oped to put rationality into the picture.

The model is a cubical affair, its three dimensions representing ways in which the abilities differ from one another. Represented are: five basic kinds of operation, four substantive kinds of information or "contents," and six formal kinds of information or "products," respectively. Each intellectual ability involves a unique conjunction of one kind of operation, one kind of content, and one kind of product, all abilities being relatively independent in a population, but with common joint involvement in intellectual activity.

This taxonomic model has led to the discovery of many abilities not suspected before. Although the number of abilities is large, the 15 category constructs provide much parsimony. They also provide a systematic basis for viewing mental operations in general, thus suggesting new general psychological theory.

The implications for future intelligence testing and for education are numerous. Assessment of intellectual qualities should go much beyond present standard intelligence tests, which seriously neglect important abilities that contribute to problem-solving and creative performance in general. Educational philosophy, curriculum-building, teaching procedures, and examination methods should all be improved by giving attention to the structure of intellect as the basic frame of reference. There is much basis for expecting that various intellectual abilities can be improved in individuals, and the procedures needed for doing this should be clear.

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# Education for Management and Technology in the 1970's

## The universities and business must foster entrepreneurship and its interaction with technology.


Howard W. Johnson


Any time in human history is one, I suppose, of paradox—of contradiction, of extreme and opposite conditions side by side. Wealth and poverty, beauty and squalor, genius and ignorance—the human condition tolerates, seems even to foster their coexistence. Dickens captured the mood of an earlier era when he wrote in *A Tale of Two Cities:*

> It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of Light, it was the season of Darkness, it was the spring of hope, it was the winter of despair.

But perhaps more than ever before in our lifetimes, such extremes exist now: the paradox of hope and despair, the contrast of the potential and the reality —extremes of which technology at times seems the common cause. For technology is at once our blessing and our bane, the wellspring of our aspirations, yet the threat to our well-being. Technology is both social benefactor and social calamity. It offers us nuclear power and the specter of thermonuclear destruction, personal transportation and urban pollution, computers which multiply our creative power and threaten our privacy, mass communication and mass propaganda, an affluent but alienated youth. Technology offers the potential of the good life, but seems unable to lessen the poverty around us. A magnificent Lincoln Center exists side by side with the slums of Harlem. There are rich nations and poor nations, and the gulf steadily widens. Huxley may well have been right to ask: "What are you going to do with all these new things?"

Clearly science is not enough. But there is no turning back. The hope, I believe, lies in a partnership of technology and management (both industrial and social), intensely responsive to human need, to so order the distribution of technology's products and our national priorities as to resolve the paradox.

Remarkably, only concerning the advantage of effective management is there reasonable agreement for the moment. Management is regarded as a positive virtue from all points of view: American, British, Russian—perhaps even Chinese. The focus is thus strongly on the improvement of management—on education for management—and especially on the symbiotic relationship existing between management and technology. Societies will be strong economically in proportion to the strength of their management systems, their ability to harness technology in the service of the market, a term that here includes both the individual's and society's needs


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—for education, transportation, housing, health, adequate food, clean air and water.

The leadership of this management system demands rare and imaginative men, and I am persuaded that the corporate task of the 1970's will be to provide the climate in which such men are nurtured and in which their abilities are brought to full flower within the corporate frame. The world is changing with such speed that only the adaptive and innovative can keep the pace. We are in the process of a social, economic, and political evolution in which clearly only the fittest of enterprises will survive.

Robert Oppenheimer characterized our time in this way (*1*):

> One thing that is new is the prevalence of newness, the changing scale and scope of change itself, so that the world alters as we walk on it, so that the years of man's life measure not some small growth or rearrangement or moderation of what he learned in childhood, but a great upheaval.

And so I strongly believe that the managerial need of the 1970's will be for men who have entrepreneurial spirit and energy; who are innovative; who have the capacity for translating ideas and discoveries into action; who are both receptive to change and initiators of change; who have a high tolerance for ambiguity and uncertainty; who have the will to take risks.

These qualities are not a property of any class of men, the product of a particular education or background. They are widely, not narrowly, distributed in the population and will flower if properly cultivated. And so we need a broad range of human resources: men who are skilled analysts, trained to quantify the quantifiable in alternative courses of action; men adept at engineering and producing the product; men with a flair for presenting the product in the marketplace. Especially will we need imaginative men with trained scientific and technical minds who will apply the cutting edge of technology to the flinty problems in the understanding and mastery of our environment. The managerial leadership of the 1970's may emerge from among men with any of these competences, but, as leaders of enterprises caught up in a changing world, these men must above all be adaptive and innovative, themselves agents of change if they and their firms are to survive. And, in fact, the collective business leadership must be distinguished by an entrepreneurial spirit if the nation's economy is to flourish.

The American historian Elting Morison, in his book, *Men, Machines and Modern Times* (*2*), made the point in this way:

> Change has always been a constant in human affairs; today, indeed, it is one of the determining characteristics of our civilization. In our relatively shapeless social organization, the shifts from station to station are fast and easy. More important for our immediate purpose, America is fundamentally an industrial society in a time of tremendous technological development. We are thus constantly presented with new devices or new forms of power that in their refinement and extension continually bombard the thick structure of our habits of mind and behavior. Under such conditions, our salvation, or at least our peace of mind, appears to depend on how successfully we can in the future become what has been called, in an excellent phrase, a completely "adaptive" society.

## The Route-128 Phenomenon

Let me illustrate my emphasis on the demand for entrepreneurial qualities in our managers by describing a remarkable development in the Boston-Cambridge area. Within the past 15 years there has been created by private entrepreneurial enterprise what the New York *Times* (*3*) has called "The Golden Semicircle," bounded by a broad highway that sweeps in a great arc around the Boston-Cambridge heartland, meeting the sea on the north and south. Bordering this highway, prosaically called Route 128, are the headquarters or branches of some 700 companies. Many of these companies are new and are the product of a remarkably fertile interplay between entrepreneurship and technology, plus, I must add, an adequate supply of fertilizing capital provided by prescient Boston bankers.

The highway itself has come to symbolize a striking innovative process ("the Route-128 phenomenon") involving scientists and engineers, bankers and venture capitalists. The corporate names tell the story: Baird Atomic, High Voltage Engineering, Cryonetics, Itek, Microwave Associates, Bio-Dynamics, Maser Optics, Parametrics, Aerospace Research. These new companies have largely been formed by young men typically in their thirties, development- rather than research-oriented, entrepreneurially minded, and with an idea they were determined to convert into a product or service and offer to the market. Many came from academic or government laboratories; others, from corporate laboratories. An important effect, in addition to the commercial and economic impact, of this flow of entrepreneurs from advanced technological organizations into businesses of their own is a significant transfer of technological knowledge. This is one of the primary mechanisms by which the basic and mission-oriented research of our space, defense, and health programs is transmuted from laboratory discoveries to marketable products and processes.

While the Boston-Cambridge area heads the list of American cities which have generated these new technologically based companies, there are others. The essential ingredients for this explosively innovative mixture, according to a U.S. Commerce Department Report (*4*), are:

a. Institutional and individual venture capital sources that are (i) "at home" with technologically oriented innovators and (ii) have the rare business appraisal capabilities necessary to diagnose the prospects of translating a technical idea into a profitable business.

b. Technologically oriented universities, located in an area with a business climate that encourages staff, faculty and students to study and themselves generate technological ventures.

c. Entrepreneurs, who have been influenced by examples of entrepreneurship (for it is our contention that entrepreneurship breeds entrepreneurship).

d. Close, frequent consultations among technical people, entrepreneurs, universities, venture capital sources and others essential to the innovative process.

## The Entrepreneurs and the Nature of Their Companies

While many aspects of this process of creation of new technological enterprises merit examination, I want to focus principally on the entrepreneurs themselves and the nature of their companies.

A study directed by Edward Roberts of Massachusetts Institute of Technology (*5*) explored the interplay between entrepreneurship and technology in the growth of over 200 companies founded by former employees of academic and government laboratories, a not-for-profit corporation, and an industrial electronics systems contractor. The companies studied were 4 to 5 years old, on the average, and though they are still small, they are growing rapidly. Their sales well exceeded that of the parent organizations. Most of these companies started in business as suppliers to the defense and space markets, but they have steadily moved in the direction of the commercial market and

commercial applications of their products. For example, after only 4 or 5 years of life, an average of 40 percent of the business of companies formed by individuals formerly employed or trained in M.I.T. laboratories came from the commercial market.

It may be useful to cite some of the characteristics of this technical entrepreneur. It is an interesting fact, one not a priori obvious, that 50 percent of the entrepreneurs studied have come from homes in which the father was self-employed. Second, since the study concerned technical entrepreneurs, it is not surprising that the group is composed of, on the whole, well-educated people with average education slightly beyond the requirements for the master of science degree. Of significance as well is the fact that the typical founder of a new company is in his early thirties. Very few of the men who move out to found their own companies are over forty. Also of interest is the fact that these men tend to be development-oriented rather than research-oriented; this suggests that those men whose primary interest is in the application of technical knowledge are the ones most stimulated to carry these skills into the marketplace.

The study went on to discriminate between the companies with higher performance and those with lower performance, and between the personal characteristics of the respective founders. The successful technical entrepreneur recognizes the importance of management skills and has typically involved in his company someone with those skills. He also manifests a concern for the people in the organization and gives careful attention to their needs and interests. It is clear, as well, that a high need for achievement characterizes the more successful entrepreneurs. The study concludes that "the difference between mere technical invention and successful innovation is largely attributable to the personal role of the entrepreneur. Better understanding and management of him and of a personally-based technical innovation process will lead to more rapid technically-based corporate and economic growth."

I have indicated that the sources of new-company formation have been university and government laboratories and industrial corporations. We understand and can encourage this flow of entrepreneurial initiative from the universities and government as representing an expression of their primary purposes of extension and application of knowledge. From the standpoint of the individual corporation, however—and I want to stress this point—such a flow presents a serious problem, since "those scientists and engineers who are committed to an action orientation and to the use of their knowledge are the ones who usually depart in this flow of entrepreneurship" (*5*). For the corporation, this entrepreneurial brain drain can be a serious problem, and it is important to recognize the causes if these technical entrepreneurs who are wellsprings of vitality in the firm are to remain—or are to remain vital.

In some fundamental respects this drain of technological entrepreneurs is a more serious national loss than the technology transfer which results from international migration of scientists and engineers. For it weakens the corporation and discloses its rigidities. It poses a higher risk for the flowering of a new idea than would exist if the originator remained within the corporate environment, sustained by its resources. Of still more serious concern, to me, is the brain drain between fields of inquiry—and especially the drawing down of national pools of scientists. Discovery in any field is certainly not directly proportional to the manpower applied. Still, a first-rate mind lost to science marginally reduces the nation's capacity for scientific inquiry. I argue, of course, for a balance appropriate to the needs of the time in a nation's mix of educated men. The contributions of the humanists and social scientists are equally vital to the nation's well-being and equally relevant to today's problems.

I am disturbed, however, when either the quality or the quantity of entrants in any field begins to lag. Thus, I was struck by the recent report from the British Council for Scientific Policy that, for at least the next several years, the annual increase in the supply of science graduates will be less than half the present rate of growth. This fact deserves both widespread notice and concern as a sign that the nation's heartbeat of scientific talent is faltering. As with the flow of entrepreneurs from their companies, this ebb from science to other fields reflects in part a weighing of opportunity alternatives, by individuals in their own interest and collectively, counter to the national interest. And as with the potential entrepreneurs, so with the potential scientists, means must be found to redress the balance. We know enough about human motivation now to know that money is not the prime mover, but still it is an important incentive if it is used imaginatively and if the tax system permits it to have a high leverage.

To return briefly to the technical entrepreneur, we have found that even those companies which seek to challenge men with the offer of opportunities to develop within the corporate framework are not wholly successful, for the policies and attitudes in the large corporation often work to defeat entrepreneurial efforts. There is evidence that entrepreneurship is characterized by youth or at least by youthful energies. Yet there appears to be a definite bias against young men taking on venture responsibility within the firm. The M.I.T. study showed that in a large electronics firm where 16 new product ventures were begun, the younger men were given less latitude for independent action, had less influence on criteria for judging their venture, experienced more trouble in securing company capital, and found less support for their project.

It is hardly surprising that many would-be entrepreneurs leave their organizations to set up their own businesses. The number who leave and their success suggest some of the potential gains to the corporation that can learn how to motivate and retain its entrepreneurially minded men within the company.

I have discussed these studies at some length, first because they shed light on one of the mechanisms in the United States by which laboratory discoveries are converted into marketable products and processes; second, because they identify some of the characteristics of that enterprising individual who should be the target of our management development energies; and third, because they suggest some of the influences within the corporation which force men of this caliber to seek outlets for their ideas outside the corporation.

I have stressed the corporation's need in the decade ahead for adaptive and innovative managers. I stress these qualities, not as the sole attributes of the manager of the 1970's, but, in a sense, as transcending qualities. There remains a requirement that the manager seek a mastery of the growing body of professional knowledge about management; that he be politically and economically educated, with a sensitivity to the environment in which his firm will exist; that he have a social awareness of the firm's responsibility in a modern society.

## Expanding Knowledge about the Managerial Process

Let me review these points, with some initial comments about the way in which knowledge about the managerial process is expanding. This "knowledge explosion" is, of course, requiring the continued education of the manager and is, itself, a reason why the manager must be receptive to new ideas and to change. I had occasion recently to examine the changes in M.I.T.'s Sloan Fellowship Program in the past dozen years. (That program, I am happy to say, will have a British counterpart soon when the London-Sloan Program gets under way at the London Business School.) In 1955 the whole field of organizational behavior had only a slim foothold in the curriculum. The late Douglas McGregor and his colleague Alex Bavelas were groping for ways to couple the theories of the behavioral sciences to the problems of management and teach them effectively to the Sloan Fellows. While we are still a long way from applying in practice all that we know from behavioral science theory, the body of knowledge about the human side of enterprise has expanded enormously in the past decade.

In the field of finance, the instruction rested largely on assessment of the firm's requirements for funds and optimum means of obtaining them. The rigorous analytical approach to risk, uncertainty, and capital cost measurement in the management of corporate assets had not yet found its way into the classroom.

Application of the computer to the problems and processes of the firm was then vaguely foreshadowed, but in the short intervening years a great new field of management information systems has developed, in parallel with the new computer and communication technology.

Marketing as a field was long on practice, short on theory and analysis. Today increasingly the uncertainties of the marketplace are giving away—or, at any rate, being narrowed—through application of statistics and the methods of operations research.

The management of research and development as a subject of inquiry hardly existed a dozen years ago. Now there is a growing body of literature and organized instruction illuminating the special problems of organization for discovery.

I might add one other observation of interest—namely, that in the mid-1950's the Sloan Fellows, as young businessmen, were outraged by the tenets of Keynesian economics. The intervening years have made the theory intellectually acceptable even though the application turns out to be politically difficult.

This is by no means a complete catalog of changes in the content of a body of knowledge available to, and appropriate to be taught to, a group of young American managers. But let me only add one more entry, which is not so much an addition to the body of knowledge as it is an important reflection of our changing times. The Sloan Fellows are themselves deeply interested in what I would call the social responsibility of the businessman. They are concerned about the condition of our cities, about the quality of our environment, about the causes of poverty and the effects of discrimination. They are concerned that their companies should be concerned about these matters, and I sense a resolution that, when their opportunity for senior leadership comes, their companies will be in the forefront of the campaign to effect change in these areas.

By the foregoing discussion of changes in the curriculum of the M.I.T. School of Management, I do not want to imply undue innovation on our part in bringing about these changes. They are a manifestation of a wide search for means to understand and improve the business process, a search greatly facilitated by the close coupling in America between the university and the business community, which exhibits itself only in part in the schools of business and in great measure between the scientific and technological arms of our universities and American industry. My primary point, of course, has been that the body of knowledge available to improve the practice of management has been growing and will grow more rapidly; that each managerial generation no longer has to learn primarily through experience and that this changes what the manager can do and what is demanded of him. The processes of management development of the 1970's must take cognizance of the needs of potential managers to acquire this body of knowledge—and skill in its application—but, more than that, must recognize that the acceleration of research on management and the rising accumulation of knowledge will very quickly make obsolete the manager who switches off his formal learning apparatus the day he leaves the university.

## Changing Structure of the Firm

It is clear that the manager must be aware of changes taking place within the firm itself. The American labor force is increasingly better educated, with all this implies for a higher level of aspiration and a need for management to tap the creative capacities of this group and to motivate them effectively. For example, by 1975, six out of ten American workers over 25 years of age will be high school graduates, and one out of four will have had some university education. Professional, managerial, clerical, and sales personnel will make up nearly half the American labor force. Professional and technical personnel will outnumber skilled craftsmen in our economy. With vast sums being spent on research and development, men engaged in such work are thus an increasing proportion of the American work force, in great demand and therefore highly mobile. New approaches to organizing and directing their work are demanded, to achieve maximum effectiveness of their efforts. Computation and communication technology are having a profound effect on the internal structure of the firm, an effect which we are really only beginning to see and whose full implications we cannot yet perceive. There seems little question that the computer is becoming an indispensable and all-pervasive element in the modern corporation. By 1975 there are expected to be 85,000 computers in operation in the United States, representing an investment of more than $30 billion. The potentials of this kind of capacity for the control of processes, for the employment of information in the firm, for the handling of routine and increasingly sophisticated decisions, is certain to have a powerful effect upon the nature of managerial work, shifting it in the direction of unstructured, nonprogrammed work and away from more routine analysis, allocation, and evaluation. Goal setting, strategy formulation, policy questions will occupy more of the manager's time, and he will be aided in his thinking by the information system at his fingertips. He will be more involved in understanding the environment and in defining the system in which he makes his decisions.

No less will the computer change education for technology and the application of technology. Its effect is already being felt in the classroom as it shows the potential for speeding the learning

process through interaction of student and computer, and for quick transfer and retrieval of information within the university library system. And, of course, the computer has enormous power as the intellectual servant of the scientist or engineer in his research or design.

A third major area of change which influences the range of knowledge, the values, and the abilities of the manager of the 1970's is the increasing demand which the American society makes on the manager and the firm for the exercise of a sense of social and ethical responsibility. I refer above to the Sloan Fellows' growing awareness in this area. Our society is clearly charging the corporation with responsibility for making its products safe and effective, and for raising the quality of the community through an active role as a corporate citizen and the application of its resources to find new solutions. It is becoming increasingly clear that the manager must understand politics and economics, in order to be sensitive to the political consequences of his actions and the consequences of politics for his enterprise, and in order to have the economic insight needed for adapting to a changing economic environment.

## Changes in Economic Environment

The evidences of this change are many. The public uproar over automobile safety is an illustration, and I anticipate that the automotive industry will be increasingly challenged to take a leading role in the solution of the problems to which the automobile has contributed in our society—problems such as congestion of the cities and pollution of the air. American business is being challenged directly to take the initiative and leadership in providing job training and job opportunities for the hardcore unemployed. The opportunities for business enterprise to be innovative in solving the problems of education, of housing, of transportation, of rebuilding our cities into a viable and enriching social environment are manifold.

There is a final dimension: American business has become international in character as never before. The British have a long history and experience in the management of international ventures. We are comparative newcomers, at least on the scale of our present international involvement in Europe. Therein lies a need to acquire new political and economic insights and cross-cultural sensitivities which were not demanded of American managers in the past.

In sum, whether we will it or not, the world is being transformed, and the business enterprise with it. This enterprise is changing internally—in products and processes, in organizational form, in the employment of information technology to speed and refine its decisions. It is growing larger through merger and acquisition and as its market grows. Externally the firm is forced to be more responsive to government, to society, to its customers, to its employees and their unions. These are both challenges and opportunities for the American business enterprise in the next decade. It is this challenge and opportunity that led me to assert at the outset that the managerial leaders of enterprises caught up in this changing world must be adaptive and innovative, themselves agents of change if they and their firms are to survive.

Alfred P. Sloan (*6*), writing from the unique vantage point of his years with General Motors, stated the point succinctly:

> The circumstances of an ever-changing market and an ever-changing product are capable of breaking any business organization if that organization is unprepared for change—indeed, in my opinion, if it has not provided procedures for anticipating change.

## Role of the University

The universities clearly have a role in aiding the individual to develop the knowledge, skills, motivation, and attitudes which characterize this adaptive and innovative spirit. At the undergraduate level, M.I.T. has been examining its programs carefully with the aim of increasing the student's independence and freedom of choice, giving him an opportunity to range more broadly over the curriculum, devising laboratory opportunities for the undergraduate to design and carry out his own projects. A particular experiment in the undergraduate program of the School of Management has attracted wide interest within M.I.T. and elsewhere by providing a selected group of students in their final 2 years the opportunity essentially to take responsibility for their own education—to define their needs and interests, organize their program, and involve the faculty and segments of the business community as resources in their educational process. The outcome has clearly been a more confident, more venturesome spirit among the men who have taken part in that program.

I see increasing concern in the graduate schools of business, as well, for the development of an entrepreneurial outlook and attitude on the part of their students. I do not suggest that the schools are turning their backs on the enhancement of analytical knowledge and capacity or of organizational skills on the part of their students. Rather, they are looking for ways to identify those students who have the entrepreneurial spark, and to reinforce rather than inhibit these qualities through the educational process.

The university's role in contributing to an individual's development by no means ends with his graduation. Education must be continuous. The successful companies will be in partnership with the universities in this process of human capital formation. Not all continuing education will have to take place within the university framework, but the university has a responsibility for setting standards and for innovation. Again, for example, M.I.T.'s new Center for Advanced Engineering Study is seeking to develop new self-study materials and to train company officials at M.I.T. who will themselves be trainers and guides in aiding others to self-renewal within the corporate frame.

This Center is a significant forward step in enabling experienced engineers and applied scientists to refresh their knowledge of the many developments in their professional fields. It is directly concerned with the problems of the engineer who finds all too often that his ability to create and exploit his experience fades because he has not had the opportunity to assimilate technological advances.

Before I leave this examination of the role of education in human development, let me speak to the issue of educational method. In this article I have not, up to this point, taken a stand in this unending debate, essentially because I am persuaded that methods are secondary to *concepts* of education. If the environment is right and the opportunities exist, the institutions will develop. In short, education is an individual rather than an institution-centered process, important as the institution's role must be. A clear sign of progress is the rise of intellectual centers for manage-

ment development in Great Britain, and I see a critically constructive purpose for them.

I have discussed the managerial needs of the future in terms of the changing body of professional knowledge in the area of management, the changing structure of the firm and of the work force, and the challenges of the firm's environment. I have tried to suggest that the managers of the next decade will require a mastery of this growing body of professional knowledge; a sensitivity to the aspirations of a better educated, more affluent, and more mobile work force; a satisfaction in the challenges of the less routine, less structured work situation; and a sense of social responsibility. But I have urged that, above all, we seek out and nurture qualities of mind and spirit which lead men to be challenged by new ideas and eager to test them. I have suggested the role of the university in this process. Now let me deal explicitly with the enterprise itself and the influence it brings to bear on the individual, which determines how he is molded—whether his ideas and initiative are suppressed or encouraged—and which in the long run will determine whether the organization retains its vitality.

## Role of the Corporation

There may be some corporate leaders who will say, "Don't worry about us. We're all right." Perhaps, but let me ask a few questions, borrowed from Frederick Kappel (*7*) of AT&T, to measure the vitality of your enterprise.

1) Do your people cling to old ways of working after they have been confronted with new situations?

2) Are your older managers adhering rigidly to the ideas, methods, and approaches of the past and passing this kind of thinking along to young managers?

3) Is management failing to define new goals that are meaningful and challenging?

4) Has your business developed a low tolerance for criticism?

5) Has there been a decline in reflective thinking about the adequacy of current operations and the needs of the future?

6) Has institutionalism begun to set in? That is, has the business come to be something apart from the people who comprise it?

7) Does the business have a reputation as a secure and stable outfit, but not a venturesome one?

Parenthetically, perhaps the test of these questions applies as well to other institutions, including governments, as to corporations. And if the answer to all these questions is a strong "No," a chief executive has reason for satisfaction and pride. If any must be answered "unfortunately, yes," then the danger signals of loss of vitality are flying. And since, as Kappel says, "vitality is an attribute of people, not of things," it follows that, "a vital business is one with vital people." The problem for the firm, then, is to challenge such people, to give them opportunities for responsibility and the exercise of initiative. And this brings us directly to the role of the corporation and the influence it exerts over the individual by its policies, its organization, and its leadership.

The first critical point in a person's development within the firm is the point of entry, and it is precisely at this point that many firms fail.

I was talking recently with a group of young men about to complete their business school studies. They were looking forward enthusiastically to their first jobs, interviewing company representatives, visiting plants, making what they believed to be careful career choices. I had neither the heart nor the desire to disillusion them, but the record shows that within 5 years 75 percent of those men will have left their carefully chosen companies and have gone on to other jobs. This is real waste for their companies and for the men, and it points up the real problems in the process by which men are brought into the firm and educated to its values and norms. The psychologists have a word for this —*organizational socialization*; by this they mean learning the ropes, being indoctrinated and trained, being told what is important in the organization. The new recruit gets his guidelines from a variety of sources: from the official literature of the organization; from examples set by senior people; from instructions given him directly by his superior; from the example of his peers who have been around longer; and from the rewards and punishments which flow from his own efforts, the response to his ideas, the degree of challenge in the assignments he receives.

The question is, What does he come to believe the company considers important? Whom you know? How you dress? What clubs you belong to? Where you live? What kind of car you drive? What political party you belong to? What your college was? Or does the company consider these matters irrelevant? Is it primarily interested in values which are pivotal or central to the enterprise, and in your intelligent and creative adherence to them?

The new employee will have spent most of his life in an educational environment—an environment that puts a premium on personal and intellectual attainment, on the creative contribution of his mind. He comes to his first company eager to apply his knowledge to its processes and problems. If he finds his values in conflict with those of the organization, he may, according to Edgar Schein (*8*), respond in one of three ways. First, he may rebel, rejecting all the values and norms of the organization, and either be expelled from it or turn his energies to defeating its goals. Second, he may settle for conformity and accept all the norms and values. We know some firms which appear to demand so much conformity that their people all seem to have been stamped out by a company cookie cutter. Unfortunately, the conforming individual curbs his creativity and thereby moves the organization toward the sterile form of bureaucracy.

The third response has been labeled creative individualism—an acceptance of the pivotal and a rejection of the peripheral values and norms. It is for this response that companies should seek. They have an obligation first to understand their own organizational socialization or indoctrination practices and to select or devise those which focus on the pivotal values only. Second, companies have an obligation to give careful training to the men who will be the first supervisors of new management recruits in the organization, for it is they who really have the power to create the climate which will lead to rebellion, conformity, or creative individualism. Too many of those first supervisors concentrate on teaching the peripheral values of "how to get ahead in this outfit" and thus undermine the possibilities for creative individualism and improvement of the organization.

There is much evidence of the effects of the quality of supervision on motivation and creativity as the individual moves through the organization. Consider, for example, a study (*9*) made at the Texas Instruments Company, a company built on new technology. This investigation of the attitudes of nearly

1400 managers at all levels of the company showed that "highly motivated managers rather consistently characterized *their supervisors* as persons who are approachable and open-minded, maintain high expectations, provide ready access to company information, *encourage initiative and risk taking, help them learn from mistakes,* and give credit for top performance" [italics added]. Poorly motivated managers often identified their supervisors as authority-oriented, not usually receptive to conflicting ideas from subordinates, oversupervising, tending to discourage initiative and risk-taking, intolerant of mistakes, inclined to look for someone to blame for mistakes, and tending to overlook success and stress failure.

Clearly one of the management development tasks ahead, if the entrepreneurial qualities we prize are to be encouraged and young managers are to be motivated toward "creative individualism," is identification and reward of managerial performance which encourages such individuality and simultaneously discourages, through training and in other ways, supervisory styles which inhibit it.

Another matter of concern is the kind of work to which the man with entrepreneurial qualities is assigned. Several years ago A. T. M. Wilson (*10*) made this point in a paper entitled "The manager and his world." He asserted what he provocatively called "an elite principle in the early development of those intended for senior positions at a later date," recalling the cliché of the British regular officer between the two wars, "Never let your potential officer get into the sergeant's mess." Although admitting that the statement contained an expression of social prejudice, he suggested that it contained some managerial insight as well. He contrasted the functions in the "commercial" areas of the firm, classifying them as routine and clerical in nature at the lowest levels; as centering, at the middle range, on the *safeguarding* of assets; but as focusing, at the top level, on the *increase* of assets, and involving the judgments and decision-sharing about risks which make up such an important proportion of top-management work. He went on to say, "There is good reason to believe that a man who may well have considerable potential for this high-level work . . . may be seriously damaged if he spends more than a short period of his career in the 'asset safeguarding' lower levels where the primary responsibilities are of a quite different character."

## Organizational Forms, Existing and Proposed

Let me turn now to a brief discussion of the organizational characteristics which influence the young manager's development—that is, those which bear on the scope of his authority and his opportunity for exercise of independent initiative.

I believe there is reasonable agreement by now that a centralized organization structure with rigid functional lines and many levels limits the manager's chances for assuming responsibility, trying out new ideas, exercising judgment. In those companies where top-management decision-making is focused on strategic planning as opposed to close control of operations, there tend to be a dispersed distribution of authority within the firm and more opportunity for innovation and creative decision-making.

Some companies have been inventive about creating opportunities for younger men to try out their entrepreneurial energies in the development of new products. These approaches have included creating product or project teams—men working together within the framework of the company but having, as a group, a sense of independence and the freedom to be wholly responsible for developing and bringing a new product to the market (that is, responsible for its design, packaging, pricing, and promotion), seeking advice within the company and using the company's resources but taking the responsibility themselves.

Harold Guetzkow (*11*) has pointed out that such freedom to innovate requires a capacity and willingness on the part of the organization to absorb risk, for creativity and innovation push into unexplored areas where there is high potential for error. To determine whether new ideas are real contributions usually requires investigation and experiment—time and resources are required, to avoid premature judgment. If the organization is too tightly run, the climate is usually unfavorable for innovation. There must also be an ethos in the organization that is conducive to change. Risk-taking must be legitimate. Managers in such firms continually ask themselves, How can this be done better?

These observations are relevant to organizations as we know them today. It is quite clear, however, that dissatisfaction with existing structures is growing, and first-rate theorists are turning their attention to a development of alternatives to the existing pyramidal structures in which authority flows downward from the top. For example, Jay W. Forrester (*12*) argues that "new thinking in the social sciences indicates that moving away from authoritarian control in an organization can greatly increase motivation, innovation and individual human growth and satisfaction." He urges the abandonment of the authoritarian hierarchy as the central organizational structure, and replacement of the superior-subordinate pair as the fundamental building block of the organization. In the new corporate form Forrester proposes, the individual would not work under the supervision of a superior. "Instead, he would negotiate, as a free individual, a continually changing structure of relationships with those with whom he exchanges goods and services. He would accept specific obligations as agreements of limited duration. As these are discharged, he would establish a new pattern of relationships as he finds more satisfying and rewarding situations." Similarly, Warren G. Bennis (*13*) believes that in the social structure of the organizations of the future there will be adaptive, rapidly changing "temporary systems." These will be organized around "problems to be solved." The problems will be solved by groups of relative strangers who represent a set of diverse professional skills. The function of the executive thus becomes that of a coordinator or linking pin between the various project groups. "People will be differentiated not vertically according to rank and role but flexibly according to skill and professional training. . . . In these new organizations, participants will be called on to use their minds more than [at] any other time in history."

These are evolving ideas from fertile and creative minds. They may or may not forecast the shape of the future. However, they do reflect a dissatisfaction with our existing corporate and organizational forms and a desire to give greater scope to the innovative and creative spirit of the individual. Clearly management development in the decade ahead will be powerfully concerned with the way in which these ideas develop.

## Summary

In summary, then, let me restate my conviction that the most critical needs of management in the next decade will be met by the identification and cultiva-

tion of the innovative, creative, adaptable individual who sets as his goal the translation of technology for society's needs. He will require a command of the growing body of managerial knowledge. He will need a continual refreshment of that knowledge through contact with the university as he seeks to deal with a world in change. If his firm is to encourage and use his creative capacity, it will be careful about his entry into the organization and his movement up the ladder, stressing only the values that count, that are pivotal, and taking care not to drive him into rebellion or conformity. The firm will be inventive about ways to give him opportunities to test his ideas. It will experiment with organizational forms which promote creativity. It will encourage adventure and accept risk. And in its success, it will be serving the needs of our societies in ways that will make our greatest hopes for technology a full and human reality.


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# Federal Research Laboratories


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There is a tendency for Americans to criticize the federal government, to object to its growth, and to take exception to its undertaking activities which have counterparts in the private economy. As a result, and without substantive criticism of their productivity, government laboratories in general tend not to receive the recognition they deserve in comparison with research and development activities and accomplishments in universities and in industry. This dedication is an appropriate occasion to help redress the balance.

All federal laboratories have programs related to the missions of their parent agencies and departments, and their principal activities center about some or all of the following functions: (i) providing the parent organization with permanent capabilities for solving new problems in less time than would be possible if the government had to contract with industry on each occasion that such needs arose; (ii) through their expert staffs providing an effective and direct route for the parent organization to take quick advantage of progress in science and technology all over the world; and (iii) providing a capability within the parent organization for expert supervision and evaluation of the scientific and technical services and products that are supplied to the government by industrial research, development, and production.

Such activities are essential if agency missions are to be expeditiously carried out, and the use of in-house governmental aid to these ends is not only the most appropriate route but is also the one most likely to be cost effective in the long run. If cost effectiveness is to be realized, the laboratory's scientific and technical staffs must be fully competent to understand and to apply the new knowledge being generated at the frontiers of the applicable disciplines. And to insure that such continuing competence exists, the laboratory's staff must be directly and personally involved in frontier research and development.

There are many to whom it seems contradictory that mission-related laboratories should be concurrently engaged in frontier research and in the more mundane support activities needed by the parent agencies and departments. But there is no such contradiction, and, to understand this, it is only necessary to know that the great bulk of the best research almost everywhere is a part-time activity of the staff, the remaining time and energy generally going into much more mundane and less glamorous occupations. This is certainly true of the research being done by the faculties in our universities. Teaching is, and is likely to remain, the principal obligation of the university's staff and it is this activity which is the university equivalent of the mission-related support which government scientists and engineers provide to their agencies when they are not engaged in research.

The Naval Research Laboratory (NRL) in general and the Hulburt Center for Space Research in particular provide outstanding examples of what enlightened management and first-rate scientists and engineers can jointly accomplish in a government laboratory. The Navy's policy of encouraging research in fundamental sciences in parallel with direct mission-related work has insured an environment to which talented people have been attracted for careers permitting not only significant contributions to national defense but also meaningful additions to the growth of science and technology in general.

The origins of NRL's space-related programs go back to the beginnings of major U.S. interest in rocketry and high-altitude and space experiments. NRL's work began in 1946 when "liberated" V-2 rockets first became available for space research. Although NRL


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