resistance rather than into strong motivation.

The culprits appear in manifold disguises:

. . Rigid, inflexible rules which must be obeyed even when the existing situation makes a mockery of an otherwise reasonable procedure. "I have to punch a time clock!" was the complaint of a number of project leaders. What an anachronism – for management to expect of a man truly creative work and full dedication to the job and then not use a better way to comply with pertinent government regulations on time keeping!

. . Unrealistic schedules or budgets which turn into formidable barriers although they could, if properly formulated, constitute significant assistance.

. . Preservation of a system for the system's sake so that men become its slaves rather than its masters.

. . And, unfortunately, many other aspects of planning, direction of operations and review.

More than fifty years ago, Henry L. Gantt,[1] the great American Engineer who proposed the first realistic management philosophy for U.S. business, warned his colleagues:

> "Our main problem is still . . . to make producers out of the vast armies of present-day busy people whose energies are being wasted in upholding an inefficient system."

Then, as today, the main difference between "control" as wrongly exercised in still too many spots, and effective "management" lies in the climate which surrounds each.

We oversimplify things perhaps too much when we refer to this difference as basically that between "autocratic" and "democratic" rule. Mr. Gantt hit the nail on the head when he remarked that

> "most people will work for the common good if you give them a chance. The trouble is that we have been clinging to an autocratic system under the mistaken notion that it was at least good for the autocrat. The fact is that it is not. Democracy is better for all of us. . . . To make democracy strong, it must be more democratic."

Thus climate emerges once again as a most powerful influence this time in the effectiveness of control. It could transform the same amount of imagination and ingenuity, of effort and energy either into a hot-bed of frustration and failure; or it could establish with them a work situation which benefits the company, its customers and employees, as well as the nation.

1. See bibliography under Alex W. Rathe, the editor of his writings.

Chapter 9 THE MANAGEMENT OF ENGINEERS: SOME ASPECTS OF PERSONNEL ADMINISTRATION

Selection and Placement

Executive effort receives support from many staff services throughout the organization. To illustrate this point, we chose the personnel department and in it just a few considerations in three areas of its responsibility, namely selection-placement and training.

Most new employees are hired in the expectation that they will be placed into specific assignments. Thus the major mission of the selection process is to match, as best as is possible under the existing circumstances, the individual's profile against the job's requirements (abilities, experience, knowledge, personality, and so on). The latter are often at the root of many problems which result from improper selection or questionable placement.

Only when management really knows what demands the work makes, does it do much good to ascertain what the individual applicant has to offer. The effectiveness of employment procedures is therefore dependent on the existence of realistic and meaningful conclusions from an analysis of job demands. This is squarely a planning task. It is also one in which our sample of companies showed few innovations. This situation is not typical of the aerospace industry alone. It concerns one of the areas of planning which, in most sectors of the economy, waits for the future for more intensive utilization.

Yet on the other side of the coin, the applicant's skill inventory, has been the subject of much more widespread investigation throughout business. It is frequently through tests (of quite diversified types) that organizations endeavor to learn more about their prospective employees' abilities. The problem for engineering management of the aerospace industry is: "How much good can come from such knowledge if it cannot be matched against the requirements of the job which the individual is to fill?"

Tests have eliminated many an applicant from obtaining employment because some traits in his makeup do not meet existing specifications. Dr. E. Finley Carter (retired), General Manager of Stanford Research Institute, who developed this organization during his tenure to the illustrious position it occupies, made these comments to one of the authors (without connection to this project):

> "Preoccupation with the well-adjusted personality is often overemphasized. Let's acknowledge that brilliance is seldom well-rounded. Rather than attempting to fill our laboratories with people who excel in personality tests and who demonstrate a healthy extroversion, we should welcome to research organizations, people whose imbalances are, or can be, creative forces."

While Dr. Carter's observations refer only to one specific point, namely a "well-adjusted personality," they are equally valid with regard to any other criterion which has not been established as being necessary through careful and thoughtful analysis of job requirements.

One comment included in our discussion of enculturation (Chapter 3) deserves repetition here because it affects selection procedures. It refers to the existence of distinctly fewer conflicts when the science-orientation of the individual and that of the company coincide. If both are basically the same (either "low" or "high" or whatever the degree), the assimilation of the engineer's or scientist's ambitions to the work objectives of the group in which he is active is greatly facilitated. Here then is one quite specific instance of how employee selection can acquire a higher measure of probability of success when it endeavors to match the applicant's (scientific) interests with those clearly established as essential for the company.

We should like to add a perhaps more frequent example of questionable selection or placement methods. It concerns the man who is placed in his first managerial assignment when he does not have a minimum of the needed talent and knowledge. In this case, a speedy replacement is generally good not only for the company and for those who work with him, but for the "supervisor" himself.

By the abruptness of this verdict we do not mean to minimize the difficulties inherent in deciding when someone is suited for a managerial job and when he is not. Many factors need to be considered. Engineering management has found helpful such items as:

. . meaningful statements of job demands for recruitment and placement efforts

. . properly designed a n d administered test batteries which yield reasonably factual information on a person's profile

. . practical criteria of supervisory performance

. . deliberate try-out of a man slated for executive work, perhaps at first on part-time tasks which show how well he scores against these benchmarks

. . and still many other "planning guides."

Because of the frequency of its occurrence, we again invite attention to the custom in many businesses where advancement to a supervisory position comes in recognition of achievements in some other activity. Many an engineer who has excelled in his technical accomplishments, finds himself promoted into management. Does it really make sense to reward an engineer for excellence i n engineering by moving him o u t o f it? (Please refer to discussion of the dual approach in Chapter 2.)

A second somewhat less fundamental point is consideration, during the selection process, of job rotation opportunities after the individual has joined the firm. Scientists and engineers have generally greater difficulties in understanding others and their work requirements as long as their own assignments are and remain in a relatively narrow area. This tends to develop expectations and an outlook which can be too restrictive. They can reduce the individual's capacity for cooperating with others in problem-solving. For example, engineers often emphasize only technical problems and personnel people usually stress human considerations, when each should think and act in terms of both.

Many other steps within the employment phases of the personnel department's tasks deserve attention to see if the existing approaches cannot yet be strengthened through more recent experience, research and methodology.

"Training"

Perhaps this term – sadly in error because of its connotation of routine – is an anachronism in modern management. But somewhat like "control," it has been in use so long that it is difficult to change. Our much too brief comments refer to personal and professional development or education in its broadest meaning.

Few industries have found their market grow so intensely in recent years as the education business. Originally, almost exclusively the domain of schools (including colleges and universities, of course), effective means for further development are now provided also by

. . professional and other associations (the American Management Association, for instance, offered well over 2,500 different educational events during 1967; they were attended by over 125,000 registrants; 20 years earlier the number of events was 12)

. . consultants

. . the companies themselves

. . and still others.

Methodology in use today bears little resemblance to that generally employed just ten or fifteen years ago. Adult education programs in particular have brought experiences onto the scene which could greatly enhance the effectiveness of primary, secondary and college level (very much including graduate and post graduate) endeavors.

A catalog that would list titles of offerings which have proved their usefulness in engineering management, would read like a complete roster of topics in every area of executive concern. Increasingly, subjects quite deliberately outside the area of business have made their appearance and shown their effectiveness ever since the pioneering experiments of AT&T in the early fifties.

The more sophisticated the audience involved, the more conceptual do those topics seem to become which attract maximum acclaim from the group. Less than twenty years ago, the inclusion of "philosophy" within an executive development program, for instance, would have been the rarest of exceptions if indeed anyone would have thought of it or dared include it. Today, and particularly in top management groups, this area stands, with long-range planning and business-government relations, at the very top of interest.

To permit the inclusion of at least a few more specific samples of effective management development work and related areas, we again quote the experiences of a company we interviewed. When their research showed findings which were potentially significant for managerial practice, they instituted Motivation Seminars. They were arranged in six two-hour sessions for all levels in the executive hierarchy, starting with top management. The first presentation was made to the president and those reporting to him. Eventually more than 2,000 supervisors attended this series.

It is interesting (because it is relatively seldom in executive development) that an examination was included in these Motivation Seminars at the midpoint period. It covered theoretic concepts

of motivation, was scored in class so that each item could be discussed and clarified further where advisable. The program also included opportunities for each participant

- . . to examine his own job and supervisory situation
- . . to identify specific applications of the theory which were meaningful to his realm of responsibility
- . . to complete a self-appraisal questionnaire and profile of his own managerial practices (in terms of traditional practice versus conclusions from motivation theory).

As a sort of follow-up to the Motivation Seminar series, existing attitude measurement programs were overhauled so as to align them for clearer identification of the various maintenance and motivation categories. Consolidated results are reviewed by corporate and division management. Each of the operating units receives a comprehensive report of these company-wide results in addition to those gathered within the scope of the department itself.

The manager in charge then sees to it that project teams are organized, through all of his supervisory levels, to pinpoint specific trouble spots, to plan and to implement corrective action. All employees receive, on a continuing basis, information on overall and departmental results, on action planned and taken.

Sensitivity training enjoys industry's attention in increasing measure. It aims at strengthening the awareness of the impact which each manager makes on his people through his communications, decisions, actions and other aspects of interpersonal contacts. Pioneered on the basis of group dynamics theory, it is employed in business in many and varied forms. One of the best known is that carried out by the National Education Association, first from a special "training" place in Bethel, Maine, which gave this type of work its more widely known nickname.

Another type of training effort, orientation for new supervisors, also has a new slant at Texas Instruments: At various spots, the operators participate in the introduction of their future bosses to their managerial responsibilities.

As a last illustration we should like to mention work simplification. It has been a fixture in progressive management for well over thirty years. Rooting in the fundamental concepts developed by Frank and Lillian Gilbreth, it represents a near-univerally applicable problem-solving approach, with heavy emphasis on participation by the individual.

In one TI program series, the standard approach is built around the formula

* define or clarify the problems
* explain the causes of the problems
* recommend corrective action
* define the positive factors in their areas
* explain causes of positive factors.

Another TI program named PACE (Profit Acceleration through Compressed Effort) begins with groups of managers and then broadens out to non-supervisory personnel. The manager in charge is the "trainer." He sets up "natural work groups," each of which has a captain. The latter continues his regular work assignment; but he also helps each member of his group who has an idea to develop it further and to write it up.

PACE, work simplification and orientation training for production supervisors do not seem, at first sight, to have special significance in engineering management. We included these examples, nevertheless, because of the conviction that the basic principles which have proved themselves so very well in manufacturing, could benefit other functions at least that much. Although we do not have experimental results to prove our point, we feel certain that this could be the case in research, development, analysis, design and other engineering functions. We believe that this is so because the crux in effective learning is motivation. With achievement such a formidable trait in the make-up of just about every creative individual, these types of training should be custom-made for use with scientists, engineers and other technical personnel.

On a number of occasions within this report, we commented upon the need for life-long learning (if we may borrow this phrase from the University of California) to increase effectiveness of professional personnel and to counter the threat of obsolescence before it arises. It is a safe forecast that progressive engineering management will pay increasing attention to the opportunities inherent in various educational efforts – way beyond encouragement of college courses or other educational programs in the subject area of the technical personnel. As effective managers, they will set the example by engaging in such efforts themselves while making them available to their scientists and engineers in a fashion that is properly tailored to their needs.

In every case, the focus must be the individual's specific requirements. This is not easy to accomplish when "standard" management development (or other) programs are the only vehicles in the

man's learning process. They can be a good starting point; but they are rarely able to do the whole job by themselves.

These pages have stressed, at many points, the need for the individual to learn more and to grow. And most companies have spent a good deal of money on activities which are aimed at achieving it. Why have the results been so often so disappointing?

Evidence gathered over many years and well beyond the boundaries of this project suggests that one reason accounts for this discrepancy more than any other. It is the fact that too many people who have acquired modern techniques or fresh skills, return to their positions only to find it difficult to use what they know. The existing work atmosphere does not harmonize with the new ideas. Action (send the men to "school" to learn novel things) and attitude ("let's not rock the boat!") are incompatible. As in every previous chapter, climate thus emerges again as the key factor for success or failure.

"Training," education, development or whatever the term, enables us to learn from the past. Those who won't, are condemned to repeat it.

Chapter 10 – THE MANAGEMENT OF ENGINEERS: MANAGERIAL PHILOSOPHY[1]

Its Roots: Society

It is not only what we do, but why we do it that counts. Like any other activity, management has two distinct operating planes:

* its techniques and tools, processes and practices (planning, supervising, reviewing, etc.) Chapters 5 through 9;
* its philosophy.

The latter constitutes beliefs, attitudes and values. At best, the former (techniques) are crutches which implement the skill and experience of the individual who applies them. More powerful than the finest tools are the frame of mind, the attitude, the philosophy of its user. It penetrates every nook and corner of thinking and action.

The attempt to use one, say techniques, without the other, philosophy, is folly. Such separation has been the cause for failure of innumerable managerial projects. For example, a suggestion system in a company with rather centralized responsibility and authority is likely to bring few results beyond frustration for those who submit an idea.

Many people believe that managing is foremost a mental attitude because results are so strongly influenced by the way managers feel about people, leadership, their obligation to innovate and to explore, to create opportunities and so on.

To an individual or a group, to a company or a nation, philosophy is so significant because it combines a taxonomy of values with a system of motivating beliefs. A life without philosophy

1. As befits a research study, every conceivable effort has been expended to keep these pages straight-factual except where our judgment has been clearly indicated as just that. Of course, any person's "objectivity" must be subjective to some degree.

The authors request the reader's indulgence when, in contrast to this basic approach, the discussion of something as personal as "philosophy" shows our own beliefs on a number of occasions. This seemed necessary in order to protect the observations on this subject from becoming so general and esoteric as to endanger their mission.

dooms us to an existence of total meaninglessness. "For what is a man profited if he shall gain the whole world, and lose his own soul."

Philosophy and society are closely intertwined. They exercise reciprocal pulls on each other. Both have been shaped by history, culture, education, religion and many other donors in traditional and novel form and any shade in between.

Over decades and centuries, these forces have developed our habits and customs, likes and beliefs, values and still many other ideas and actions. They have been joined by a host of perhaps more contemporary agents, such as politics, information, economics, etc. This heritage is alive in every moment's thought or event. Where it is suppressed, · :e one of the more explosive situations in these not entirely tranquil times.

Representing society, this complex array of factors exercises its influence at all times on every individual, any group, each company and the nation as a whole. The resultant effect is often neither rational nor logical nor easily explained in any way. It is simply there. While hard to unravel after the fact, it is even more onerous to foretell.

Yet these reactions are one of those inputs in any decision which, say, a business makes. And when public response has been misjudged, even the most carefully planned project falls short of its anticipated success or fails entirely.

The carefully engineered safety campaign of the Ford Motor Company, for instance, some ten or fifteen years ago, was close to a marketing fiasco. But today the very essence of these efforts is accepted; it will probably be taken for granted, as a matter of (by then established) tradition, in another few years.

Dissecting the influence of the environment, that is of society, upon business or government or any other institution represents an undertaking way beyond the scope of this project.

However, two general conclusions may be stated:

. . Just as the philosophy of any sector of a country, the philosophy of management has to be in harmony with that of society. If this is not the case, conflict is inevitable; if it is not immediately visible, it is that much surer in coming.

. . Executives at every level in the corporate hierarchy must include the environment in

their calculations. At the present state of knowledge, this requires judgment perhaps more often than will be the case when we know more about society itself.

Its Focus: The Individual and His Group

The highest authority in the United States, the Constitution, has placed the Human Being as an individual squarely center-stage. This governs–should govern– the role of each person not merely in the affairs of state but in business efforts, educational activity and every other aspect of endeavor.

Each individual has a dual role:

- . . He is the means by which society is formed and its very end.
- . . He is the cause for the existence and the functioning of any democratic group and simultaneously the judge of its efficiency.
- . . He is the key building element of the nation's life and the ultimate objective of the social organism around him.

John Stuart Mill commented: "A state which dwarfs its men in order that they may be more docile instruments in its hands even for more beneficial purposes, will find that with small men no great things can be readily accomplished." We cite this quotation because it also applies to the business scene when we replace the word "state" with "organization." A similar thought was expressed in more modern form when a picket in a strike of engineers at an aerospace plant carried a sign: "I am a human being; do not fold, staple or mutilate!"

Of course there have been – still are – many instances in which business, government or other practice does not always place the individual into the position which he deserves and in which he can do his best. We suggest that the cause for this is not necessarily insensitivity on the part of the management. It is rather, in many cases, a reflection of something much larger and much more influential, namely of society itself.

The relationship of the individual with the group of which he is a member, has been a matter of intense debate since the start of recorded history. One of the most baffling questions has been: At what point should the group take over the priority position of the individual – in full or in part?

Answers from any point on the wide spectrum between the two extreme possibilities have come from different societies, cultures, economies, religions and other bodies. The authors agree with those who feel that the choice depends on where the greater Good lies that needs protection against possible encroachment from lesser values.

A great deal of research has been done on the individual person and his role in groups. Most of this has been within the past few years and decades. There is very little that predates this generation yet remains valid. The roster of major contributions must include such names as Argyris, Bavelas, Blake, Costello, Haire, Kahn, Katz, Lawrence, Likert, Litterer, Maslow, McClelland, Pelz, Shartle, Zaleznik and others. We have chosen Douglas McGregor as their spokesman for several reasons:

* His comments are based on his own work and that of a number of others.
* His observations have been borne out in progressive business practice perhaps more widely than others.
* His writings have been more widely read by executive audiences than the books of many of his colleagues, perhaps because of his careful avoidance of too much "jargon."

McGregor talks in terms of two contrasting views, Theory X and Theory Y. The former is based on opinions on how people behave and on how many organizations think they do. These views are still widely held by most commercial, industrial and governmental practice as well as nearly everywhere else in the United States and way beyond it, probably all over the globe.

The principles of Theory X are:

. . Since management is responsible for what a firm does, the company comes first in their thinking.

. . Human efforts have to be directed by the boss to assure attainment of organizational goals. Thus the manager sets objectives for his people; controls their actions closely; and modifies their behavior to fit the needs of the enterprise.

. . An arrangement where thinking and power are concentrated at the top is better for all concerned.

The rationale underlying Theory X is that the organization will operate better and produce more in the impersonal climate of authoritarianism or paternalism. This is so because people do not like to think; that is why management has to tell them what to do and how to do it. Also people do not like to work; that is why management has to hold a club over their heads.

There is no question that very many persons behave like this in sizable sectors of business (some schools, homes, government agencies and other parts). However it is pretty certain that this is not the consequence of man's nature. It rather seems to be the result of the treatment (including some management policies, practices and philosophies), which uncounted millions have been experiencing over decades and centuries. Once this contention is proved beyond the shadow of a doubt, the conventional approach to dealing with people that underlies Theory X will become a classic exhibit of a mistaken notion of what is cause and what is effect.

In contrast, Theory Y rests on modern behavioral science research on how human beings w o u l d behave without such constraints. It has been put into practice by as yet a small minority of the more progressive firms. Their ranks, though, are swelling at an encouraging rate. The principles of Theory Y are:

. . Management does not merely have, as under Theory X, the responsibility to direct the enterprise but also to develop its human assets.

. . Success of the company can be increased materially when the individuals whose efforts make the advance of the organization possible, progress too.

In pronounced contrast to Theory X, the rationale behind Theory Y is that people like to think – though not merely about the business and its advancement, but also about themselves and their aspirations. It proposes that people also like to work; positive motivation toward that end is a much more powerful influence on human behavior than negative forces such as imposed direction.

Illustration 29 compares Theory X and Y; and illustration 30 recaps some typical results from both (see following two pages).

	Opinions reflected in Theory X	Research findings used in Theory Y
1. Man's Nature	the push button idea of man	realization of the complexity and of the continuous shifts in human needs, desires and ambitions
	homo sapiens shuns work as much as he can	he works as naturally as he plays and rests
		depending upon the situation, work can be either a source of satisfaction or of punishment
	people are inherently lazy	many individuals are generously endowed with initiative, ingenuity and imagination – if we would only let them use these talents.
2. Goals	company objectives are supreme; employees must pursue them	a healthy human being will voluntarily accept corporate goals as means to reaching his goals, but he has also very distinct ambitions of his own
	the aims of an organization and those of an individual are in conflict	personal and organizational objectives are compatible
	most individuals are not interested in the company	they commit themselves to all kinds of endeavors depending on the rewards which come from their achievement; (for many, the most significant reward is the opportunity for self-actualization)
3. Motivation	man has to be led by fear of punishment or deprivation of some kind if the firm wants to get anything done	most people respond to many influences, very much, including self-propulsion and self-discipline
	all but perhaps a few prefer to be treated this way because they like to shun responsibility	the majority do not only accept, but (can learn to) seek and treasure responsibility

Illustration 29: COMPARISON OF THEORY X AND THEORY Y

Theory X	Theory Y
organization reaches its goals and is satisfied	company enjoys better operating results, attains higher objectives enterprise and employees reap greater satisfaction
force breeds counter-force; antagonism, hostility; as a minimum: resistance to change	synergy can go to work: The overall results for everyone are larger than each could hope to achieve for himself
no or stunted development for most except possibly a few at the top	opportunities for growth for those who want them
narrow power pyramid	wider, more effective and more equitable distribution of responsibilities
clogged communications	better two-way flow of information
management policies, procedures, methods, rules, etc. manage people	people manage the system
a climate of subordination	a climate of collaboration

Illustration 30: TYPICAL RESULTS FROM THEORY X AND THEORY Y

As climate has such a heavy influence, especially with creative people, the differences between Theory X and Theory Y climate are likely to show salient features such as these:

Theory X	Theory Y
Compliance and conformity	Individuality
The power of unilateral and increasing pressure	The supremacy of teamwork
The compulsion of fear	The stimulation of reasoning
The law of force	The force of the law of the situation
Lethargic, fatalistic people	Active people
"Dictators ride tigers they dare not dismount; and the tigers are getting hungry."	"All men are created equal . . . endowed by their Creator, with certain inalienable rights."

Illustration 31: Climate under Theory X and Theory Y

A "contributory climate," as proposed in the concluding section of this chapter, incorporates, among other distinctive points, all of the cardinal characteristics of the Theory Y column.

Some of the leaders of industry and government have followed the ideas of Theory Y long before McGregor formulated them. Because of his research and the work of others in the field, it is now possible for every manager to act in more effective fashion. The pioneers of progressive management did by instinct what we, their pupils, can do now from knowledge.

As the great majority of contemporary practice more nearly resembles Theory X than Theory Y, the problems of transition from one to the other are a matter of downright practical significance. They are caused, in the main, by the need to widen the limiting vistas about the foundation on which Theory X rests.

This demands changing, not our character, but rather our beliefs about people. It calls for greater sensitivity on the part of the manager to others and their reactions to him. It demands a much more sophisticated and individualistic approach to dealing with people. It affects managerial strategy, policies, procedures, philosophy and any other form of managerial thought and action. It requires personal growth and maturity.

Theory Y works best in a business setting that is used to change. This includes the aerospace industry for which Theory Y should therefore be of more immediate practical concern than it may be for more traditional industries.

The transition from Theory X to Y is more nearly a life-time effort in most cases. And it is not always successful. This is so because X and Y are the extreme points on a spectrum. There are many variations, lots of possible mixtures and combinations, manifold interim points. But there is no upper limit, at the Y end, to a real leader's ever-growing capability to attract ever-more competent followers and to enlist their potentially ever-increasing talents for ever-more challenging opportunities with ever-rising results.

The focus of Theory Y is the individual, with his needs and ambitions, his actions and reactions. Placing him at the heart of the philosophy of modern management combines the discoveries of the most novel research with the traditions of the mainsprings on the strength of which our country has been developing for nearly two hundred years.

Its Significance: Management's Mission and Leadership

What is Management's Mission? Progress = Profit + Service

The individual business is a (sub) sub system in a larger system, namely the U.S. economy or the world. This is why the orbit that circumscribes the reciprocal influence between a company and its environment is so wide. The effects from the operations of a firm are evident not merely within the corporate confines but way beyond them. Consequently the enterprise has to take its surroundings into full consideration even in decisions and actions which seem to concern internal matters only.

The objective of any effort includes progress. In business, it must benefit many. Obviously the organization which produces it is entitled to its share. So are the individuals who made this achievement possible, that is the employees, owners, customers and all those who are affected by management's actions in the direction of the activities of the enterprise. This includes

* vendors
* subcontractors

* other business establishments
* the community
* government
* and still others.

For business, "progress" has always included profit. This is so because profit is the economic lifeblood of a free enterprise economy. U.S. business need not defend itself against the view held by a miniscule minority of ignorant people who think that making a profit is improper or immoral, insidious or close to illegal. The record speaks for itself: The exceptional instances of unconscionable profits serve as proof of the rule by the very contrast to the vast majority of others.

On the contrary, we believe it is improper, immoral and insidious not to make a profit. This would threaten the livelihood of employees. It would cause losses to investors. It would endanger the business of suppliers; and it would deprive the community of a potentially productive facility.

To quote Mr. Haggerty, Chairman of TI: "We do not exist to make a profit. We exist to create useful products and services; and it is the opportunity to operate at a profit that is the incentive to create, make and market these useful products and services for our society."

The manager also exists to make the enterprise serve the community more effectively. Since Henry L. Gantt first expressed his pioneering thoughts on this (see also Chapter 8), the leadership of U.S. business has made continuing headway toward this goal. "Service" is a difficult concept and a new one to some firms. It aims at achieving some common good. It is performed in recognition of the legitimate aspirations which exist within and outside the organization. It embodies a personal commitment to society which should accompany any contrast among moral men.

Mr. Gantt observed nearly fifty years ago: "Under autocratic methods, to render service is a sign of inferiority; the man of power compels the service of others. Under democratic methods, he has the prerogative to serve." Service blends private corporate interests with concern for the public good. Each specific company must reinforce, within its sphere, the efforts by others to maintain a healthy nation for all its citizens and to accelerate lasting progress. Service is a corol-

lary to, and the correct exercise of, the right to leadership in a free society. It acknowledges that the ultimate function of the manager is to organize and deploy the manifold resources of society for the elevation of human conditions.

A few examples of such opportunities on a broad national and international scale are:

. . The increasing challenges to mankind by the physical imbalances and human conflicts that mark our times.

. . The preservation of our natural ecology which has assumed a new dimension of urgency.

. . Speeding the material progress of developing nations before they are engulfed by revolution.

In a scope that is more readily manageable within one company, it is "service" when management recognizes the mutuality of interests on the part of (at least some of) its employees and of the organization. This should apply particularly to those in the work force whose thinking forms the basis of the entire business. In an aerospace company, this means a goodly portion of its scientists, engineers and managers.

It is "service" when these men and women have the opportunity to develop while at work; when they thus become more responsible and more mature individuals; when their loyalty to the business makes them as proud to be on its payroll as they are to be citizens of their country; when they can advance -- renew -- themselves as they contribute to the progress of their organization.

It is "service" when management pulls up to the peaks of the economic performance of the firm those aspects of its operations which have not yet reached that height.

We believe that it is the combination of profit and service that counts. Society needs both of these results. They are symbiotic. That is, they have to exist simultaneously since one needs the other. Profit without service can become thievery; and service without profit may mask as charity. The executive is neither a pickpocket nor a social worker. He is a leader of men through whom the material and human assets become useful to the nation.

We submit further that it is the union of profit and service which adds up to progress. Thus management's mission, progress, is achieved when the results of the work it directs include profit and service – for the customer; the firm itself; the owner; and everyone whose life is affected by the activities of the corporation. Even when this is the case, a second decisive

point is the make-up of this progress, with every aspect of its size and spread, calibre and character, singly and collectively.

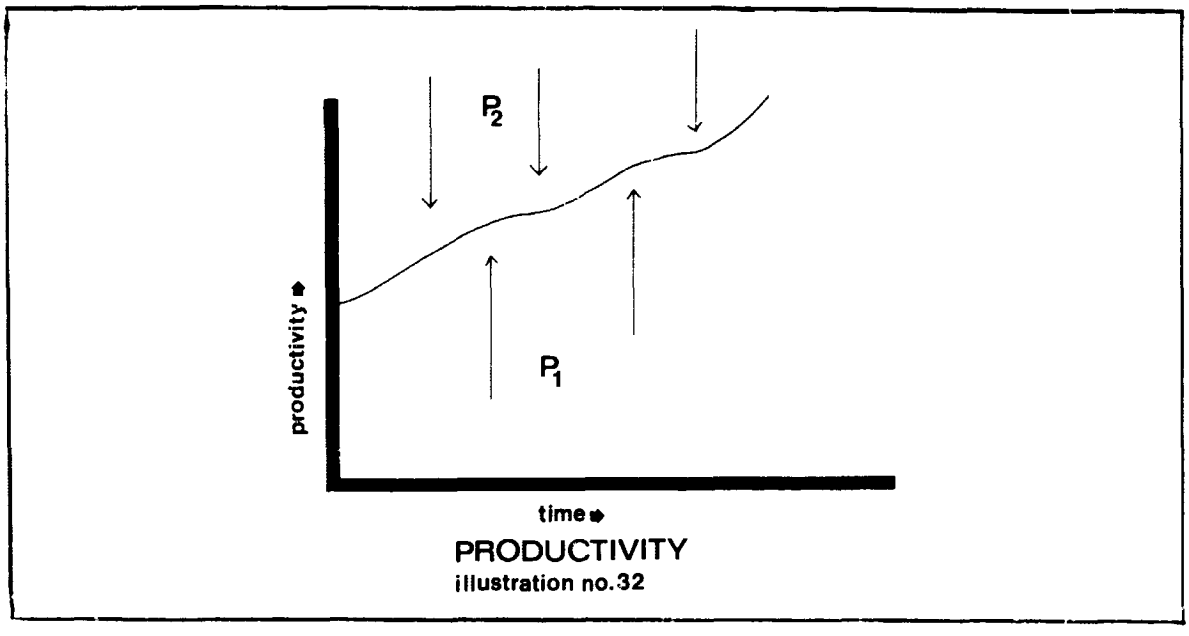
These thoughts are advanced on behalf of the aerospace industry. They are quite generally applicable throughout business. The specific form which they take in a specific company depends on the objectives, personnel and environment. Our comments on the various parts of management's task (planning, etc.) have been based upon this concept. It is in the preceding chapters (2 to 9) then that suggestions for specific adaptations are spelled out.

A mission is based on objectives. But many a goal that seemed worthwhile, when first advanced, has faded into oblivion when no practically useful approach to it could be found. This is why it is proper to show the feasibility of the targets inherent in management's mission as just proposed. The road that leads to successful accomplishment of this mission has two main arteries: Productivity and Innovation.

How Is the Mission Accomplished?

1. Productivity

Productivity – we are using this term in its broadest possible scope – represents the ratio of output over input. A probervial feature of U.S. society, its development over time shows a consistent long-term trend upwards (Illustration 32).



The traditional approach to productivity has been an analysis of the forces p_1 through which the graph could be pushed up. Pressure from supervisors, many financial incentives, control in the "old" form, general bonuses and similar influences are typical examples. Cause being more significant than effect, we suggest a shift in emphasis by greater attention to the forces p_2 which have been holding the curve wherever it may be. Among these are

* economics
* reluctance to work hard(er) and other expressions of a person's motivation
* social pressure from groups, such as the admonition "not to work yourself out of a job" and additional evidence of the group's motivation
* the calibre of management and its impact on the personnel in the organization.

It is not surprising that motivation represents a dominating force also on this scene. As long as it remains shackled, it will be one of the forces p_2 which retard productivity. Yet here as elsewhere, its latent power can be unleashed by better management and its grip on productivity shifted from a braking to an accelerating position.

It is interesting that a huge and highly prestigious study[2] appears to confirm our reasoning from an entirely different point of view. Intended to investigate the causes of economic developments (or their lack) in Great Britain – balance of payments, economic growth, etc. – it was conducted of course completely independent of the efforts which underlie this report. Published in June 1968, it contains many conclusions which go well beyond those pertinent to these pages.

What we refer to here is that part of the explanations which the Brookings Study gives for the existing situation in England. Among other influences it points to a measure of productivity, namely the output per worker that comes from "advance in knowledge, better management, better methods, imagination and hard work." This indicator rose but little in that country; all except one of the areas it covers (which we underlined in the preceding sentence), are some of the very aspects which the conclusions and recommendations in this report endeavored to highlight as stepping stones to progress via the productivity route.

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2. Entitled "Britain's Economic Prospe. ," the study was made by the Brookings Institute under the direction of Dr. Richard E. Caves, Harvard University.

2. Innovation[3]

We are aware of no case in which progress has been possible without change. Obviously the intent has to be innovation for the sake of progress, not for change as such.

Change in behalf of advancement has long been recognized as being economically attractive. It is only in more recent years that we find it also representative of a specific managerial leadership style. Most if not all executives put emphasis on effective operations. This represents desirable change -- as far as it goes; but it does not go very far when organizations are content only to do what the other fellow does, although they try to do it better. It still remains the same thing.

An enterprise without change is an enterprise without much life. In contrast, innovation provides an enormous stimulus to progress. It has become one of the crucial dimensions in the mission which forwardlooking leaders have set for themselves. Management plays such a decisive role because, to be successful, innovation needs not merely to be encouraged but put to work. Maxwell discovered the scientific foundation for the generation, transmission and reception of what were later called "radio waves"; Hertz succeeded in producing them experimentally; but it was Marconi and Sarnoff who made these discoveries a commercial reality.

For full effect, top management itself should participate in the innovating process. This does not mean that it is they who will think up all desirable changes; their unwavering support is needed, though. More importantly, their own attitudes and actions have to demonstrate at every turn that change is welcome here. Innovation in the interest of progress has to become a way of life that characterizes the entire organization from the summit down and all the way up again. Hesitation to exercise such leadership is tantamount to abdication of managerial responsibility. It could conceivably jeopardize the future, the very survival of the enterprise.

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3. The companion study to this one will produce a paper on "Innovation" under the authorship of Dr. Fred Landis, Professor and Chairman of Mechanical Engineering, New York University. This is why we are limiting these comments here to some aspects which have a particularly close bond to the problems of management philosophy as discussed in these pages. For example, the difference between "improvement" and "innovation" has been disregarded.

If any company (group, organization, nation, etc.) should believe that continuing development is n o t necessary, it testifies to the fact that it has already embarked on the inevitable road to decline and eventual surmise. This is the case even though it may enjoy the highest prosperity right now. What it needs is a change in its course to include change.

Increasing orderliness and systematization are at times mistaken for innovation. Mr. Roy L. Ash, President of Litton Industries, put it this way: "The manager who revels in order and methodology . . . will still be shuffling his neat pile of papers when his results-oriented competitor will have reached his goals." Commenting on those who defy the need for change, Parkinson suggests that the last act of a dying organization is to get out a new and enlarged edition of its rule book.

Innovation is needed not merely in research, development and design. Although such comment goes beyond the scope of this project, we want to mention that it is equally mandatory in any other function, such as, for instance,

* in manufacturing (a classic example: automated assembly lines; or numerically controlled machine tools)
* in marketing (systems selling; supermarkets)
* in finance (mutual funds; GI and FHA loans)
* in personnel (programmed learning; the steel industry's Human Relations Committees and their year-round work prior to contract negotiations)
* in transportation (containerization; the Tokaido Super Express)
* in communications (television; satellites)
* and indeed in management (influence of philosophy and climate; the nature of contributory leadership).

Going one step further, innovation in the form of economic development is also one cornerstone for the security of an entire nation, witness the significance in the dichtomy of developing and developed countries. The last term is another indication of the sad state of semantics; possibly unavoidable in a field that is still in its early stages, it is nevertheless a particularly regrettable choice. A developed society certainly needs further development if it is to progress.

Of course, there can be too much change or too fast change. In many cases, technical innovation needs support from social changes. It happens frequently that, although one exists, the other may not yet be ready. The threat of dislocations, for instance, may be too great, at least without the

time lag needed to adapt to the altering or altered circumstances. The problem of resistance to automation is one of unfortunately too many other examples. Is the occasional objection to space exploration another one?

The creation of an equilibrium between tradition and change thus becomes one of the key considerations in managing innovation. As pointed out in Chapter 5, there is strength in both. Doing away with all "old things" is as bad as outright rejection of any innovation. The crux is a judicious balance which assures the greatest amount of advantages with minimum shortcomings. Decisions on the extent (and also the timing) of change represent some of the most sensitive and critical tests for executive judgment. Without these precautions, innovation can imperil stability; when properly managed, innovation assures stability-in-motion.

A target as ambitious and difficult as innovation faces many obstacles. Among the more frequent barriers are

* insensitivity, resistance, even hostility toward change
* nostalgia for the "good, old days"
* "stupor of mind and spirit," as John Gardner put it
* lack of understanding of what is involved
* memories of sad experiences with earlier change
* and possibly as many additional reasons as there are people, and still more.

All of them are rooted in the mind although quite a few have been planted there by the external environment of life and work. Every single one reflects a reluctance to move into a new direction. The surest antidote is the creation of such movement on the volition of those who don't. This brings us back to motivation. It moves people ahead – under their own power.

It does so especially well when the consequences of innovation appear to the individual(s) who has so far resisted it, to be in his favor on balance. Rightly or wrongly, he cares much less about the effects of change upon the company. It is his own self which counts. Thus emphasis of opportunities for growth, maturity, recognition, self-realization, renewal, and other personal advantages is as important as it is truthful.

However, it is not only w h a t is at stake that motivates a human being; h o w it is to be accomplished has similar influence. This is why the progressive manager should be concerned

not merely with the fact that there will be change; he ought to be equally alert to the manner in which it is to be effected. We are indebted to Mr. James O. Jensen, Associate Director, AMETA, for the thought that a hitherto perhaps neglected aspect of innovation is the way in which change is introduced.

Executives insist upon establishing and maintaining order. This does not facilitate change. To accomplish that, too, astute management provides, deliberately, opportunities which permit the change of this very order – in orderly fashion. Persistent guard over the preservation and effectiveness of this type of arrangement is important since change is the one thing that will not change.

Innovation and Productivity are the two primary means by which business reaches the ends inherent in management's mission, namely progress in its blend of profit and service. They need a catalyst – leadership. Responsibility for the accomplishment of the mission rests in leadership.

Leadership

This is another subject for which business can draw not only on its own experiences but on the lessons of history as well. There is so much source material because the chronicle of the world embraces such prodigious evidence. It illustrates magnificent and devasting consequences from the actions of the most diversified kinds of leaders. It demonstrates what happens when leadership succeeds or fails, is absent or impotent, usurped or overpowering.

There are wide differences of opinion on the matter since leadership is something so acutely personal. One's philosophy is at its heart; personality, skills and experience; knowledge and culture; the situation and the people involved; time pressure; and indeed the mission itself – these are just a few of the other influences which mold individual styles. Even when considering only one specific pattern, its underlying concepts take on quite varying shapes in the hands and minds of different people.

We limit ourselves to a brief discussion of one form because these studies have confirmed our conviction that this type is clearly superior in conjunction with the mission of management just proposed. We have termed it "contributory" leadership. It bases itself on a philosophy whose foundations are the principles, attitudes and beliefs developed in this report. They suggest that

. . the prerogative to lead is the crucial activity of the executive

. . he is personally responsible for the results from the efforts he directs, and for the means by which they were attained

. . power with,[4] rather than over people is most effective in the long run.

This leadership is contributory because of the boundless opportunities which the manager can create for useful contributions from all conceivable sources to the success of the undertaking at hand. The following two points are paramount.

1. Legitimacy in the Use of Authority

Evidence of legitimacy accumulates as authorized personnel is engaged on approved projects in permissible manner when

* there is voluntary cooperation, not coercion or manipulation of those led
* duty comes before right
* authority is a means, not an end in itself
* it aims at achievement, i.e. fulfillment of the mission.

Just as society influences each of its parts, i.e. also a firm, so has the latter the opportunity to make an impact on society. Before an enterprise can succeed in advancing a thought or action, management must often pave the way carefully and thoroughly to facilitate acceptance. Being entrusted with the direction of activities, management owes this leadership role the obligation to make its capabilities felt in the broadest appropriate sphere. This charge reflects itself in many ways. It includes

* 1. above all, the attainment of management's mission, in all its aspects
* 2. the advance of productivity
* 3. the creation of the proper mixture of innovation and tradition
* 4. the judicious deployment and utilization of all of the resources at its command – at least most of the time
* 5. the responsibility to be the spokesman on their behalf
* 6. last but indeed not least, the generation of a climate that fits the mission and the prevailing style of leadership; the project, its opportunities and constraints; the people and their surroundings
* etc.

4. This term was coined by Mary Parker Follett; see bibliography under L. Urwick and H.C. Metcalf, the editors of her writings.

The first four have been dealt with in this and previous chapters; the sixth will be discussed a few pages hence ("contributory climate"). The fifth deserves a brief comment right here.

When we know our cause is right, steadfast pursuit of what we have found to be proper – after enlistment of the best possible competence; after thoughtful study and judgment, appraisal and re-appraisal – is a sine qua non for those in a trusteeship position. If there is opposition, persistence in our mission is one of the finer examples in the legitimate exercise of authority.

But there is a corollary of equal importance: There has to be persistence also in attempts to dispel the reasons for the existing antagonism. This means the exertion of every possible effort to turn as many as feasible from obstructing forces into supporting allies whose motivation parallels the direction of the subject concerned.

This second task demands at times more than the first. Not always is the environment ready to fall into line. The recognition of what has to be done must often span an awesome gulf before it reaches those affected by the contemplated action and solidly adverse to it.

More and more executives view their authority as a legitimate opportunity to educate others to the necessities of the situation; to lead, not to drive them to appreciation and acceptance of whatever may be at stake. The leadership style of the progressive manager relies on voluntary and willing agreement, not on machinations or force. NASA's reaction to questions raised in some parts of the country about the advisability of the scope of our space effort is a splendid illustration of the thoughts just expressed, i.e., of the responsibility of the stewards of a mission to be the irrefutable spokesman on its behalf.

2. Followership

Leadership in a free society carries with it the obligation to acquire a followership and to maintain it. Its constituents are individuals. God has endowed each with many faculties – to use, not to leave dormant. The workplace still provides the best opportunity for most of us to exercise this privilege. From such activity comes back to man, in return, (profound) satisfaction with the work done and with its results.

The theme is perhaps best expressed in the word mutuality (or system). Where, for example, one individual's contributions move things forward, he has earned for himself the right to free-

dom of information and action to the extent to which this furthers his role in the firm. As he enjoys this, he has to be willing to accord it to others who also need it. Foremost he must be ready to abide by the company's right to the same prerogative because it was that organization's philosophy which set the tone for the relationship.

The same goes for respect. Where one man's efforts are successful, he is entitled to recognition. If his work is not deemed worthy of acknowledgment, why let him do it in the first place? Yet as he expects respect for himself on the strength of his contributions, so does he need to extend it to others who also merit it because of their labors.

Management's leadership position requires that it takes the first step. But where management starts the cycle, the employee has to close it. When he gives his employer what is properly due the corporation, he has earned for himself continuation of the situation. Conversely, chronic failure to reciprocate can – and should – end the privilege of remaining a member of a free society and of enjoying the advantages inherent in the system. Mutuality is a two-way street.

An identical line of reasoning applies to results. What benefits the project should bring a gain to the individual who advanced the undertaking – and indeed vice versa. One without the other could become exploitation; one coupled with its counterpart is "service."

Its Power: Contributory Climate

Leadership and mission reflect philosophy; and philosophy-in-action becomes the climate in which men live and work. Like philosophy, climate is invisible; like the electric current we cannot see either, climate represents a potentially paramount force. Its influence is all-pervasive. It is responsible for most of the conditions (stimuli) which the individual perceives at work, consciously or not, and which affect his thinking, conduct and performance. For example, one employee may be happy to stay after hours to take care of a sudden rush situation; another one, working in the same climate, may not be ready to do so.

Climate has a direct impact on our actions, too. A beneficial spirit will, when governing good deeds, elevate them to ever-higher levels; were such a spirit to guide questionable actions, it would succeed in mitigating their otherwise fully unacceptable consequences. Conversely, a sinister

philosophy is likely to pull down what would else be effective activity.

The penetrating influence of climate on everything is illustrated also by the fact that so many comments in previous chapters had to refer to these pages.

The first attempt to measure "climate" in a company was made, to the best of our knowledge, through the initiative and under the leadership of Mr. Harleston R. Wood, Chairman and President of Alan Wood Steel Company. We have not been able to find any source which has gone beyond the result of this pioneering work although ten years have passed since. As an example of the exceptionally skillful and practical design of the index which records if a desirable climate[5] exists, we merely quote one component:

> "A department head does not mind missing a meeting and sending a subordinate who he knows will probably disagree with him about some parts of the agenda. And this subordinate presents to the meeting not only his own opinion but also the (different) opinion of his absent boss."

We are indebted to Mr. Wood for these additional thoughts: "A perfect climate[5] exists

* "when any two people in an organization feel free to talk to each other openly and with complete frankness about anything that interests them about the organization;
* "when they feel they can do this with the absolute certainty that no one will resent their having done so;
* "and when this freedom of communications encourages people to compete with each other for advancement."

Mr. Wood continued: "This would be perfection. I am certain that most of us could feel that we have improved our climate[5] a great deal if we brought it up to a level considerably lower than this.

We have termed "contributory climate" the atmosphere that contributory leadership creates. It is an environment of progress. It is characterized by the acknowledgment of the uniqueness of each person. It transplants onto the business scene some of the basic principles which constitute the essence of our national form of government. This seems eminently proper since both, government and business, are parts of the same society.

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5. Mr. Wood actually used the word "atmosphere."

This climate[6] replaces fear with reasoning. It cultivates fairness. It merges efficiency with enjoyment. It unshackles motivation. It promotes responsibility and insists on strict personal accountability.

It allows each man to safeguard his integrity when he joins others in a group. It fosters the voluntary assimilation of these people, with their individualities intact, into one smoothly functioning whole. It supports communications and other interactions within and beyond their circle as circumstances permit this in the pursuit of their tasks. It recognizes that the aggregate of the contributions of just "average" people who make up the team, is superior in the long run to those which any o n e individual could make unless he were a genius. It relies as much as possible on self-determined cooperation and self-discipline for coordination and control.

It is a contributory climate because it rests on farthest-reaching and sovereign contributions by its populace. It admits to its realm everyone who is competent in whatever the work is that has to be done; in addition, he has to be willing to do his best on behalf of his company, his group and himself. His membership is valid as long as his contributions warrant.

This climate aims at fuller utilization of existing skills and talents, experience and knowledge. It enables each person to acquire fresh ones to the extent to which he earns this privilege by unstinting use of what he already has. It supports growth. Through ample opportunities for goal-connecting (Chapter 3), it stimulates dedication-to-achievement. It is result-oriented.

It nourishes the spirit as it allows individuals and organizations to "realize themselves" in their work. It raises productivity and invigorates innovation. It reinforces adaptability to change through an ordered yet flexible system that has thoughtful provision for the change of this very order in orderly manner.

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6. We do not claim, of course, to have invented the underlying concepts. If we are fortunate, our observations advance them to a small degree. Our description is intentionally optimistic. An approach to the state proposed is quite possible today. It is more than that; it is necessary if developments in the years immediately ahead are to make these ideas the practical reality which they can, and deserve to, become.

We respectfully submit that contributory climate foresees an advance which is much less staggering than NASA's acceptance in 1960 of the task to land a man on the moon ten years later (Illustration 33).

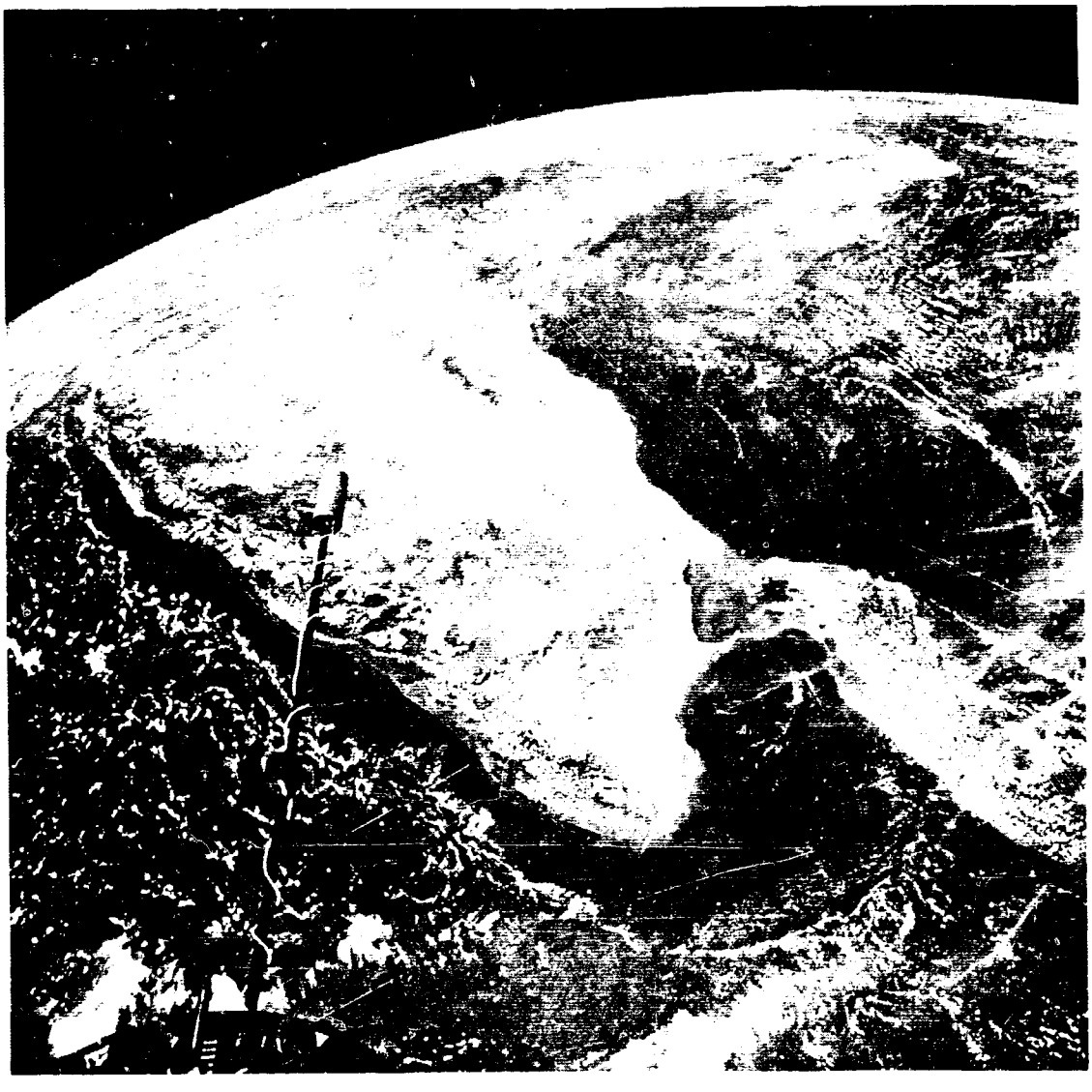

Illustration No. 33

Gemini XI over India, photographed from a distance of 540 nautical miles above the earth's surface, looking north. Ceylon and Bay of Bengal to the right; Arabian Sea to the left. N A S A photograph.

It makes the "control limit" for achievements surge upward because it triggers multiple chain reactions:

* For one, as motivation grows, results rise.
* Secondly, the contributions which each member makes to the success of his company, are mirrored in the returns which he receives.
* Thirdly, the advancement of the enterprise enriches the environment, i.e., society.
* And finally, all three are – should be – operative in inverse sequence as well.

What progress that adds up to!

Contributory climate is rooted in an economically and socially sound philosophy of business which, in turn, spawns management's mission. It is created by contributory leadership which counts, among its constituents, people whose distinguishing watchwords are Capability and Courage. They are identified by their Dependability and Discipline. Their hallmarks are Vision and Vitality; their credentials – Ingenuity, Intelligence and Integrity.

They represent a force whose sound Judgment, Experience and Knowledge entitle it to make decisions. They are a mainstay of our economy – this team of progressive scientists, engineers and managers. They deliberately develop the Productivity of the resources in and for their organization.

Their Creativity and Common Sense entitle them to stipulate when Tradition will take precedence or when Innovation is called for. Their stature shows itself in nothing more clearly than in their Humility. They realize that it is what the most vapid individual can bring to the situation that enables others to exercise Leadership toward Progress in a free society.

Chapter 11 – STUDY HIGHLIGHTS

Summary of Findings

The objective of this project has been the identification of the major factors in engineering managing practices and attitudes as well as their effect which help obtain a better understanding of the interdependence of engineering and management. Our comments dealt with these two factors, i.e. (1) with the Engineer and his work (in Chapter 2) and (2) with Engineering Management (in Chapters 4 to 10); one of their links, Motivation, was taken up in Chapter 3. Conclusions were discussed in detail in every chapter. The pages which follow, highlight some of the major findings.

Chapter 2 ("The Engineer: The Man and His World"): We began our analyses with a composite of the typical traits of engineers and drew a number of conclusions among which these seem most important:

> . . There is not such a person as a typical engineer or typical somebody else. There are only individuals. Each is different, unique, an entity in himself. Each tries to live and work to be himself.
>
> . . The value systems of engineers and managers differ. To a large extent, this is caused by differences in their work, its objectives and its role within the organization. If these dissimilarities are disregarded, mutual understanding is much more difficult. Conversely, appreciation of the scientific and engineering viewpoint enables the skillful executive to improve operating results considerably. It also makes possible a significant change in the attitude of technical personnel and, as a result, in the calibre of their work.
>
> However our culture, with its distinct orientation to managerial values, emphasizes the existing schism. It will perpetuate it until there is much wider understanding and recognition of the engineer's contribution to society.

Chapter 3 ("Motives in Action"): Because of its overriding significance in every phase of engineering management, we discussed motivation as a separate item, utilizing a large number of the more fundamental research findings in that field. To capitalize on them, we suggested numerous specific steps:

. . Most individuals are strongly influenced by their motivation in their behavior and thus in their work performance. Some existing (engineering) management practice works to the detriment of motivation. One of the major pitfalls is the failure to distinguish between maintenance factors and motivators. This stifles the creative individual. It also dooms those who are content in their rut to remain "bricklayers" for the rest of their lives.

. . The authors offered the concept of "goal-connecting" as the approach by which the individual reaches his personal ambitions, at least to some extent, as he helps his firm attain its objectives.

Chapter 4 ("The Systems Approach to Management: The Management Cycle"): We looked at managerial practice on the basis of a simplified model of the process of managing.

. . We proposed as its subsystems those of (1) Planning, (2) Direction of Operations and (3) Review.

. . These components are time-phased. They operate as a system; their link is information; because of its special characteristics, the coupling between the review element of one with the planning portion of the next cycle is termed "feedback."

The cyclical nature of the management process facilitates a much more realistic representation of the dynamics of work and life. It makes the application of systems analysis to problems of management possible. It permits the executive to learn from experience. He can keep himself, his people and their work attuned to changes in the situation.

. . We advocated an expanded capability in Management Research and Development as a first auxiliary to the basic planning-operating-review matrix.

Chapter 5 ("The Management of Engineers: Planning"): This report stressed the need for more creative and more flexible planning. Our observations focussed on five specific topics:

. . The formulation of work objectives in general and their effect upon individuals as well as their performance on the job in particular.

. . The need for safe linkage between long-range and short-term planning.

. . The provision for flexibility in structure; (a rigid and slow-moving organization, that was adequate in the past, is an obstacle to innovation today).

. . The superiority of the principle of decentralization if the prerequisites for this more advanced manner of managing are met.

. . The extension of the principle of participation to applications in more areas of planning.

. . The contributions of planning to the work climate and vice versa.

Chapter 6 ("The Management of Engineers: Direction of Operations"): We omitted two of the three major segments of this particular executive task, namely decision-making and communications since they are treated extensively in the literature. Concentrating upon the third, i.e., supervision (because most books and seminars, in contrast, have so far remained silent on its basic nature), we found:

- . . Its twin components are Motivation and Coordination. Its theme is Dedication to Achievement. Its objective is Results.
- . . Many problems and difficulties can be mitigated or eliminated when the role of the supervisor is better defined.
- . . Coordination requires the properly timed balancing of (human and material) capabilities and the linking of all resources needed for the task involved.
- . . More meaningful participation by the engineer in deliberations of the managerial aspects concerning his work is desirable. It recognizes the professional character of the man. It also increases significantly the opportunities for, and the calibre of his technical leadership.
- . . The influence of executive leadership upon climate is particularly pronounced.

Chapter 7 ("The Management of Engineers: Review and Feedback"): As in the case of some other portions of this report, this chapter reflects several findings by the authors which had their roots in other projects. They include results from research in which one of us has been engaged for over twenty years. This permitted incorporation into these pages of significantly wider and as yet unpublished analyses dealing with these areas:

- . . The nature and role of information could be examined thoroughly. Guidelines were suggested for the collection and use of data.
- . . The mission of review to serve the future rather than the past, was investigated in some detail.
- . . Climate emerges again as the most powerful factor in this segment of the managerial task.

Constituting a subject in its own right, we nevertheless dealt with feedback as a part of our comments upon review. This seemed permissable because we advanced only this one proposition:

- . . A study of the effectiveness of feedback is likely to be one of the most fruitful starting points for significant improvements in engineering management.

Chapter 8 ("The Management of Engineers: A new Concept of 'Control' "): We analyzed the nature of "control" and proposed several specific steps to improve its effectiveness which are directly applicable to many problems of engineering management.

. . Control is one of the results of the full process of managing. It is neither one of the parts of this process nor something separate.

. . Responsibility for any task can not be separated from the right to control it, without potentially serious consequences.

. . The manner in which control is exercised shapes climate to a marked degree.

Chapter 9 ("The Management of Engineers: Some Aspects of Personnel Administration"): In the interest of more complete coverage, we added comments on selection-placement and "training" of which these are representative:

. . Employment practices can be significantly improved through more meaningful analysis of actual job demands than is available on not infrequent occasions.

. . Not unexpectedly, our studies confirmed the need for life-long learning not merely by scientists and engineers but by managers as well.

. . Much investment in "training" is dissipated when the existing climate resists innovation.

Chapter 10 ("The Management of Engineers: Managerial Philosophy"): The comments in this chapter were the premises on which the specific observations in Chapters 2 through 9 rest. We proposed that

. . Philosophy is the force that propels the management system. Its roots lie in Society; its focus is the Individual and his Group. The significance of managerial philosophy is reflected in its Mission, the approach to these objectives and in its Leadership.

. . Management's mission is the assurance of Progress. Its constitutents are Profit and Service. Because it has had such encouraging beginnings, the concept of "service" strikes us as one of the most promising approaches to the opportunities as well as to the solution of many of the problems which confront management today and in the future.

. . Two of the main arteries to the fulfillment of management's mission are Productivity and Innovation.

. . The catalyst for these results is Leadership.

. . In turn, these preceding three parameters (Mission, its approach via Productivity and Innovation, and its Leadership) are the main features of Climate which shows the power of philosophy-in-action.

This project scrutinized a wide variety of topics. If it were possible to single out one subject to indicate the locus of greatest impact in the interplay of management upon engineering, we would unhesitatingly select "climate." The working atmosphere within which scientists, engineers and the executives

themselves operate deserves the most dedicated and creative attention by managers on all levels of the hierarchy in every organization.

To facilitate this, we introduced the concept of "contributory climate." An environment of progress, it combines findings which stem from the latest state of knowledge known to us, with lessons which originated in the vast complex of experiences in management. The former are drawn from many disciplines; the latter span hundreds of years of activity in business and commerce, government and education as well as in many other sectors of human endeavor.

A Challenge to Engineering Management

The project was limited to engineering management. Our examination of the subjects in Chapters 2 through 10 (as well as of those which had to be deleted from investigation within the framework of this study) have supplied persistent confirmation of one fact: Conclusions and recommendations for engineering management have equal applicability to other areas of management and vice versa. They rest firmly on principles which characterize general management. It will take but slight – not fundamental – modifications to adapt them when the background of the personnel and the nature of the work involved are different in the various functions of a business enterprise.

The ideas work well, as proved by the record of the more forward-looking leaders in aerospace and other industries. We realize that their transfer into sectors not yet convinced of their validity and power is likely to be plagued by the N-I-H (not-invented-here) Syndrome. If that is the case, it would constitute still another piece of evidence that the observations made in these pages are justified. As it is in every other instance, such "resistance to change" would be a symptom of the very causes discussed.

Adherence to the principles proposed would enable engineering management to add yet another one to its roster of achievements. Together with blazing a trail to technical breakthrough which it has helped make a reality on so very many occasions, it would then also take the lead to comparable accomplishments in the field of management.

This opportunity beckons all who, like scientists and engineers and managers in aerospace, have long striven to escape the most deplorable of all fates: To be born; to subsist for many years; and then to die – without ever having lived.

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