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Designing Socio-Technical Systems for Greenfield Sites[1]

In the arguments that are going on about the democratization of work, we can see people talking past each other because they have fundamentally different models or paradigms of what work is all about. These paradigms are consistent within themselves but quite irreconcilable with each other. If you are looking at work through one paradigm you cannot see what is seen through another.

At the heart of the traditional paradigm of work is the master/servant relation. Logically, this is a relation of asymmetrical dependence: the servant is dependent on the master for the job. As far as the master is concerned the servant is a redundant, replaceable part. From this relation the notions of managerial prerogatives and the right to hire-and-fire flow naturally.

Over the past 15 to 20 years a new paradigm has emerged (cf. Emery and Thorsrud, 1976). It is a relation of symmetrical dependence, a relation of cooperation within work. It expresses a refusal to accept the role of servant in a master/servant relation. It accepts, however, that workers are often able to do their work better with good management and that management can do nothing without workers.

The conflict between these paradigms comes to a focus on the role of the foreman. In the old paradigm the foreman/first-line supervisors are the essential link between managerial decision making and shop floor activity but are not themselves part of management. Neither, of

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course, are they accepted as workers. They are in the unenviable role of being the meat in the sandwich.

In the new model of work there is no place for the role of foreman. Such a role is quite antithetical to the notion of there being cooperation on the job. It implies that the workers are not being trusted to keep up their end of a relation of symmetrical dependence.

The role of the foreman is so central to the traditional authoritarian system that the first question to ask of any proposed scheme for democratization of work is: what does it do to the foreman's role? If it leaves that role intact then the scheme is fraudulent--at best mere icing on the cake. Most representative schemes are of this nature. While the elected representatives are off at their council meetings, the foreman continues to rule the roost. Similarly, most of the job enrichment, job enlargement schemes put forward by Herzberg, Scott-Myers and Ford leave the foreman's role quite untouched. For those who see the world of work through the traditional paradigm these schemes have an attraction. They can accept that happier workers could be more docile, maybe even produce more. They can accept that dull, meaningless and repetitive work activities make for unhappy workers and hence that there is some value in rewriting the individual job specifications to put more meaning in the task and provide more variety. What they simply cannot accept is that people would better perform even these improved jobs, and better coordinate them, if the foreman was not standing over them. Their implicit assumption about "the psychology of the worker" is obvious from the argument that is usually thrown in to clinch the case: "If the foreman was not there a natural leader would emerge and probably be even harder on them."

When people have had years to build a work culture on a different and opposing

paradigm, it is painfully difficult to change the situation by mere scientific argument. One is

inclined, in fact, to the pessimistic view that the great physicist Max Born expressed in looking

back over the turbulent history of quantum physics:

> A new scientific truth does not triumph by convincing its opponents and making them
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> see the light, but rather because its opponents eventually die, and a new generation grows
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> up that is familiar with it (quoted by Kuhn, 1962, p.150).

We have experienced many difficulties in introducing the new paradigm into

established workplaces. It has been like trying to fight one's way through a World War I defense

system. The first line of trenches are occupied by the trade union officials and can be negotiated

beforehand. Behind this is a second line of trenches that arises from the formulation of on-the-

job customs and procedures. This second line is held by the rank and file of workers. These

defenses are specific to the workplace and protect individual workers from abuse even when their

trade union officials desert them or are powerless to intervene.   Working people have no

alternative to developing this second line of defense: the law of the land or the powers of the

unions usually do not reach far enough into the workplace to prevent abuse of managerial

prerogatives. However, these defenses can readily blind workers to changes that serve their

interests. The defenses have usually emerged for good reasons that are now buried in the past,

the occasions and the authors forgotten. That they emerged for some good reason is the reason

for their being sacrosanct and the reason for their being extremely difficult to negotiate. In fact,

any attempt to negotiate them is seen, ipso facto, as proof of evil managerial intentions.

Sophisticated socio-technical analysis that proves the existence of joint benefits to workers and management helps, but not much in these circumstances.

Greenfield sites offer a good chance for a socio-technical analysis to make a contribution because in such cases a second line of defense has not emerged and most matters can be negotiated beforehand with trade union officials (and laid down for the new management). The workers and management can start from the beginning in conditions that allow for cooperation or open confrontation.

If socio-technical analysis is to play its part then:

It must be involved in the planning process before technical planning has preempted too many options with regard to who is to be employed and how they are to be organized. This is contrary to common practice where the technical designers are guided only by such simple-minded criteria as minimal manning.

It must be concerned with creating those interfaces between the technical and the social system that allow for the fulfillment of the human requirements of a job and an organization of people around the work which is maximally self-governing.

The first requirement can be met only by the relevant decision-makers becoming more conscious of their social responsibility. Social scientists, or engineers-cum-social scientists, have the responsibility for identifying what has to be taken into account in order to design effective socio-technical systems; systems that are rewarding to all that take part in them.

In "Some Characteristics of Socio-Technical Systems" (1959, revised 1978) I tried to spell out what we knew about these desiderata. A lot of discussion has taken place since that was written. The need for greenfield site design has become more critical as more and more organizations find that they are incapable of undoing the exploitative and defensive systems built

into their existing plants. There is, furthermore, the chance that by demonstrating what can be

done at a new plant, the management and workers in the old plants will be inspired to follow suit.

In designing a social system to operate efficiently a modern capital intensive plant,

the key problem is that of creating self-managing groups to man the interface with the technical

system. The term "self-managing group" deserves comment as it highlights why I should want to

talk about the groups' management problems. Through the 1950s and 1960s it was common to

refer to democratized work groups as "semiautonomous groups." Only in the 1970s was it felt

that the idea was more clearly conveyed by the concept of self-managing groups. I do not think

that the shift in terminology was accidental or arbitrary.

The first studies of democratized work groups were in traditional work settings,

e.g., coal-mining faces, textiles and metal fabrication. In each of these cases the most serious

problem was that of how much autonomy work groups could have which would be consonant

with company production plans, maintenance procedures, safety rules and personnel practices.

Cooperation within the groups was no real problem, as most people could easily master the tasks

done by others and hence help out or relieve others as the need arose. Control over each others'

contribution to the group task was also of little problem. The workplaces were intimate enough

to enable each to see what the others were doing or not doing. All of the tasks were well enough

understood to enable others to judge whether the workmanship was up to standard, and the

constant face-to-face interaction made it reasonably easy to generate group pressure on those not

pulling their weight. This last comment should not be taken to imply that these groups pressure

everyone to keep up with the best and fastest workers. (In my experience the bull-gang

atmosphere has only emerged when a group's reward was based on a simple index of quantity

produced.) Typically, these groups are far more conscious of, and responsive to, variations in

skill, intelligence, age, etc., including daily variation due to health, than any foreman could be

expected to be no matter how well versed in human relations theory. People in relatively stable

groups, even up to platoon size, seem to be remarkably adept at keeping books on favors given

and debts due, and yet not at all impatient about balancing the books.

Thus it was that in these kinds of work settings we had simply to work out

beforehand what was going to be the group territory, what were adequate performance levels and

rewards and what limits to group autonomy had to be observed. That done, it could be left to the

group to learn how they would manage themselves. In the case of our first Norwegian

experiment--in the wiredrawing department of the Oslo Iron and Steel Works--I do recall very

serious discussions about whether the groups should first be taught the art of group self-

management. The previous mode of individual working had, as our interviews had shown,

completely inhibited any sense of group identity, mutual respect or cooperativeness. We decided

that such teaching would be a bit too insulting to the self-respect of the workers. After both

shifts had been working for several weeks it was obvious that we need not have worried.

This emphasis on degrees of autonomy started to change with our very first case

of a continuously operating process plant--the chemical pulp department of the Hunsfoss Pulp

and Paper Company in 1964. Although we did not appreciate it at the time, we were probably

fortunate that there was a further complication. At the heart of the production of chemical pulp

was a batch method of digesting the wood chips. Each batch took approximately 16 hours in the

cooker and there was no way of knowing how successfully the process was going until it

emerged from the cooker. Thus each batch was started on one shift and finished on another

(even two shifts later). Responsibility could not be located within a shift group; it had somehow

to be located within the ensemble of four shifts that provided the continuous manning. The

conditions of an open workshop and face-to-face interaction were not present (cf. Miller,

1959/Vol. II, "Technology, Territory and Time: The Internal Differentiation of Complex

Production Systems"). There also seemed to be restrictions on the degree of multiskilling; a

person from another section of the department could be trained to take an assistant's role in a

particular section but the prospect of one person being thoroughly versed in more than one

section seemed to be well in the future. Even within a shift, the operators were so widely

scattered that there was little chance of them overseeing each other.

Under the conditions found at Hunsfoss, it became clear that autonomy was

critically dependent on the cross-shift group evolving forms of effective self-management.

Intuition and common sense could not suffice when the people whose tasks were interdependent

were in no position to see what the others were doing; when the effectiveness of group pressures

was grossly attenuated; and when it was very difficult to judge what had contributed what to any

result.

Subsequently it became clear that, if work was to be democratized for

interdependent workers who are widely separated by their skills or by space and time, the critical

problem was not that of deciding on the degree of autonomy that should be allowed but of

devising information systems that enable effective self-management. To allow any degree of

autonomy in the absence of an effective information system would be simply to induce anarchy, a

laissez-faire situation where each of the interdependent parts went its own way. In describing

this matter I have used the notion of an "information system" as a piece of shorthand to refer to

an information system that is about agreed objectives and review of performances. An

information system that simply reported on what each interdependent part had performed would

degenerate into an unhelpful exercise in one-upmanship and scapegoating.

My basic proposition in this paper is that under such conditions, self-managing

groups have problems with controlling and coordinating their efforts that are much greater than

would be the case if they were bureaucratically organized, as is the case similarly with the setting

of their objectives.

Let us look first at how control and coordination are achieved in a bureaucratic

section. The fundamental premise of bureaucratic organization is that each individual is allotted

a personal task that must be performed and is usually allotted workplace and working hours. The

more these matters are laid down in rules, regulations and job specifications, the easier it is to

pinpoint movements that are out of control. In the absence of such fine controls, supervision

usually requires strong rewards and penalties. Control is then simply a matter of supervisors

overseeing the individuals in their sections to make sure that they are at their allotted workplaces

during the specified working hours and performing their allotted tasks. Coordination is

simplified because in overseeing for purposes of control supervisors have, or think they have,

knowledge of which workers are behind with their task, which ahead and what shuffling of

people between jobs needs to be done to catch up on the backlog. If no one is ahead supervisors

may decide that some work is less urgent and may be allowed to lag; alternatively, reserves held

by superiors may be called on. Such reserve forces are commonplace as the individual workers

in this system are motivated to pretend that they are fully occupied with their allotted tasks, even

when they are not, and to cry "overload" when, with a bit of extra effort, they could cope. The

reserves are not always designated as such. They usually accrue through an incremental process

of overmanning. When the work being done by one person regularly piles up to what the

supervisor takes to be one-and-a-half manshift loads, another person is sought to split the work.

It will be noted that the problems of coordination tend to be solved by evasion--"delegating"

them up the chain of command--rather than by trying to get a better grip on the actual work

situation.

The setting of objectives is also much easier for the supervisor or superintendent

in a bureaucracy. It is enough if supervisors know the order of importance that their direct

superintendent places on the different tasks to be performed by their sections. It is of no concern

of theirs if the superintendent has got it wrong from the organization's point of view. In matters

to which the superintendent is indifferent, supervisors are free to order them according to their

personal preferences and feelings.   Even if they get this wrong, they can escape blame by

pointing to the lack of explicit orders from above.

At a theoretical level we can note that control in a bureaucracy is made easier by

familiarity with the myriad of rules, regulations and job specifications and by familiarity with the

dodges the workers are likely to employ. Coordination is made easier by familiarity with what

the boss wants and a personal style of management that gets the job done. Supervisors will not

seek efficiency in the use of their resources if that is likely to lead to some resources being taken

away or to the weakening of their case for additional resources. The setting of objectives is a

similar mixture of familiarity and personal preference (the dimension of Probability of Choice

[Ackoff and Emery, 1972]) and of effectiveness (the dimension of Probable Effectiveness). The

dimension of organizational choice that is absent is that of Relative Value or Intention. In its

absence the question of efficiency can be of only academic interest.

We need to note also that any attempt to run a bureaucracy by "management by objectives" is fundamentally flawed by the fact that the objectives of supervisors for their sections are not the objectives of any one of their subordinates whose objectives are limited to their own allotted subtask. The same lack of identity holds between superintendents and the supervisors reporting to them.

So far I have discussed a bureaucratic section as if it were working at one place and time and was not beyond the ability of the supervisor to supervise. What special difficulties are posed for a bureaucratic organization when the section task is performed on different shifts, in separate workplaces or when the task involves several specialist skills in the work force? The bureaucratic form of organization copes with this problem with the greatest of ease, although with a further loss of efficiency--it simply throws up another level of traditional supervisory roles.   As most organizations in real life are of this complex type it is not difficult to see why the overwhelming majority of schemes to introduce management by objectives and integrated information systems fail to get off the ground.

Let us now turn to the difficulties that self-managing groups face in controlling and coordinating their activities and in setting their objectives. Some of the difficulties are obvious. Control is more difficult because no one is so free of other duties that they can, at practically any time of their choosing, make an overall inspection and no individual has formal authority over any of the others. Coordination is difficult for much the same reason: no one can spend much of their time seeing how work is going with the other sub-groups, and no one can command help from others, they can only request help. Nor can they so readily request extra

resources from the next line of command. The supervisor has usually been told, "This is the job for your section and these are the resources you will have at your command." It is not his or her fault if there turns out to be a mismatch, although he or she will probably justify the request on the grounds that things have changed rather than suggest that the superiors made a misjudgment or are incompetent. A self-managing group, on the other hand, will have started with a negotiated agreement about the resources they needed to perform their task. They will need hard evidence in order to renegotiate the agreement.

To add to these difficulties, no one in an extended or multiply skilled group will know at any one time who is doing what and where. Hence it can be difficult to know who best to seek immediate help from or who needs help. This is far more confusing than in a bureaucratically organized section. In such a section, one can count on each person being engaged with the subtask spelled out in the job specification at the work station allotted.

The situation is not all negative. Members of a self-managing group are in a position to subject each other to fairly continuous and close scrutiny, even when they are split into sub-groups through which they rotate. This can be a direct scrutiny when one is helping another by sharing the same subtask or by just assisting with a less skilled part of the task. It can be indirect evaluation _if_ the group members understand the technical interdependencies within the total group task. Thus, there is a considerable potential for exercising intra-group controls in a realistic and sensitive manner. They are not likely to be misled by the face a worker would show to a supervisor. Furthermore, the relation among members of such a group is a relation among "us," and hence requests for assistance are going to be very much more powerful than requests made in a "them-and-us" context.

These potentialities are not going to be realized in an extended group, let alone sustained, unless the difficulties discussed above are overcome.

The face-to-face semiautonomous group can take its own ongoing activity as a common reference for its constituent members. Seeing what is going on around them, the group can decide what they should be doing next, or be seen by others to be defaulting. In a bureaucratic section, extended or face-to-face, they have only to look over their shoulders to see the common reference--the supervisor. For the extended self-managing group, relations have to be mediated by reference to the group task as it is reflected in symbols that are free of temporal and spatial limitations and free of professional jargon.

Thus it is that self-managing groups require an *integrated information system.* It is not something imposed to enable someone in higher authority to keep track of the groups and the resources they use but a requirement that is intrinsic to their self-management. In the Hunsfoss example mentioned earlier, this was reflected in the demand for a central information center, continuously updated throughout each shift and across shifts by the operators themselves, to keep track of what was in the "pipeline" and to measure progress against targets. All parameters that could be significant for any part of the group task were recorded, not just those that, in the past, some supervisor or superintendent had a fad about. By the same token, standing rules and regulations for plant operation were gradually replaced by standard operating procedures that evolved with accumulating empirical evidence. I do not know how far the latter continued to evolve, but eight years after moving toward this form of organization I was able to observe that the information center was still the hub of operator activity and still growing in its comprehensiveness.

In discussing the need for an integrated information system that will allow group members to know what is happening in other parts of their system, I have been guilty of putting the cart before the horse for ease of exposition.

No integrated information system is of use unless there is:

- a need to know;

- an ability to understand what is conveyed;

- an ability to learn from what is understood.

The need to know will be felt by group members only if they accept responsibility for the achievement of group objectives. Many things, such as potential reward and trust of management, will affect the acceptance of responsibility. One thing is sure, however, and that is that a group will not accept responsibility, or will quickly regret accepting responsibility, for an open-ended commitment. Setting group goals as moving from output level A percent to output level A+ i o percent is one such open-ended commitment. It does not delimit the responsibilities of the group to the organization because it does not specify the inputs that are allowable and necessary. Appropriate objectives must so specify inputs and outputs that a group can demand to be judged on "value added" (or saved).

In bureaucratically organized systems hardly any supervisors or superintendents have any notion of the value added by their area of command. In a system of self-managing groups such information is mandatory, and hence it is necessary conscientiously to apply the tools of the management sciences. To seek to continue to manage by the seat of one's pants is to court disaster in one's industrial relations

It will be obvious that input/output analysis at this level throughout an

organization is going to provide an unusually high level of organizational self-consciousness, but

only at the expense of considerable instrumentation andlogging and the discomfort of

considerable reorganization of those many support services that seem to defy objective

evaluation.

Generation of this sort of information is of little use if it is understood by

only a few in the group. Under those circumstances knowledge becomes power. By implication,

this takes us beyond training for doing a specified job to education in what is involved in the total

group task. Insofar as the task reaches from material inputs to a product, we are referring to

polytechnical education. In bringing on-line a new fertilizer plant in Norway in 1967, we thought

it revolutionary to provide a theoretical course of 200 hours for operators. To do the same thing

in a highly capital intensive mining and milling operation in 1978, we have had to specify more

than 500 hours of formal classroom education for operators.

Effective use of this knowledge and information cannot be taken for

granted, nor can one place too much responsibility for combining these factors on experts outside

the group. It becomes necessary for the group to have the means and the skill to monitor what it

does with at least the proficiency that in past decades was shown by quality control engineers and

production planners. Fortunately, the growth in computer assisted analyzers has made this

possible.

Where these three conditions are met, a viable integrated information

system is possible - Not only does this ensure that the operators are alert to what is going on in

the process they are operating and hence able quickly to take appropriate action; it also provides

the means for continuously learning how better to do their job, which, in my experience, is the

critical criterion. If, at any point in the life of a plant, the learning curve plateaus, there is reason

to believe that the management of the self-managing groups has gone bad.

This brings me to my last point. How does one manage an organization

where the interface with the technical system is Primarily controlled by self-managing, groups of

operatives? Not only has the foreman gone, but also the whole layer of production planners,

quality controllers, etc., that Frederick Taylor so fervently espoused. Even the role of

departmental and shift superintendents is cast into doubt.

It seems to me that the primary tool of management is the negotiated

agreement on group objectives. I have already alluded to the destructive nature of agreements

that simply define outputs. Clearly, the agreement must cover the "minimum critical

specifications" (to use Herbst's 1974/Vol - 11 phrase) for economic transformation of the inputs

to the product, within legal limits imposed for such things as human safety and health. This

should not be difficult for management who, after all, have skilled resources at their command,

or on call. Since the negotiations are about the operation of a technical system that has some

unifying character, this should be a much easier problem than carving a group task up into

individual work stations and manshift units (on spurious estimates of "norms", cf. Baldamus,

1961). It needs only to be added that the negotiations are about a ***socio-technical system***, and

hence among the minimum critical specifications to be negotiated are the selection of group

members, their training and their access to other skilled personnel.

The point I have wished to make in this paper is that the move toward

self-management in complex organizations is going to mean more conscious management, not

more of the laissez-faire, seat of the pants management which is the bread and butter of the

bureaucracies.

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