

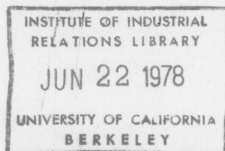
AUTONOMY AND TECHNOLOGY: A CONTINGENCY APPROACH

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## Introduction

Numerous experiments in job enrichment, direct worker participation and autonomous work groups have been reported (e.g. Emery & Thorsrud 1969, Paul et al 1969, Anon. 1973). However, conceptual and theoretical bases for those experiments have been lacking. Consequently, little cumulative knowledge regarding the effects of different job designs on productivity and workers' has been gained.

"Worker autonomy" and "participation" are currently value-loaded concepts in the organization of work. Both industrial engineers and social scientists often base the assignment of organizational decision-making on their personal values and opinions of workers' needs and abilities. While we do not deny them the right to do so, we do question value-loaded design decisions when those are made under the banner of "Scientific Management" or some psychological theory. What appears to be needed are genuine job design theories, which generate propositions and experimental work to test those propositions.

Research indicates that the contingency approach currently employed in organizational theories is also appropriate on the micro-organizational level. Different technologies and individual differences require different task designs. Not every worker necessarily prefers an enlarged job and autonomous work groups could be very unproductive for a certain work force and under certain technological conditions. (Davis 1962, Blood & Mulin 1967, Morse 1970, Hackman & Lawler 1971)

This paper develops a contingency model for task-related decision-making and reports on its subsequent validation in existing work settings.<sup>\*</sup> Observed measures of technology and autonomy will be described and practical implications of these findings on the design of jobs are discussed.

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# A MODEL OF DECISION-MAKING IN TASK SYSTEMS

A task system is a set of activities together with the resources needed to transform a certain input into a specified output within a given time.

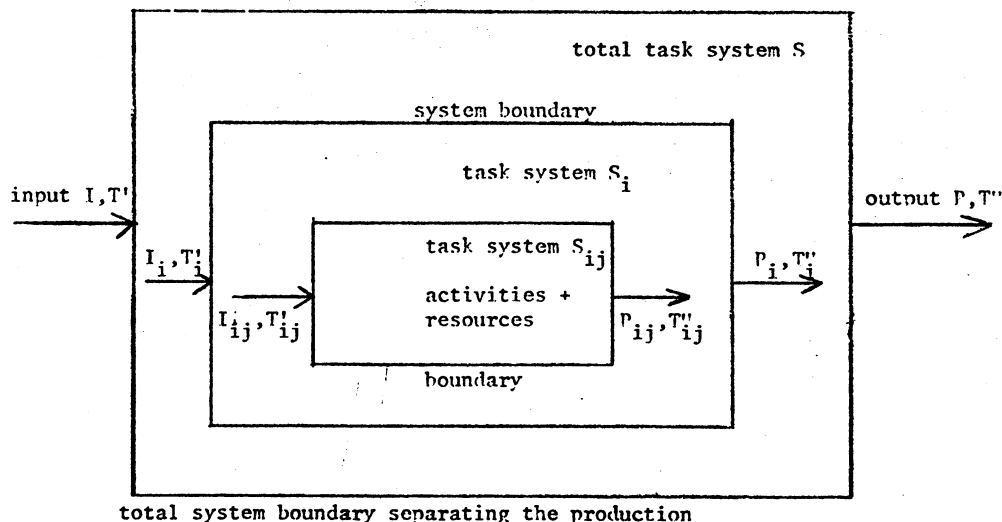
As the number of activities increases so does the complexity of the task system; the task system is usually then split into sub-systems in order to better manage the total system. (Beer 1966, Emery J.C. 1969)

Each sub-system is a task system identified by an input and output which clearly separate it from the environment of other sub-systems.

The interface between a sub-system and its environment is called the system boundary. A system boundary implies some discontinuity, caused by a differentiation in process, product, client, territory, time or type of human resources.

A total task system can be depicted by the following diagram:

FIGURE 1: MODEL OF A TOTAL TASK SYSTEM



The total system is composed of a hierarchy of sub-systems. Thus task systems  $S_{ij}$  is a sub-system of  $S_j$  and task system  $S_j$  is a sub-system of task system  $S$ . This hierarchal structure of task systems results from the need to reduce the complexity of the total system, and does not necessarily imply authority relationships.

Each task system is identified by its input,  $I$  and output,  $P$  in terms of their characteristics and their time dependency  $T' \rightarrow T''$ .

The transformation from input into output, i.e. the task performed by the task system, is performed by two types of activities, namely: operating activities and decision activities.

Operating activities directly contribute to the conversion process and in some way bring about a change in the throughput of the system. Decision activities effect choices between alternative ways of action and relate the operating activities to each other.

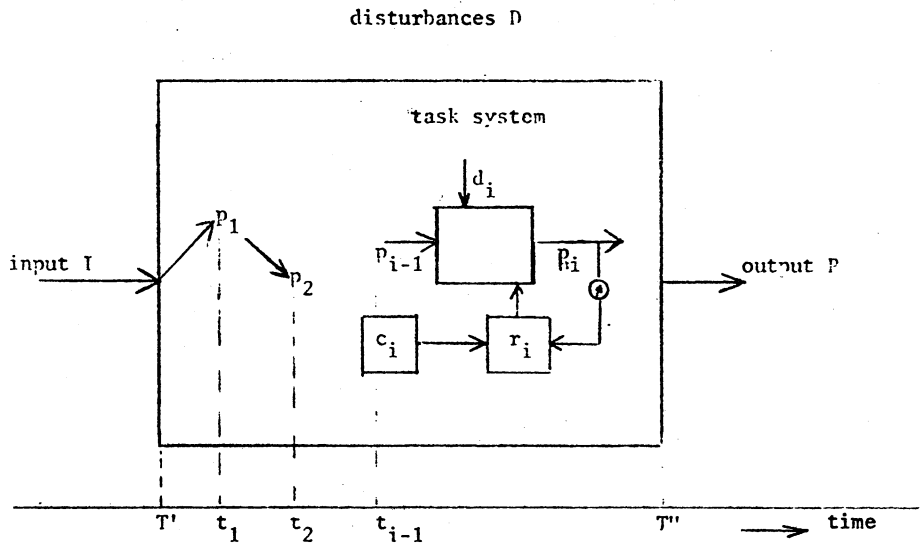
#### A classification of Task Decisions

Decision activities can be either of a control or of a regulatory nature. Decisions that specify the outcome or target of a process are made by a controller, while the regulator keeps the process on target by counteracting disturbances. For example, the required temperature in a room is set by a control decision while a thermostat regulates the heating process in such a way that the required temperature is maintained.

Control decisions can be concerned either with transactions across system boundaries or with action within the task system. Decisions of the first type, called boundary control decisions, connect the task system in terms of resource planning, quality and quantity specification, and scheduling of inputs and outputs.

Control decisions of the second type, called intrasystem control decisions, determine ways and means of transforming the input into the output, in terms of work methods and speed of work. The relation between boundary control decisions and intrasystem control decisions is illustrated in the following diagram:

FIGURE 2: SCHEMATIC REPRESENTATION OF TASK CONTROL AND REGULATION



The characteristics of input I and output P and time  $T'$  and  $T''$  are specified by boundary control decisions, while  $p_1 \dots p_n$  and  $t_1 \dots t_n$  are specified by intrasystem control decisions.

Regulation is composed of two steps, monitoring and counteraction. Monitoring involves the detection of deviations between actual values of the process variables and the desired values set by control decisions; counteraction involves the resetting of the process on target.

Regulation decisions are subordinate to the appropriate control decisions.

Thus the regulator must obey the controller as illustrated in Figure 2.

Intrasystem control decisions  $c_1 \dots c_n$  specify  $p_1 \dots p_n$  respectively; their accumulation gives output  $P$  as specified by boundary control decisions.

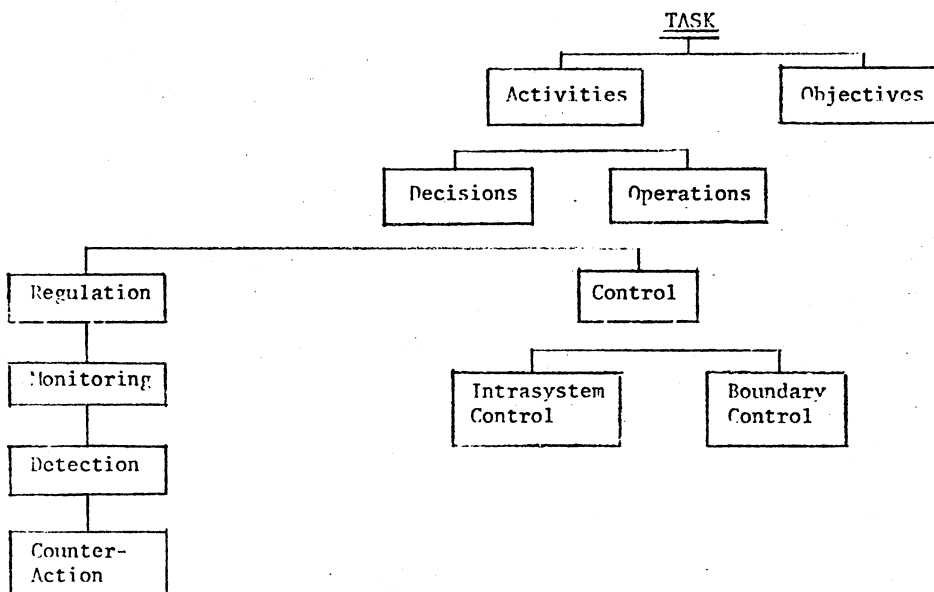
The task system is subject to disturbances  $D$ , which can be decomposed into  $d_1 \dots d_n$ , each affecting a particular phase in the transformation process.

These disturbances are detected and counteracted by regulators  $r_1 \dots r_n$ , which must obey controllers  $c_1 \dots c_n$ .

The classification of task activities is illustrated in Figure 3, which shows task decisions classified into three groups:

1. Boundary control decisions, which set quality and quantity specifications, the time schedule of inputs and outputs of the task system, and the allocation of human and physical resources to the task system.
2. Intrasystem control decisions, which select the activities and sub-goals for the conversion of the system inputs into the outputs specified by the boundary control decisions, and which assign to task activities the resources provided for by boundary control decisions.
3. Regulation decisions, which counteract disturbances generated outside the task system, as well as those occurring during the conversion process.

FIGURE 3: CLASSIFICATION OF TASK ACTIVITIES



Decision activities can be performed by components of the task system to which the decisions refer, that is by autonomous decision-making, or by components outside the particular task system.

Autonomy of the task system in boundary control decisions is simply not feasible, since coordination between the different task systems would depend on a haphazard fitting of a number of independently-made decisions.

The assignment of intrasystem control decisions is discussed elsewhere. (Dar-El & de Haan 1976)

Factors such as cycle time, task repetitiveness, skill level, the task performer's need for autonomy and his autonomy in regulation proved to be relevant for autonomous intrasystem control decision-making.

This paper is primarily concerned with the conditions under which autonomous regulation by the task system is most effective.

Regulation keeps the transformation process on target by counteracting disturbances or unpredictable events occurring during work.

Consider the major factors in regulation:

1. Information concerning disturbances is transmitted to the regulator through one or more communication channels. The capacity of each of these channels will determine to what extent information on disturbances will be transmitted to the regulator. Communication Theory (first enunciated by Shannon (1949)) states that for complete transmission of information, the channel capacity should possess at least the same variety as that of the message transmitted. The existence of informal information networks in an organization result from the inability of formal communication channels to transmit the variety proliferated in the organization.

At the work-station level the usual communication channels are:

- a) direct contact between supervisor and worker, b) progress and quality reports, and c) requests for repair and maintenance. Fewer communication channels between disturbance sources and the regulator would result in less administration in terms of forms, reports, and supervisor attention required to transmit complete information about the disturbances.
2. A second factor of importance in every regulation is the time lag or delay in the regulation. The time lag is the time elapsed between disturbance occurrence and regulator response. Time lag has a major impact on the quality of the regulation. In general, time lags



should be reduced, since they may lead to instability of the system. A more technical discussion can be found in textbooks on Control Theory and Cybernetics. (e.g. Forrester 1961, Pask 1961)

Reduction in time lag can be achieved by making transmission channels as short as possible and by placing the regulator as close as possible to the transformation process.

3. The third major factor in the regulation process is the capacity of the regulator, i.e., its ability to cope with a large variety of disturbances. The Law of Pequisite Variety (Ashby 1956) states that only variety in the regulator can counteract variety from the disturbances and that in order to cope with all such disturbance variety, the regulator must possess at least the same amount of variety. This law implies that the response set of the regulator (worker, supervisor or any other system component) should match the variety of disturbances, i.e., the regulator should possess the skills and knowledge necessary to cope with all kinds of contingencies.
4. A regulator with an adequate response set may be highly efficient but not necessarily effective. In order to be effective, the regulator must pursue targets that are identical to the targets set by the controllers.  
For example, when the rate of work is set at 10 pieces a minute by the controller and the task system produces at a steady rate at 6 pieces a minute, the regulation of the speed of work is efficient, since a constant speed is maintained, but the effectiveness of the regulation is low, since the process is not kept on target. Hence, a necessary condition for effective regulation is that the regulator identifies his own goals with those of the controller.

5. The risk involved in a failure of the regulator should also be considered.

Regulation failure in work settings with high dependencies between task systems will affect all these task systems. This risk of failure is measured by the extent to which faulty regulation with consequent improper functioning of a task system will disrupt the functioning of other task systems. In other words, risk can be measured by the disruption potential of the task system.

Let us consider the implications of these factors on the assignment of regulation decisions. The number of communication channels and time lags can be reduced by placing the regulator as close as possible to the transformation process; both will be minimal when regulation and transformation are performed by the same system component. In other words, autonomous decision-making within the task system will lead to optimal regulation, subject to the regulator having adequate response set and proper goal identification.

This leads to the following propositions:

- Proposition 1 When the task performer has an adequate response set as well as goal identification, autonomous decision-making will lead to optimal regulation.
- Proposition 2 Autonomous regulation becomes increasingly important with an increasing disturbance level.
- Proposition 3 Task systems with a high disruption potential should be autonomous in regulation, with the condition that the task performer has an adequate response set as well as goal identification. If this condition cannot be met (i.e. if either sufficient goal identification or adequate response set is not possible) then regulation should be performed outside the task system.

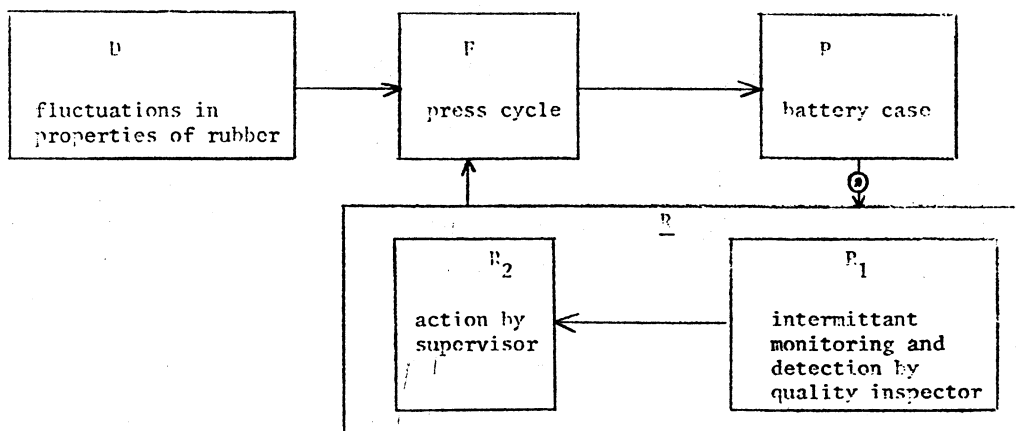
To illustrate Propositions 1 and 2, consider a work-station in an industrial setting where the operator's task consists of feeding rubber into a press mold and, after processing, in removing the finished products (car battery cases) from the press.

The quality of the product depends on pressure, mold temperature, and press cycle time. These process variables need to be adjusted according to the varying properties of the rubber. In other words, the output quality of the task system specified by boundary control decisions, must be regulated for the disturbances caused by the fluctuations of input quality.

In this particular work-station, to avoid tampering with the process, the press was locked and the key kept with the supervisor.

Deviations in quality were reported by the quality inspector to the supervisor, who then adjusted the press. This regulation process is illustrated in Figure 4.

FIGURE 4: DIAGRAM OF NON-AUTONOMOUS REGULATION OF A RUBBER PROCESSING OPERATION

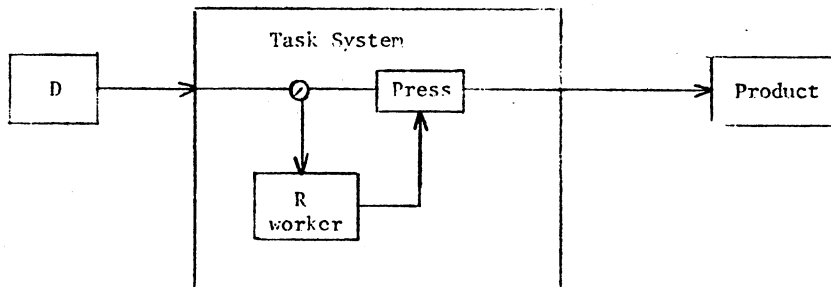


The regulation is error-controlled and has a high lag, since it is activated only when deviations occurring are detected intermittantly in the output. The time lag resulting from the intermittance of monitoring and the length of the information route will result in a number of rejects before the regulation takes effect. Moreover, this will occur quite frequently with increasing fluctuations in the rubber properties.

On the other hand, autonomous regulation by the worker would involve his inspecting the rubber entering his work-station and occasionally adjusting the press as required. This arrangement is shown in Figure 5, where a continuous and effective regulation is possible, so that disturbances are counteracted before they can affect the output of the task system.

This situation would be possible only if the worker has an adequate response set, which must be provided for by adequate training. One way of ensuring his goal identification would be through means of a multi-factor incentive plan which includes product quality.

FIGURE 5: DIAGRAM OF AUTONOMOUS REGULATION OF A RUBBER PROCESSING OPERATION



## EXPERIMENTAL VALIDATION OF THE MODEL

The model was tested in work-stations manned by single workers, although it is also valid for task systems operated by a group of workers. In the latter case one also deals with group autonomy, a factor that would have introduced many complex variables and would have excessively broadened the scope of the research.

The sample population consisted of 411 work-stations and was drawn from 12 Israeli companies deliberately selected to secure diversification as to technology, production rate and worker characteristics, such as age, seniority and education. The twelve companies from which the sample was drawn belong to three industrial sectors: the kibbutz (4), Histadrut, (3) and private sector (5).

It was felt that in the Israeli industrial setting these sectors adequately represented relevant organizational context variables. Size proved to be confounded with sector in our sample. The privately-owned factories were large-sized, the Histadrut medium, and the kibbutz factories small-sized.

The leadership style of supervisors could be another modifying variable in the relationship between autonomy, technology and worker characteristics. Therefore, a measure of supervisory style was included.

However, the findings showed evidence neither for modifying effects nor for direct effects of supervisory style on worker autonomy.

Data on technology and autonomy were collected by observation.

Data on worker background variables, attitudes and perceived autonomy were collected by structured individual interviews.

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\* The measure developed by Haire & Ghiselli & Porter (1966) and Clark & McCabe (1970), which scores the manager's style on an autocratic-democratic scale, was employed.

### Measurement of the major research variables

The worker's autonomy in regulation decisions is indicated by the degree to which phases of the regulation process are assigned to him.

Each regulation involves a monitoring and detection phase and an evaluation and decision phase, which is then followed by action.

When none of these phases is assigned to the worker his autonomy is zero, since he performs only the transformation process, without any discretion in regulation..

When the worker only monitors and detects, his range of discretion is limited to binary (yes-no)decisions. On detecting a deviation, he informs his supervisor, the quality inspector, or the maintenance department and continues monitoring.

Evaluation and decision-making for corrective action would represent the next higher level of autonomy. Within this third level the discretion of the worker could vary from complete freedom to deciding according a set of detailed rules. However, it proved to be extremely difficult to establish unequivocal definitions as a basis for a reliable objective measure of the different degrees of autonomy within the evaluation and decision phase of regulation. Therefore, for the present research, regulation autonomy was scored on a three-point scale as follows:

1. Zero autonomy; worker performs no monitoring or detection functions.
2. Only monitoring and detection are done, thus only binary decisions are made.
3. Evaluation of alternatives and decisions for action are made by the worker.

Regulation keeps the production process on target by blocking and counteracting the flow of disturbances to essential variables of the process. The extent of autonomy the worker has in the regulation of each of these variables is not necessarily the same. A worker can be completely autonomous in quality regulation while material flow is regulated by a service worker or by the supervisor.

For a proper functioning of a task system, the regulation of the following variables were deemed to be essential.

- (a) The flow of materials and parts entering the work-station.
- (b) The quality of these materials and parts.
- (c) The quality of the output of the work-station.
- (d) The state of equipment and tools.
- (e) The output flow.

The degree of the worker's autonomy in the regulation of the first four of these variables was measured by direct observation of the work and by questioning the worker on his reactions to all kinds of possible disturbances.

There are three possible causes for deviations in the output flow:

1) an insufficient input flow, 2) a breakdown of the equipment, 3) a change in the operator's work pace. Consequently, the regulation of output flow involves the regulation of input flow and the equipment characteristics measured by items (a) and (d), as well as the regulation of work pace.

The worker regulates his pace of work by slowing down or speeding up his actions, that is, by resetting control decisions in the speed of work.

Since the cause of deviations in work pace is the worker himself, no distinction can be made between autonomy in regulation and control autonomy.

Autonomy in pace setting was measured by observation of the work station and was marked on a three-point scale : (1) the work pace for each unit processed is fixed, (2) an average work speed is fixed, since units are, to some extent, allowed to accumulate in front of the operator, (3) the worker sets his own work pace. \*

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\* It appeared that pace was fixed for only 8% of the work stations. Thus it seems that strictly paced work and its presumably negative effects, so often mentioned by industrial sociologists, is a rather marginal phenomenon in industry.

The five measures of regulation autonomy proved to be highly reliable.

The items correlate moderately with each other. Hence it can be argued that the measures differentiate between different aspects of autonomy and that each gives a distinct contribution to the total autonomy measure.

An index of Regulation Autonomy was computed by summing the raw response to the five items. The scores ranged from 5 to 15 with a mean of 11.4 and standard deviation of 2.2

A correlation of  $r = 0.44$  ( $p < 0.01$ ) was found between Observed Regulation Autonomy and Perceived Regulation Autonomy. The latter was measured by summing the scores on the worker's perceived autonomy in regulation of Input Flow, Input Quality, Output Quality, Equipment and Work Pace.

Goal Identification of the worker is the extent to which he conceived of the task goals set by the organization as his personal goals. In this study goal identification was measured by asking the worker to what extent he considered it important to be useful to his company.

The response set of the worker refers to the number of alternative responses the worker is able to provide for counteraction of disturbances.

Both the worker's skill level and his job experience determine his response set.

An index of the response set was constructed by combining the worker's skill level and his job seniority. The skill level was measured by the skill requirements of the task in terms of required learning time, experience and formal training.



The Disruption Potential of a work-station is defined as the extent to which a breakdown of the work-station will affect the functioning of other work-stations. The effects of the disruption find their ultimate expression in costs resulting from production losses and idle machine and man hours.

Three factors are involved in the disruption potential of a work-station:

- (a) the dependency structure of the work-flow,
- (b) the production flexibility,
- (c) the importance of the work-station in the total production.

These factors were measured by 9 true-false items which outlined the disruption potential of the work-station.

Responses were obtained by direct observation and by questioning the supervisor.

Table 1 lists the 9 items.\*

The index of Disruption Potential was obtained by summation of the scores of the separate items.

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The measure shows some similarity with the Work-flow Rigidity scale developed by Hickson et al (1969) from which some items were adapted.

TABLE 1: DISRUPTION POTENTIAL MEASURE

1. In case of breakdown of the work-station, stations following are compelled to stop work immediately.
2. In case of breakdown of the work-station, stations following can continue working for less than one hour.
3. In case of breakdown of the work-station, stations following can continue working for less than one day.
4. The output of the work-station serves as input to several other work-stations.
5. In case of breakdown of the work-station, preceeding work-stations are also compelled to stop working.
6. The task performed in the work-station is not performed in any other work-station.
7. In case of breakdown of the work-station, re-routing of the work is not possible without serious disruntion of the production.
8. The work-station is operated on more than one shift.
9. An item of major importance in the production process is produced in the work-station.

The task disturbance level refers to the predictability or variability of events occurring during task performance. Uncertainty inside the task system as well as in its environment has become a key concept in organizational theory, but adequate measures are lacking. (e.g. Perrow 1967, Hage & Aiken 1969, Bell 1966, Lawrence & Lorsch 1967)

The measures of perceived predictability of task events are likely to be modified by experience and job seniority. Measuring the frequency and nature of disturbances by continuous observation or work sampling would indicate most adequately the task disturbance level, but time constraints made these measuring methods unfeasible.

The disturbance level was measured by the stability of the characteristics of the materials processed in the work-station relative to specified tolerances.

Stability was judged by an observer and scored on a three-point scale.

The Bell (1966) item for measuring the predictability of work as perceived by the worker and supervisor was also employed, but no meaningful distribution was obtained. Apparently, contrary to the nursing work in Bell's sample, industrial work is characterized by a low disturbance level.

### Hypotheses and findings

Strictly speaking, testing the validity of the model together with its propositions, should include a total cost measurement (direct, indirect and long term costs) associated with each work-station -an exceedingly complex, expensive and time consuming task. However, since one can assume that organizations generally act in a rational way and strive for efficiency, then it is expected that decisions are assigned according to the given propositions. Consequently the following research hypotheses were derived from the propositions:

- (1) Workers with a high response set and goal identification are more likely to be autonomous in regulation.

The findings shown in Table 2 confirm this hypothesis with respect to the relation between response set and autonomy.

TABLE 2: REGULATION AUTONOMY ACCORDING TO THE RESPONSE SET OF THE WORKER  
(IN PERCENTAGES)

Response Set of the worker		Regulation Autonomy			Total	
		(low)1	2	3(high)	%	N
(low)	1	38	44	18	100	( 37)
	2	36	37	27	100	(151)
	3	28	32	40	100	( 78)
(high)	4	15	27	58	100	( 59)

$$\chi = 0.31, P < 0.01$$

A weak relation, ( $\chi = 0.12$ ) at the 0.02 significance level, was found between goal identification and regulation autonomy. However, indications were that autonomy leads to goal identification and not the reverse, as originally hypothesized.

One can argue that the supervisor's trust of the worker intervenes between goal identification and autonomy. When the worker identifies himself with his task objectives, it is assumed that he will be trusted by his supervisor, who then will give him more autonomy. However, no relation was found between either the supervisor's and goal identification, or between the supervisor's trust and autonomy. Thus, it seems that the attitudes of the worker concerning his work are either not perceived by his supervisor or are not taken into consideration when assigning him autonomy.

- (2) When task disturbance level is high, the task performer is more likely to be autonomous in regulation.
- (3) Workers in work-stations with a high disruption potential are more likely to be autonomous in regulation when their response set and goal identification are high, and less autonomous when their response set and goal identification are low.

Table 5 shows both hypotheses to be correct with respect to the interrelation between disturbance level, disruption potential, response set and regulation autonomy. \*

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\* The scales of regulation autonomy, response set and disturbance level were dichotomized and the disruption potential scale was divided into three categories for purposes of crosstabulation.

TABLE 3: DISRUPTION POTENTIAL BY REGULATION AUTONOMY ACCORDING TO DISTURBANCE LEVEL OF THE TASK AND WORKER'S RESPONSE SET

Percentage of workers with a High Autonomy					
Disruption Potential	Response set				Total
	Low		High		
	Disturbance Level		Disturbance Level		
	Low	High	Low	High	
	Low	53% (45)	68% (37)	69% (36)	
Medium	49% (78)	48% (21)	49% (49)	65% (17)	(165)
High	4% (49)	31% (13)	46% (13)	67% ( 3)	( 78)

The findings support the proposition of Perrow (1967) who suggested that decision-making should be decentralized for tasks in which the raw material is highly variable and its nature is not well understood. Moreover, Table 3 explains the failure of Hage & Aiken (1969) and Mohr (1971) to validate Perrow's proposition.

The relation between autonomy and task disturbance level or task predictability is contingent on the task performer's response set and the disruption potential of the task system.

When the disturbance level is low, and consequently only sporadic regulation is required, almost none of the workers (4%) with a low response set, working in a work-station with a high disruption potential, are given high autonomy. When in the same work setting, the disturbance level is high, 31% of the workers are highly autonomous. Apparently the importance of speedy regulation in high disruption potential situations overrides risks of errors that exist when the response set is low.

But when disruption potential is low and response set is high, 69% of the workers were highly autonomous even for a low disturbance level. Obviously self-regulation in this low risk situation is optimal, since no additional training of the workers is required. Thus the direction of the relationship between autonomy and disturbance level (from 4% to 31%) was reversed by the worker's response set and the work-station's disruption potential (~~from~~ 69% to 31%).

Goal identification did not alter the relationship between autonomy and disruption potential as could be expected from the findings with respect to hypothesis (1). In this context it is interesting to note the study by Fullan (1970). Fullan found a relation between the worker's identification with his company and the type of technology employed which ranged from continuous processing, via craft technology, to mass production. His findings might be explained by the intervention of autonomy between technology and identification with company. The high disruption potential and relatively many disturbances which are characteristic for continuous processing necessitate a high regulation autonomy, which then leads to identification of the worker with his company.

## CONCLUSIONS

Our efforts have been directed to the development and validation of a cybernetic model of task related decision-making.

The model distinguished between regulation and control, and suggested that considerations for assignment of autonomy in each of these decisions should be different. Perrow (1967) and Hage & Aiken (1969) recognized the difference between control and regulation when making a distinction between organizational power and work discretion, but, lacking an adequate model, did not fully explore its implications.

This paper is primarily concerned with self-regulation of task systems (as distinct from self-control). It continued the recent research on the relation between organizational structure variables such as centralization of decision-making, and predictability in task events and technology. The findings showed that effective self-regulation of a task system is a function of technology variables as well as worker characteristics, and thus reinforced the arguments for a contingency approach to job design.

Finally let us point out the major implications of the research findings for job design:

Most effective regulation is achieved by self-regulation. Consequently, work-stations with a high disruption potential and high disturbance level in which effective regulation is essential should be operated by workers with learning abilities.

When such workers are not available, disruption potential could be reduced (i.e. through buffer storages) or regulation should be done outside the work-station.



The findings showed that the degree of worker identification with his work and company is currently not considered in job design practice. The research model shows this practice to be erroneous. However, one should remember that by nature of the research method the model is a static one, while job design itself is, of course, a dynamic process.

The findings did indeed indicate that autonomy leads to goal identification, which then makes the extension of autonomy more feasible.

Worker characteristics, in terms of attitudes and abilities, should be considered in job design as dynamic rather than static given variables.

Changing the traditional approach of "fitting the man to the job" into another static approach of "fitting the job to the man" by some sort of job enrichment makes no **real** difference in the long term.

Job design should be a continuous organizational process. This research investigates some of the important variables to be considered in that process.

## REFERENCES

- ANON., 1973, Work in America (Cambridge: MIT Press), p. 188-201.
- ASHBY, W. ROSS., 1936, An introduction to Cybernetics (London: Chapman & Hall Ltd.)
- BETZ, STAFFORD, 1966, "Decision and Control: the meaning of operational research and management cybernetics" London, Wiley.
- BELL, G.D., 1967, "Variety in work" Sociology and Social Research, 50.
- BLOOD, P.R. & HULIN, C.L., 1967, "Alienation, environmental characteristics and worker responses". Journal of Applied Psychology, 51.
- CLARK, A.W. & MC CABE, S. 1970, "Leadership beliefs of Australian managers" Journal of Applied Psychology, 54.
- DAR-EL, E. & de HAAN, U. 1976, "Autonomous task Decision-making and its implications for Job Design" (mimeo ), Faculty of Industrial and Management Engineering, Technion, Haifa,
- DAVIS, L.E. 1962, "The effects of Automation on Job Design" Industrial Relations, 2.
- EMERY, J.C., 1969, "Organizational Planning and Control Systems" Fairbairn-Mac Millan, Canada.
- EMERY, F.E. & THORSRUUD, E. 1969, "Form and Content in Industrial Democracy" Tavistock, London.
- FORRESTER, J.E. 1961, "Industrial Dynamics" Cambridge, Mass. MIT Press, N.Y., Wiley.
- FULLAN, M., 1970, "Industrial Technology and Worker Integration in the Organization" American Sociological Review, 35
- HACKMAN, J.R. & LAWLER III E.E., 1971, Employee reactions to Job Characteristics, J. Appl. Psychol, 55
- HAGE, J. & AIKEN, M. 1969, "Routine technology, social structure and organizational goals" Administrative Science Quarterly, 14.
- HAIRE, M. & GHISELLI, E.E. & PORTER, L.W. "Managerial Thinking: An International Study" John Wiley & Sons, N.Y., 1966.

REFERENCES (continuation)

- HICKSON, D.J., PUGH, D.S. & PHEYSFY, D.C., 1969 "Operations technology and formal organization: an empirical reappraisal"  
Administrative Science Quarterly, 14.
- LAWRENCE, P.R. & LORSCH, J.V., 1967, "Organization and Environment"  
Harvard Business School. Division of Research. Boston.
- MOHR, L.B., 1971, "Organizational Technology and Organizational Structure"  
Administrative Science Quarterly, 16.
- MORSE, J.J., 1970, "Organizational Characteristics and Individual Motivation"  
from Studies in Organizational Design, ed. Lorsch, J.J. &  
Lawrence, P.R. Dorsey Press, Illinois.
- PASK, G., 1961, "An Approach to Cybernetics"  
Hutchinson & Co., London.
- PAUL, W.J., ROBERTSON, K.B. & HERZBERG, E., 1969, "Job Enrichment pays off"  
Harv. Business Rev., 47
- PERROW, CH., 1967, "A framework for the comparative analysis of organizations"  
American Sociological Review, 22
- SHANNON, C.E. & WEAVER, W., 1949, Mathematical Theory of Communication  
(Urbana: University of Illinois).