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New information flows cut new organization channels.

MANAGEMENT in the 1980's

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Over the last decade a new technology has begun to take hold in American business, one so new that its significance is still difficult to evaluate. While many aspects of this technology are uncertain, it seems clear that it will move into the managerial scene rapidly, with definite and far-reaching impact on managerial organization. In this article we would like to speculate about these effects, especially as they apply to medium-size and large business firms of the future.

The new technology does not yet have a single established name. We shall call it *information technology*. It is composed of several related parts. One includes techniques for processing large amounts of information rapidly, and it is epitomized by the high-speed computer. A second part centers around the application of statistical and mathematical methods to decision-making problems; it is represented by techniques like mathematical programing, and by methodologies like operations research. A third part is in the offing, though its applications have not yet emerged very clearly; it consists of the simulation of higher-order thinking through computer programs.

Information technology is likely to have its greatest impact on middle and top management. In many instances it will lead to opposite conclusions from those dictated by the currently popular philosophy of "participative" management. Broadly, our prognostications are along the following lines:

(1) Information technology should move the boundary between planning and performance upward. Just as planning was taken from the hourly worker and given to the industrial engineer, we now expect it to be taken from a number of middle managers and given to as yet largely nonexistent specialists: "operations researchers," perhaps, or "organizational analysts." Jobs at today's middle-management level will become highly structured. Much more of the work will be programed, i.e., covered by sets of operating rules governing the day-to-day decisions that are made.

(2) Correlatively, we predict that large industrial organizations will recentralize, that top managers will take on an even larger proportion of the

innovating, planning, and other "creative" functions than they have now.

(3) A radical reorganization of middle-management levels should occur, with *certain classes* of middle-management jobs moving downward in status and compensation (because they will require less autonomy and skill), while other classes move upward into the top-management group.

(4) We suggest, too, that the line separating the top from the middle of the organization will be drawn more clearly and impenetrably than ever, much like the line drawn in the last few decades between hourly workers and first-line supervisors.

The New Technology

Information technology has diverse roots — with contributions from such disparate groups as sociologists and electrical engineers. Working independently, people from many disciplines have been worrying about problems that have turned out to be closely related and cross-fertilizing. Cases in point are the engineers' development of servomechanisms and the related developments of general cybernetics and information theory. These ideas from the "hard" sciences all had a direct bearing on problems of processing information — in particular, the development of techniques for conceptualizing and measuring information.

Related ideas have also emerged from other disciplines. The mathematical economist came along with game theory, a means of ordering and permitting analysis of strategies and tactics in purely competitive "think-" type games. Operations research fits in here, too; OR people made use of evolving mathematical concepts, or devised their own, for solving multivariate problems without necessarily worrying about the particular context of the variables. And from social psychology ideas about communication structures in groups began to emerge, followed by ideas about thinking and general problem-solving processes.

All of these developments, and many others from even more diverse sources, have in common a concern about the systematic manipulation of information in individuals, groups, or machines. The relationships among the ideas are not yet clear, nor has the wheat been adequately separated from the chaff. It is hard to tell who started what, what preceded what, and which is method and which theory. But, characteristically, application has not, and probably will not in the future, wait on completion of basic research.

Distinctive Features

We call information technology "new" because one did not see much use of it until World War II, and it did not become clearly visible in industry until a decade later. It is new, also, in that it can be differentiated from at least two earlier industrial technologies:

(1) In the first two decades of this century, Frederick W. Taylor's *scientific management* constituted a new and influential technology — one that took a large part in shaping the design of industrial organizations.

(2) Largely after World War II a second distinct technology, *participative management*, seriously overtook — and even partially displaced — scientific management. Notions about decentralization, morale, and human relations modified and sometimes reversed earlier applications of scientific management. Individual incentives, for example, were treated first as simple applications of Taylorism, but they have more recently been revised in the light of "participative" ideas.

The scientific and participative varieties both survived. One reason is that scientific management concentrated on the hourly worker, while participative management has generally aimed one level higher, at middle managers, so they have not conflicted. But what will happen now? The new information technology has direct implications for middle management as well as top management.

Current Picture

The inroads made by this technology are already apparent, so that our predictions are more extrapolations than derivations.[1] But the significance of the new trends has been obscured by the wave of interest in participative management and decentralization. Information technology seems now to show itself mostly in the periphery of management. Its applications appear to be independent of central organizational issues like communication and creativity. We have tended until now to use little pieces of the new technology to generate information, or to lay down limits for subtasks that can then be used within the old structural framework.

Some of this sparing use of information tech-

[1] Two examples of current developments are discussed in "Putting Arma Back on Its Feet," *Business Week*, February 1, 1958, p. 84; and "Two-Way Overhaul Rebuilds Raytheon," *Business Week*, February 22, 1958, p. 91.

nology may be due to the fact that those of us with a large commitment to participative management have cause to resist the central implications of the new techniques. But the implications are becoming harder to deny. Many business decisions once made judgmentally now can be made better by following some simple routines devised by a staff man whose company experience is slight, whose position on the organization chart is still unclear, and whose skill (if any) in human relations was picked up on the playground. For example:

> We have heard recently of an electric utility which is considering a move to take away from generating-station managers virtually all responsibility for deciding when to use stand-by generating capacity. A typical decision facing such managers develops on hot summer afternoons. In anticipation of heavy home air-conditioning demand at the close of working hours, the manager may put on extra capacity in late afternoon. This results in additional costs, such as overtime premiums. In this particular geographical area, rapidly moving cold fronts are frequent. Should such a front arrive after the commitment to added capacity is made, losses are substantial. If the front fails to arrive and capacity has not been added, power must be purchased from an adjacent system at penalty rates — again resulting in losses.
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> Such decisions may soon be made centrally by individuals whose technical skills are in mathematics and computer programing, with absolutely no experience in generating stations.

Rapid Spread

We believe that information technology will spread rapidly. One important reason for expecting fast changes in current practices is that information technology will make centralization much easier. By permitting more information to be organized more simply and processed more rapidly it will, in effect, extend the thinking range of individuals. It will allow the top level of management intelligently to categorize, digest, and act on a wider range of problems. Moreover, by quantifying more information it will extend top management's control over the decision processes of subordinates.

If centralization becomes easier to implement, managers will probably revert to it. Decentralization has, after all, been largely negatively motivated. Top managers have backed into it because they have been unable to keep up with size and technology. They could not design and maintain the huge and complex communication systems that their large, centralized organizations needed. Information technology should make recentralization possible. It may also obviate other major reasons for decentralization. For example, speed and flexibility will be possible despite large size, and top executives will be less dependent on subordinates because there will be fewer "experience" and "judgment" areas in which the junior men have more working knowledge. In addition, more efficient information-processing techniques can be expected to shorten radically the feedback loop that tests the accuracy of original observations and decisions.

Some of the psychological reasons for decentralization may remain as compelling as ever. For instance, decentralized organizations probably provide a good training ground for the top manager. They make better use of the whole man; they encourage more active cooperation. But though interest in these advantages should be very great indeed, it will be counterbalanced by interest in the possibilities of effective top-management control over the work done by the middle echelons. Here an analogy to Taylorism seems appropriate:

> In perspective, and discounting the countertrends instigated by participative management, the upshot of Taylorism seems to have been the separating of the hourly worker from the rest of the organization, and the acceptance by both management and the worker of the idea that the worker need not plan and create. Whether it is psychologically or socially justifiable or not, his creativity and ingenuity are left largely to be acted out off the job in his home or his community. One reason, then, that we expect top acceptance of information technology is its implicit promise to allow the top to control the middle just as Taylorism allowed the middle to control the bottom.

There are other reasons for expecting fast changes. Information technology promises to allow fewer people to do more work. The more it can reduce the number of middle managers, the more top managers will be willing to try it.

We have not yet mentioned what may well be the most compelling reason of all: the pressure on management to cope with increasingly complicated engineering, logistics, and marketing problems. The temporal distance between the discovery of new knowledge and its practical application has been shrinking rapidly, perhaps at a geometric rate. The pressure to reorganize in order to deal with the complicating, speeding world should become very great in the

next decade. Improvisations and "adjustments" within present organizational frameworks are likely to prove quite inadequate; radical rethinking of organizational ideas is to be expected.

Revolutionary Effects

Speculating a little more, one can imagine some radical effects of an accelerating development of information technology — effects warranting the adjective "revolutionary."

Within the organization, for example, many middle-management jobs may change in a manner reminiscent of (but faster than) the transition from shoemaker to stitcher, from old-time craftsman to today's hourly worker. As we have drawn an organizational class line between the hourly worker and the foreman, we may expect a new line to be drawn heavily, though jaggedly, between "top management" and "middle management," with some vice presidents and many ambitious suburban junior executives falling on the lower side.

In one respect, the picture we might paint for the 1980's bears a strong resemblance to the organizations of certain other societies — e.g., to the family-dominated organizations of Italy and other parts of Europe, and even to a small number of such firms in our own country. There will be many fewer middle managers, and most of those who remain are likely to be routine technicians rather than thinkers. This similarity will be superficial, of course, for the changes we forecast here will be generated from quite different origins.

What organizational and social problems are likely to come up as by-products of such changes? One can imagine major psychological problems arising from the depersonalization of relationships within management and the greater distance between people at different levels. Major resistances should be expected in the process of converting relatively autonomous and unprogramed middle-management jobs to highly routinized programs.

These problems may be of the same order as some of those that were influential in the development of American unions and in focusing middle management's interest on techniques for overcoming the hourly workers' resistance to change. This time it will be the top executive who is directly concerned, and the problems of resistance to change will occur among those middle managers who are programed out of their autonomy, perhaps out of their current status in the company, and possibly even out of their jobs.

On a broader social scale one can conceive of large problems outside the firm, that affect many institutions ancillary to industry. Thus:

- What about education for management? How do we educate people for routinized middle-management jobs, especially if the path from those jobs up to top management gets much rockier?
- To what extent do business schools stop training specialists and start training generalists to move directly into top management?
- To what extent do schools start training new kinds of specialists?
- What happens to the traditional apprentice system of training within managerial ranks?
- What will happen to American class structure? Do we end up with a new kind of managerial elite? Will technical knowledge be the major criterion for membership?
- Will technical knowledge become obsolete so fast that managers themselves will become obsolete within the time span of their industrial careers?

Middle-Management Changes

Some jobs in industrial organizations are more programed than others. The job that has been subjected to micromotion analysis, for instance, has been highly programed; rules about what is to be done, in what order, and by what processes, are all specified.

Characteristically, the jobs of today's hourly workers tend to be highly programed — an effect of Taylorism. Conversely, the jobs shown at the tops of organization charts are often largely unprogramed. They are "think" jobs — hard to define and describe operationally. Jobs that appear in the big middle area of the organization chart tend to be programed in part, with some specific rules to be followed, but with varying amounts of room for judgment and autonomy.[2] One major effect of information technology is likely to be intensive programing of many jobs now held by middle managers and the concomitant "deprograming" of others.

As organizations have proliferated in size and specialization, the problem of control and integration of supervisory and staff levels has become increasingly worrisome. The best answer

[2] See Robert N. McMurry, "The Case for Benevolent Autocracy," HBR January-February 1958, p. 82.

until now has been participative management. But information technology promises better answers. It promises to eliminate the risk of less than adequate decisions arising from garbled communications, from misconceptions of goals, and from unsatisfactory measurement of partial contributions on the part of dozens of line and staff specialists.

Good illustrations of this programing process are not common in middle management, but they do exist, mostly on the production side of the business. For example, the programmers have had some successes in displacing the judgment and experience of production schedulers (although the scheduler is still likely to be there to act out the routines) and in displacing the weekly scheduling meetings of production, sales, and supply people. Programs are also being worked out in increasing numbers to yield decisions about product mixes, warehousing, capital budgeting, and so forth.[3]

Predicting the Impact

We have noted that not all middle-management jobs will be affected alike by the new technology. What kinds of jobs will become more routinized, and what kinds less? What factors will make the difference?

The impact of change is likely to be determined by three criteria:

1. *Ease of measurement* — It is easier, at this stage, to apply the new techniques to jobs in and around production than in, say, labor relations, one reason being that quantitative measurement is easier in the former realms.

2. *Economic pressure* — Jobs that call for big money decisions will tend to get earlier investments in exploratory programing than others.

3. *The acceptability of programing by the present jobholder* — For some classes of jobs and of people, the advent of impersonal rules may offer protection or relief from frustration. We recently heard, for example, of efforts to program a maintenance foreman's decisions by providing rules for allocating priorities in maintenance and emergency repairs. The foreman supported this fully. He was a harried and much blamed man, and programing promised relief.

Such factors should accelerate the use of programing in certain areas. So should the great interest and activity in the new techniques now apparent in academic and research settings. New journals are appearing, and new societies are springing up, like the Operations Research Society of America (established in 1946), and the Institute of Management Sciences (established in 1954), both of which publish journals.

The number of mathematicians and economic analysts who are being taken into industry is impressive, as is the development within industry, often on the personal staffs of top management, of individuals or groups with new labels like "operations researchers," "organization analysts," or simply "special assistants for planning." These new people are a cue to the emergence of information technology. Just as programing the operations of hourly workers created the industrial engineer, so should information technology, as planning is withdrawn from middle levels, create new planners with new names at the top level.

So much for work becoming more routinized. At least two classes of middle jobs should move *upward* toward *de*programedness:

(1) The programmers themselves, the new information engineers, should move up. They should appear increasingly in staff roles close to the top.

(2) We would also expect jobs in research and development to go in that direction, for innovation and creativity will become increasingly important to top management as the rate of obsolescence of things and of information increases. Application of new techniques to scanning and analyzing the business environment is bound to increase the range and number of possibilities for profitable production. Competition between firms should center more and more around their capacities to innovate.

Thus, in effect, we think that the horizontal slice of the current organization chart that we call middle management will break in two, with the larger portion shrinking and sinking into a more highly programed state and the smaller portion proliferating and rising to a level where more creative thinking is needed. There seem to be signs that such a split is already occurring. The growth of literature on the organization of research activities in industry is one indication.[4] Many social scientists and industrial research managers, as well as some general managers,

[3] See the journals, *Operations Research* and *Management Science.*

[4] Much of the work in this area is still unpublished. However, for some examples, see Herbert A. Shepard, "Superiors and Subordinates in Research," *Journal of Business of the University of Chicago,* October 1956, p. 261; and also Donald C. Pelz, "Some Social Factors Related to Performance in a Research Organization," *Administrative Science Quarterly,* December 1956, p. 310.

are worrying more and more about problems of creativity and authority in industrial research organizations. Even some highly conservative company presidents have been forced to break time-honored policies (such as the one relating salary and status to organizational rank) in dealing with their researchers.

Individual Problems

As the programing idea grows, some old human relations problems may be redefined. Redefinition will not necessarily solve the problems, but it may obviate some and give new priorities to others.

Thus, the issue of morale versus productivity that now worries us may pale as programing moves in. The morale of programed personnel may be of less central concern because less (or at least a different sort of) productivity will be demanded of them. The execution of controllable routine acts does not require great enthusiasm by the actors.

Another current issue may also take a new form: the debate about the social advantages or disadvantages of "conformity." The stereotype of the conforming junior executive, more interested in being well liked than in working, should become far less significant in a highly depersonalized, highly programed, and more machine-like middle-management world. Of course, the pressures to conform will in one sense become more intense, for the individual will be required to stay within the limits of the routines that are set for him. But the constant behavioral pressure to be a "good guy," to get along, will have less reason for existence.

As for individualism, our suspicion is that the average middle manager will have to satisfy his personal needs and aspirations off the job, largely as we have forced the hourly worker to do. In this case, the Park Forest of the future may be an even more interesting phenomenon than it is now.

Changes at the Top

If the new technology tends to split middle management — thin it, simplify it, program it, and separate a large part of it more rigorously from the top — what compensatory changes might one expect within the top group?

This is a much harder question to answer. We can guess that the top will focus even more intensively on "horizon" problems, on problems of innovation and change. We can forecast, too, that in dealing with such problems the top will continue for a while to fly by the seat of its pants, that it will remain largely unprogramed.

But even this is quite uncertain. Current research on the machine simulation of higher mental processes suggests that we will be able to program much of the top job before too many decades have passed. There is good authority for the prediction that within ten years a digital computer will be the world's chess champion, and that another will discover and prove an important new mathematical theorem; and that in the somewhat more distant future "the way is open to deal scientifically with ill-structured problems — to make the computer coextensive with the human mind." [5]

Meanwhile, we expect top management to become more abstract, more search-and-research-oriented and correspondingly less directly involved in the making of routine decisions. Allen Newell recently suggested to one of the authors that the wave of top-management game playing may be one manifestation of such change. Top management of the 1980's may indeed spend a good deal of money and time playing games, trying to simulate its own behavior in hypothetical future environments.

Room for Innovators

As the work of the middle manager is programed, the top manager should be freed more than ever from internal detail. But the top will not only be released to think; it will be *forced* to think. We doubt that many large companies in the 1980's will be able to survive for even a decade without major changes in products, methods, or internal organization. The rate of obsolescence and the atmosphere of continuous change which now characterize industries like chemicals and pharmaceuticals should spread rapidly to other industries, pressuring them toward rapid technical and organizational change.

These ideas lead one to expect that researchers, or people like researchers, will sit closer to the top floor of American companies in larger numbers; and that highly creative people will be more sought after and more highly valued than at present. But since researchers may be as interested in technical problems and profes-

[5] See Herbert A. Simon and Allen Newell, "Heuristic Problem Solving: The Next Advance in Operations Research," *Operations Research*, January–February 1958, p. 9.

sional affiliations as in progress up the organizational ladder, we might expect more impersonal, problem-oriented behavior at the top, with less emphasis on loyalty to the firm and more on relatively rational concern with solving difficult problems.

Again, top staff people may follow their problems from firm to firm much more closely than they do now, so that ideas about executive turnover and compensation may change along with ideas about tying people down with pension plans. Higher turnover at this level may prove advantageous to companies, for innovators can burn out fast. We may see more brain picking of the kind which is now supposedly characteristic of Madison Avenue. At this creating and innovating level, all the current work on organization and communication in research groups may find its payoff.

Besides innovators and creators, new top-management bodies will need programmers who will focus on the internal organization itself. These will be the operations researchers, mathematical programmers, computer experts, and the like. It is not clear where these kinds of people are being located on organization charts today, but our guess is that the programmer will find a place close to the top. He will probably remain relatively free to innovate and to carry out his own applied research on what and how to program (although he may eventually settle into using some stable repertory of techniques as has the industrial engineer).

Innovators and programmers will need to be supplemented by "committors." Committors are people who take on the role of approving or vetoing decisions. They will commit the organization's resources to a particular course of action — the course chosen from some alternatives provided by innovators and programmers. The current notion that managers ought to be "coordinators" should flower in the 1980's, but at the top rather than the middle; and the people to be coordinated will be top staff groups.

Tight Little Oligarchy

We surmise that the "groupthink" which is frightening some people today will be a commonplace in top management of the future. For while the innovators and the programmers may maintain or even increase their autonomy, and while the committor may be more independent than ever of lower-line levels, the interdependence of the top-staff oligarchy should increase with the increasing complexity of their tasks. The committor may be forced increasingly to have the top men operate as a committee, which would mean that the precise individual locus of decision may become even more obscure than it is today. The small-group psychologists, the researchers on creativity, the clinicians — all should find a surfeit of work at that level.

Our references to a small oligarchy at the top may be misleading. There is no reason to believe that the absolute numbers of creative research people or programmers will shrink; if anything, the reverse will be true. It is the *head men* in these areas who will probably operate as a little oligarchy, with subgroups and sub-subgroups of researchers and programmers reporting to them. But the optimal structural shape of these unprogramed groups will not necessarily be pyramidal. It is more likely to be shifting and somewhat amorphous, while the operating, programed portions of the structure ought to be more clearly pyramidal than ever.

The organization chart of the future may look something like a football balanced upon the point of a church bell. Within the football (the top staff organization), problems of coordination, individual autonomy, group decision making, and so on should arise more intensely than ever. We expect they will be dealt with quite independently of the bell portion of the company, with distinctly different methods of remuneration, control, and communication.

Changes in Practices

With the emergence of information technology, radical changes in certain administrative practices may also be expected. Without attempting to present the logic for the statements, we list a few changes that we foresee:

- With the organization of management into corps (supervisors, programmers, creators, committors), multiple entry points into the organization will become increasingly common.
- Multiple sources of potential managers will develop, with training institutions outside the firm specializing along the lines of the new organizational structure.
- Apprenticeship as a basis for training managers will be used less and less since movement up through the line will become increasingly unlikely.
- Top-management training will be taken over increasingly by universities, with on-the-job train-

ing done through jobs like that of assistant to a senior executive.

◐ Appraisal of higher management performance will be handled through some devices little used at present, such as evaluation by peers.

◐ Appraisal of the new middle managers will become much more precise than present rating techniques make possible, with the development of new methods attaching specific values to input-output parameters.

◐ Individual compensation for top staff groups will be more strongly influenced by market forces than ever before, given the increased mobility of all kinds of managers.

◐ With the new organizational structure new kinds of compensation practices — such as team bonuses — will appear.

Immediate Measures

If the probability seems high that some of our predictions are correct, what can businessmen do to prepare for them? A number of steps are inexpensive and relatively easy. Managers can, for example, explore these areas:

(1) They can locate and work up closer liaison with appropriate research organizations, academic and otherwise, just as many companies have profited from similar relationships in connection with the physical sciences.

(2) They can re-examine their own organizations for lost information technologists. Many companies undoubtedly have such people, but not all of the top executives seem to know it.

(3) They can make an early study and reassessment of some of the organizationally fuzzy groups in their own companies. Operations research departments, departments of organization, statistical analysis sections, perhaps even personnel departments, and other "odd-ball" staff groups often contain people whose knowledge and ideas in this realm have not been recognized. Such people provide a potential nucleus for serious major efforts to plan for the inroads of information technology.

Perhaps the biggest step managers need to take is an internal, psychological one. In view of the fact that information technology will challenge many long-established practices and doctrines, we will need to rethink some of the attitudes and values which we have taken for granted. In particular, we may have to reappraise our traditional notions about the worth of the individual as opposed to the organization, and about the mobility rights of young men on the make. This kind of inquiry may be painfully difficult, but will be increasingly necessary.

AMONG the "determinists" in administrative theory — and in this category fall most of those who call themselves behaviorists — the notion is widely held that what an individual institution may be able to accomplish is controlled by the general environment in which it operates. I suppose a certain amount of support may be secured for this position by an oversimplified reading of biology as well as of psychology and sociology. But the behaviorists are wrong. They are wrong not because what they assume lacks truth but because they leave out of consideration the contriving factors in man's intelligence. . . .

Or putting the matter more positively, what we have to assume in administration is that man, being intelligent, is capable of a growing amount of free will. That he can help to determine his environment and not merely be bound by it and conform to it. And if you think that this is an idle notion, how else can you explain the American tradition, with the self-confidence and daring that our pioneers exhibited, their lusty proclivity to take chances and to experiment, their insolent disregard for convention and for the shibboleths of the Old World which would have tied them to the rule of privilege and the powerful? Do we want at this stage in our national history to turn our backs on all this — the chief virtue that has given us what success as a nation we have achieved?

Marshall E. Dimock, *A Philosophy of Administration*
New York, Harper & Brothers, 1958, pp. 21–22.