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Organizational Choice and the New Technology[1]

Eric Trist has had an immense impact on modern social science and is well known for many different contributions. Three of these have had a particular impact on my own development. First, there is the idea that organizations are not subject to forces of blind determinism and that those who design and manage organizations always face a choice in deciding how organizations are to operate in practice. Second, there is the strong emphasis on the social aspect of organization expressed most vividly in the idea that organizations are socio-technical systems that can be designed in ways that tap, enhance and develop human potentialities. Third, is the idea that organizations can become open-ended evolving systems that learn and change along with the wider social ecology.

In this paper I want to explore the implications of these ideas with reference to the challenges and opportunities posed by development in microprocessing technology.

Organization and Technology: A Question of Choice

As is well known, Trist's ideas on the relation between organization and

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technology were first addressed in his seminal paper with Ken Bamforth on the introduction of the "longwall" method of coal getting in British mines (Trist and Bamforth, 1951/Vol. II, "The Stress of Isolated Dependence: The Filling Shift in the Semi-Mechanized Longwall Three-Shift Mining Cycle"). This method of mining introduced a type of assembly-line technology to the coal face and was accompanied by an increasingly mechanistic and bureaucratic style of work organization. In common with so much technological and organizational change occurring at the time, the quest for organizational efficiency in the mines was associated with a raw determinism that simultaneously mechanized production methods <u>and</u> the web of human relations through which they were organized. Trist and Bamforth's article highlighted the problems of this determinism, showing that the mechanization of work relations often had adverse human, social and organizational consequences and that any particular technology could usually be used within the context of a variety of organizational forms. Trist demonstrated that the advantages of technological developments could be harnessed within the context of work systems that were self-organizing rather than rigidly organized; social and organic rather than mechanistic and bureaucratic; and open and evolving rather than closed. In this 1951 article and subsequent writings (e.g., Trist et al., 1963) he stressed that there was no deterministic link between technology and organization and that the introduction of new technologies always presents an occasion for organizational choice.

Organizational Choice and Microprocessing Technology

Recent developments in microprocessing technology make it helpful to

remember the lessons to be drawn from this early work, for we are in danger of making exactly the same mistakes that were made in adapting organizations to machine technology. Many applications of the new technology are still accompanied by determinism and attitudes that harness the power of the technology within the context of old and narrow concepts of organizations--particularly the bureaucratic. For example, many managers and systems designers, who view "organization" as synonymous with "bureaucratic control," merely use the new technology to enhance productive efficiency or to implement the idea of the centrally controlled organization in which almost every action and decision can be monitored and influenced by those in control. New wine is poured into old bottles: the immense capacities offered by the new technology are merely channeled into old and established ways of doing things rather than used as a transformative influence capable of changing how we organize in ways that we may never have thought possible. More than any other development of the twentieth century, the new technology offers a means of transforming organizations in a way that simultaneously makes them effective, efficient, humane and intelligent. In short, it offers a means of realizing the human and organizational values and capacities that Trist and his Tavistock colleagues have espoused over the years. But for these values and capacities to be realized in practice, it is important that those who use and implement the technologies are aware of the choices they face.

The New Technology Can be Used to Transform Organization

Three characteristics of microprocessing technology seem particularly important in appreciating its transformative potential:

- **its multifunctionality;**
- **its ability to create an identity between organization and information;**
- **its ability to redefine and restructure part/whole relations.**

Multifunctionality

Microprocessors are multipurpose tools. They create capacities. Microprocessors are much more flexible than conventional machines that are designed to perform highly specific functions and to achieve predetermined goals. They create means rather than promote ends, and they promote generalizability rather than narrow specialism.

However, whether this capacity for multifunctionality is realized in practice depends on the way the technology is used. It is a matter of choice. Consider, for example, the contrasting ways in which the technology has been used in both manufacturing and office applications. In some manufacturing firms, robots and other microprocessing systems have merely been used to promote the efficiency of existing modes of work organization. They are frequently used in automobile manufacture to replace people on the assembly line as efficient single-purpose machines. In other applications, however, they are used to transform work systems to promote multifunctionality and thus to increase the flexibility of systems. A good example, again drawn from the automobile industry, is found in the flexibility of those systems of car production where variations in the model being produced can be made on an ongoing basis. Under the so-called kanban (signpost) system, certain Japanese manufacturers can produce different cars in whatever sequence is desired

on the very same assembly line because the technology has been designed so that it can serve many ends at once.

In many offices the new technology is often used just to streamline existing bureaucratic arrangements rather than to transform the organization of work by utilizing the technology to diffuse information and control and thus to promote more generalized, holistic forms of organization. The former tends to produce new kinds of bureaucratic organization where the computer, rather than specific line-managers, is in control of a fairly static organizational design. Use in the latter way tends to create organizational arrangements where people possess a greater ability to process and interpret information and thus to extend capacities for intelligent, adaptive action. In the former case, the office becomes a more efficient quasi-bureaucratic machine that is able to perform predefined tasks in an optimal way. In the latter case the office becomes more like a self-organizing entity that can learn and evolve as it negotiates new challenges, opportunities and insights. Developments in information-processing technology, particularly in allowing multiple points of entry to central data systems and the use of decentralized "local" systems and developments in audiovisual communications technology (e.g., telephone, satellite, PBX), enhance capacities for multifunctional organization to an extraordinary degree.

The Identity Between Organization and Information

The new technology is by nature an information-processing technology and, like no other technology before it, has a capacity to create an identity between information and organization. The use of microprocessing facilities allows organizations to become

more and more like information systems. Consider, for example, how whole offices and departments are being replaced by computers. Organized relations between people become replaced by relations within and between computer programs. The form and structure of an organization increasingly becomes synonymous with the design of these programs and other information-processing capacities.

The identity of organization is being transformed by this development. Face-to-face interactions between people are increasingly being replaced by interactions with an information system. In the process, the idea of an organization as a spatial domain is being replaced with the idea that organizations are networks of information. And, as microprocessing technology continues to develop our capacities for information processing and general communications, we may expect organizations to become much more decentralized and less visible than they are now, with people working and interacting from their homes rather than their offices, engaging in televised transactions rather than flying across continents, and so on. All this has enormous transformative potential, changing our very conception of what organization is all about and opening the way to many new forms of organization in practice.

The Redefinition and Restructuring of Part/Whole Relations

All the above developments have important implications for the way we understand part/whole relations. Traditionally, organizations have been viewed as composites of separate parts, whether of people, machines, resources or knowledge. Developments in the new technology have a capacity to undermine and restructure this

distinction between part and whole, for in multifunctional systems that are spatially separate rather than integrated, organizations need no longer be just the sum of their parts. They can develop in ways that allow each part to approximate and develop capacities that formerly could only be realized through the activities of the whole, or major sections of the whole. Consider, for example, how the new technology allows people to develop and design their own "user-drive" information systems or to examine and manipulate centralized data banks in ways that allow them to set their own bounds on the contributions they are able to make to their organizations. Formerly, such contributions would require coordinated activities from quite separate parts of the organization, e.g., the information users, systems designers and others involved in the general control and management of the organization.

The user-driven potential of the new technology provides a means of creating organizations where loosely coupled parts set the pace and direction of the organization as a whole. The new technology creates a potential for creating organizations possessing very different kinds of part/whole relations in which different "parts" are in a position to take initiatives and assume leadership roles. A prototype of this model of organization is found in systems employing autonomous work groups where each group strives to achieve the character of a complete system of organization and where each member of the group attempts to possess the skills and abilities required by the whole. This kind of organization is based on a system of relations where the distinctions between part and whole are very blurred. The whole is encoded and active in each and every part. The new technology creates a means of developing these kinds of relationships to an extent that has not really

been possible before.

Realizing Transformative Potential in Practice

Whether organizations are able to develop and utilize these aspects of the new technology to their full extent will depend on the kind of organizational choices that are made. In particular, choice will depend on the ability of those making decisions relating to the use and design of the new technology (especially software applications) to appreciate that there are alternatives to the bureaucratic concept of organization and that we need not limit our use of the technology to re-creating bureaucracies in a streamlined and hi-tech form.

Thus, to break free of the bureaucratic concept, new ideas about organization are necessary. We need ways of thinking that will allow us to promote multifunctionality rather than narrow specialization, that allow us to create organizations that are more like open-ended networks than closed physical entities and that permit initiative and direction that are decentralized and heterarchical rather than invested in a narrow group of individuals. We need, in short, a way of organizing that can make organizations as flexible and adaptive as the new technology they are now in a position to use.

As a way of developing this kind of organizational capacity, colleagues working with Trist at York University have been experimenting with the image of a holographic system as an organizational design.

The Holograph as a New Metaphor for Organization

A holograph is a photograph taken with a lensless camera using laser beams, where approximations of the whole image are stored in all the parts. Thus, if the photographic plate is broken, an approximation of the entire image can be reconstituted from any of the parts.

Although holography originally developed as a rather abstract aspect of laser science, holographic principles are now being used to explain many aspects of the world around us. Neuro-scientists like Karl Pribram of Stanford University have suggested that the brain may operate in accordance with holographic principles and that holography may be demonstrating basic organizing principles that pervade the whole universe (Pribram, 1975, 1979; Bohm, 1978, 1980).

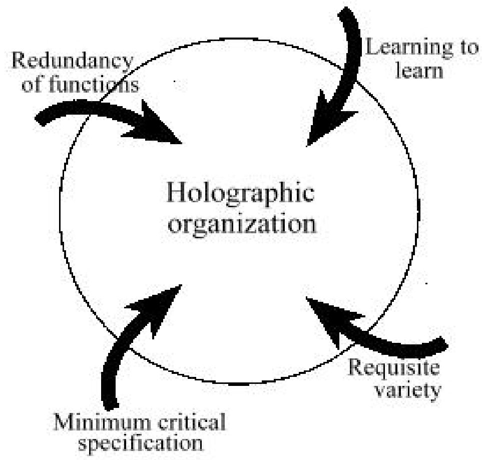
For our purposes here the main point about research on holography is that it identifies a new organizing principle that has close affinity with the capacities created by microprocessing technology. Microelectronics is an information-processing technology that creates the kind of self-organizing ability demonstrated in the way a holographic image can be reconstituted from any of its parts. By using holographic imagery as a means of thinking about how the new technology can be used in practice, we have a means of creating organizations that depart from bureaucratic principles on almost every count.

Facilitating Holographic Organization

As I have suggested at much greater length elsewhere (Morgan and Ramirez,

1984; Morgan, 1986), it is possible to build organizations that have holographic, brainlike capacities by developing the implications of four interrelated principles (Figure 1). Collectively, these principles provide a means of designing organizational forms so that

Figure 1
Principles of Holographic design



each part of the system strives to embrace the qualities of the whole and to self-organize in an ongoing way. The principle of *redundant functions* shows a means of building wholes into parts by creating redundancy, connectivity and simultaneous specialization and generalization. The principle of *requisite variety* helps to provide practical guidelines in the design of part/whole relations by showing exactly how much of the whole needs to be built

into a given part. And the principles of *learning to learn* and *minimum critical specification* show how we can enhance capacities for self-organization.

Any system with an ability to self-organize must have an element of redundancy in internal design because without redundancy capacities for action are completely determined. Redundancy represents a form of excess that allows the system some room to manoeuver. Without such redundancy, a system has no real capacity to reflect on and question how it is operating and hence to change its mode of functioning in constructive ways. In other words, it has no capacity for intelligent action in the sense of being able to adjust action to take account of changes in the nature of relations within which the action is set.

Fred Emery (1967) has suggested that there are two design methods for building redundancy into a system. The first concerns a strategy involving a *redundancy of parts*, where each part is precisely designed to perform a specific function, special parts being added to the system for the purpose of control and to back up or replace operating parts whenever they fail. Redundancy here is built into "spare parts." The design principle is mechanistic and is clearly reflected in the bureaucratic form of organization, where the primary concern is to design a structure of precisely defined jobs (parts) that fit together to form a coherent whole. Special procedures are introduced to ensure that the parts function in accordance with the original design in the form of rules, controls and supervision. The result is typically a hierarchical structure where one part is responsible for controlling another.

If we look around the organizational world, it is easy to see evidence of this

kind of redundancy; the supervisor or manager who spends his or her time ensuring that *others* are working; the troubleshooter or maintenance team that "stands by" waiting for problems to arise; the employee reading a newspaper or idly passing time because there is no work to do; employees passing a request or problem to colleague Y "because that's his job, not mine"; the quality controller searching for mistakes and defects that, under different conditions, could much more easily be spotted and rectified by those who produced them. Under this design principle, the capacity for redesign and change of the system rests with the parts assigned this function--for example, production engineers, planning teams and systems designers. Such systems are organized, and can be reorganized, but they have little capacity to self-organize.

The second design method proceeds by incorporating a *redundancy of functions*. Instead of adding spare parts to a system, extra functions are added to each of the operating parts so that each part is able to engage in a range of functions rather than perform a single specialized activity. The system is thus specialized and generalized at one and the same time. An example of this design principle is found in organizations employing autonomous work groups where members acquire multiple skills so that they are able to perform each other's jobs and to substitute for each other as the need arises. At any one time, each member possesses skills or functions that are redundant in the sense that they are not being used for the job at hand. However, this organizational design possesses flexibility and a capacity for reorganization within each and every part of the system which is absent from systems of fixed functional design.

Systems based on redundant functions are holographic in that capacities

relevant for the functioning of the whole are built into the parts, creating a completely new relationship between part and whole. In a design based on redundant parts, e.g., an assembly line where production workers, supervisors, efficiency experts and quality controllers have fixed roles to perform, the whole is the sum of predesigned parts. In the holographic design, in contrast, the parts are a reflection of the nature of the whole, since they take their specific shape at any one time in relation to the contingencies and problems arising in the total situation. Under this design principle, roles and activities can be changed in an ongoing manner to meet and solve problems that arise, with a minimum of external help. This contrasts with situations based on redundant parts where problems typically activate a hierarchy of authority and control. When a problem arises on an assembly line it is typically viewed as "someone else's problem," since those operating the line often do not know, care about or have the authority to deal with the problems posed. Problems lie outside the domain of one's normal job, and remedial action has to be initiated and controlled from elsewhere. A degree of passivity and neglect is thus built into the system. In systems based on redundant functions, the nature of one's job is set by the changing pattern of demands with which one is dealing. Needless to say, the two design principles create qualitatively different relationships between people and their work. Under a system of redundant parts, involvement is partial and instrumental; under the principle of redundant functions, involvement is more holistic and absorbing.

Implementing holographic organizational design inevitably raises the question of how much redundancy should be built into any given part. While the holographic principle suggests that we should try to build everything into everything else,

in many human systems this is an impossible ideal. In many modern organizations the range of knowledge and skills required is such that it is impossible for everybody to become skilled in everything. So what do we do?

It is here that the idea of *requisite variety* becomes important. This principle, originally formulated by W. Ross Ashby (1952, 1956), suggests that the internal diversity of any self-regulating system must match the complexity of its environment if it is to deal with the challenges posed by that environment. Or, to put the matter differently, any control system must be as varied and complex as the environment being controlled. Used within the context of holographic design, this means that all elements of an organization should embody critical dimensions of the environment with which they have to deal so that they can self-organize to cope with the demands they are likely to face.

The principle of requisite variety thus gives clear guidelines as to how the principle of redundant functions should be applied. It suggests that redundancy (variety) should always be built into a system where it is *directly* needed, rather than at a distance. This means that close attention must be paid to the "boundary relations" between organizational units and their environments to ensure that requisite variety always falls within the unit in question. Design must proceed from questions such as: What is the nature of the environment being faced? Can all the skills for dealing with this environment be possessed by every individual? If they can, then build around multifunctional people, as in the model of the autonomous work group discussed earlier. If not, then build around multifunctioned teams that collectively possess the requisite skills and abilities and where each individual member is as generalized as possible, creating a pattern of overlapping

skills and knowledge bases in the team overall. It is here that we find a means of coping with the problem that everybody can not be skilled in everything; by recognizing that, when this is the case, the multidisciplined team or work group becomes the basic unit around which the organization is built. Organization can thus be developed in a cellular manner around self-organizing groups that have the requisite skills and abilities to deal with the environment in a holistic and integrated way.

The principle of requisite variety thus has important implications for the design of almost every aspect of organization. Whether we are talking about the creation of a corporate planning group, research department or work group in a factory, it argues in favor of a proactive embracing of the environment in all its diversity. Very often managers create the reverse circumstance, reducing variety in order to achieve greater internal consensus. Corporate planning teams are often built around people who think along the same lines rather than around a diverse set of stakeholders who can actually represent the complexity of the problems with which the team ultimately has to deal.

The principles of redundant functions and requisite variety create systems that have a capacity for self-organization. For this capacity to be realized and to assume coherent direction the two further organizing principles also have to be kept in mind: ***minimum critical specification*** **and** ***learning to learn.***

The first of these principles reverses the bureaucratic principle that organizational arrangements need to be defined as clearly and as precisely as possible. In attempting to organize in this way, one eliminates the capacity for self-organization. The principle of minimum critical specification (Herbst, 1974/ Vol. II, "Designing With

Minimal Critical Specifications") suggests that managers and organizational designers should primarily adopt a facilitating or orchestrating role, creating "enabling conditions" that allow a system to find its own form. One of the advantages of the principle of redundant functions is that it creates a great deal of internal flexibility. In autonomous work groups, for example, every member is usually capable of substituting for every other member, creating numerous <u>potential</u> forms of organization. The more one attempts to specify or predesign what should occur, the more one erodes this flexibility. The principle of minimum critical specification thus attempts to preserve flexibility by suggesting that, in general, one should specify no more than is absolutely necessary for a particular activity to occur.

In running a meeting, it may be necessary to have someone to chair the meeting and to take notes, but it is not necessary to institutionalize the process and have a chairperson and a secretary. Roles can be allowed to change and evolve according to circumstances. In running a group or project, bureaucratic patterns of fixed hierarchical leadership can be replaced by a heterarchical pattern where there is no leading element and where the dominant element at any given time depends on the total situation. Different people can take the initiative on different occasions according to the contribution they are able to make. Instead of making roles clear and separate, they can be left deliberately vague, ambiguous and overlapping so that they can be formulated and clarified through practice and inquiry. The basic idea is to create a situation in which inquiry rather than predesign provides the main driving force, encouraging organization members to reflect on what they are doing and to take appropriate action. This style helps to promote forms of

questioning and conflict between competing ideas that can keep organizations flexible and diversified while remaining capable of evolving sufficient and appropriate structure to deal with the problems that arise.

The principle of minimum critical specification thus helps to preserve the capacities for self-organization that bureaucratic principles usually erode. The danger of such flexibility is that it has the potential to become chaotic. This is why the principle of *learning to learn* must be developed as a fourth element of holographic design.

A system's capacity for coherent self-regulation and control depends on its ability to engage in processes of single- and double-loop learning (Bateson, 1972; Argyris and Schon, 1978). These two levels of learning allow a system to guide itself with reference to a set of coherent values or norms, while questioning whether these norms provide an appropriate basis for guiding behavior. For a holographic system to acquire integration and coherence and to evolve in response to changing demands, these learning capacities must be actively encouraged. The members of such a system must share some sense of collective identity while being prepared to question, challenge and change this identity as circumstances require. In an autonomous work group, for example, it is necessary that members find a sense of value in the kind of activities in which they are engaged and in the products that they produce. They should be open to the kinds of learning that allow them to contribute to changes in the design of these activities and products in an active way. Given that there are so few predetermined rules for guiding behavior, direction and coherence must come from the group members themselves as they set and honor shared values and norms that are allowed to evolve along with changing circumstances.

One of the most important functions of those responsible for designing and managing the kind of "enabling conditions" referred to earlier is that of helping to create a context or ethos that fosters this kind of shared identity and learning orientation.

Holographic Organization and the New Technology

There are many aspects of microprocessing technology that facilitate this kind of holographic organization. This technology can diffuse information, communications and control in a way that has not really been possible up to now. It has an important decentralizing potential and, as Pava (1983) has noted, can promote many transformations in existing organizational arrangements that are highly consistent with a general move towards a more holographic style of organization.

The technology

- **allows tools, machines and human beings to be endowed with an information-processing capacity that enables increased "intelligence," adaptability and self-direction;**
- **allows for the linking and meshing of people and machines to increase communication, adaptability and self-direction;**
- **dissolves the need for hierarchy and command as a primary mode of communication and coordination;**
- **diffuses information-processing capacities by allowing multiple points of entry to central data systems and by creating the capacity for developing on-the-spot local information systems;**

• provides the possibility of many people, not merely the top management, being able to acquire an overall view of an organization and its work and thus to evolve decisions and policies relevant to the whole;

• reduces the transaction costs in the process of communication and decision making;

• transforms traditional skills and knowledge bases, making them widely rather than narrowly available--and more accessible--thus reducing the need for experts and other professionals;

• increases the possibility of self-sufficiency and thus the capacities for self-organization;

• dissolves the need for proximity as a basis for interaction, creating new possibilities for communication and coordination;

• increases in general the scope for user-driven systems of work design and organization.

Interestingly, the holographic style of organization is highly consistent with certain lines of advanced computer systems design that are moving toward the development of relational data bases with multiple points of access and potential patterns of interaction and toward the development of fully integrated user-driven systems. In many applications (e.g., Tapscott et al., 1985) it is being learned that such systems tend to be most effective when they are designed and driven by the people that ultimately have to use them. Computer systems that are imposed on organizations by external consultants, remote

systems designers or top management appear to be nowhere near as successful as those that are designed in conjunction with those who are closest to knowing what information and designs are required and who ultimately have to use them--that is, the users.

The principles of holographic design provide a coherent frame of reference for guiding the way microprocessing technology is introduced into an organization and how it is allowed to evolve. In contrast with bureaucratic approaches, which tend to favor top-down styles of design and implementation, the holographic model favors bottom-up approaches where the required degree of integration and balance between central and local information systems, mainframes, personal computers, etc., is established through a system where the parts (users) are allowed to shape the nature and direction of the whole. Of course, trade-offs and hard decisions have to be made. Duplication and redundancy have to be constrained by economic and other realities with which an organization is dealing but there are always holographic means of dealing with these issues. Use can be made of "technology" or "systems development" teams that reflect the range of interests represented in the organization in accordance with the principle of requisite variety. These teams can formulate policy and establish appropriate degrees of integration in a way that allows the developing use of the technology to exert a transformative influence on the organization as a whole. Ideas on organizational design that emphasize the importance of decentralization over centralization--as in the principles underlying autonomous work groups (Susman, 1976; Herbst, 1962); organic networks (Burns and Stalker, 1961; Kingdon, 1973); and the concept of the multidivisional "M-form society" (Ouchi, 1984)--all have an important role to play. The key to such designs is to create systems that allow the

parts of an organization, whether individuals or groups, to remain separate yet integrated.

The thrust of this kind of approach is to create user-driven styles of organization where people occupy the foreground and where the technology (powerful though it may be) occupies a supporting role. This approach requires appreciation of the essential interdependence between people and technology and of the fact that technological change, on the scale made possible by the microelectronics revolution, may require extensive organizational transformation. The potential of the technology rests not just in changing the way we do things, but in changing what we actually do.

In arguing that a new mind-set is required to deal with the implications of the new technology, my intention is not to replace one kind of determinism with another. I have advocated a holographic style of organization to harness the potential of the technology that may be viewed as a new imperative. I have chosen to develop the argument in stark terms because I feel that the bureaucratic attitude is so entrenched in the way most of us think about organization that we often need this kind of stark argument in order to have any chance of breaking free of traditional practice.

In adopting and developing the implications of the technology, we do face a choice. And, starkly presented, it is a choice between approaches that reflect the traditional bureaucratic values, or more democratic, holographic values. The power of the bureaucratic mode of thought, and the substantive interests that it sustains, leaves little room for anyone to expect that managers and others with the power to change prevailing modes of organization will do so overnight. The move from bureaucratic to more holographic styles of organization inevitably has an impact on power relations within an

organization and is often constrained by existing power structures. As many others have noted, developments in the new technology are a double-edged sword in this regard; they simultaneously increase the potential for centralization *and* decentralization according to the organizational choices that are made. My real hope is that by achieving an understanding of the holographic model of organization, we may have a better means of realizing the decentralizing, democratic potential of the new technology and thus of moving organizations closer toward the humanistic vision that Eric Trist has always thought realizable, and which he has spent so much time and energy trying to achieve in practice.

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