CQWL

JOB DESIGN CRITERIA TWENTY YEARS LATER

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Introduction

In 1955, the Journal of Industrial Enginering carried the results of a study by Davis, Canter, and Hoffman, which examined the criteria used by production planners and designers in manufacturing. The authors had based their analysis on the response to a questionnaire sent to a representative sample of large American industrial firms, and on the results of interviews with a number of other large manufacturing companies. Davis et al. took the position that there were underlying principles for designing production processes that would carry over to the design of jobs. They proposed to bring these principles to light in order to better understand the manner in which the content of jobs was designed in American industry. Their results indicated that the most important consideration in job design was the minimization of the time required to perform the operation. They reported that the principles of job design they found reflected the mass-production precepts of specialized jobs and repetitive work, which minimized the individual employee's contribution to the production process. They cited, for example, designer preference for emphasizing highly specified, low-skill operations, to the detriment of increased job satisfaction. Davis et.al.concluded that to counter this, a comprehensive criteria of effective job design must include not only the immediate and direct cost of production time, but also the more indirect economic and social costs to companies and workers.

Although the study has been widely cited over the years, its impact on both designer practices and on further research concerning them appears limited. This results in part from the fact that the problems associated

with sub-optimization of short-term technical costs have only gradually become apparent in manufacturing engineering (c.f., Kildrige & Wester, 1963; Ingall, 1965; Davis, 1966; Basu, 1973). Today, with productivity and quality of working life viewed as complementary and integrated issues at the national level - and attracting increased attention and concern internationally - the time has come for the reexamination of the issues raised in that early study.

No direct replications of the study by Davis, et al. are known. Developments in computer application and information system design have revealed the potential for a similar design constraint in the larger universe of white collar administrative and service organizations (c.f., Boguslaw, 1965). This possibility was further explored in a recently reported study of British and Swedish information system analysts (Hedberg and Mumford, 1975). Like Davis and his colleagues, Hedberg and Mumford tapped some of the values and models underlying the design of work systems and the content of jobs in those systems. They set out to examine the values of systems analysts toward the motivational job design aspects of the computerized systems they design. Mumford and Hedberg measured a number of specific attitudes and opinions which together constituted a model of man held by systems analysts. Their report separated the model into two: an "organizational model of man" which represents the favored form of department structure, and the "individual model of man" -- a composite of the characteristics of the average person for whom the job is designed. In general, the British and Swedish respondents together produced a somewhat inconsistent organizational model of man. While the respondents favored well-defined, structured, and monitored jobs for people, they also stated preference for greater downward delegation and non-financial incentives (such as challenging work) in those same jobs. As Hedberg and Mumford state:

> The areas where [systems analysts] want structure and definition, are those over which they have a great deal of influence when they design systems, namely job content and work controls. Yet it can be argued that by imposing a tight structure and tight controls, they eliminate opportunities for challenging work and group decision making. This could suggest a perhaps unrecognised conflict between the way they design systems and their personal more democratic values. (p. 47 , Emphasis added)

These personal values seem also to be reflected in the designers' perceptions of employees as individuals. Describing their individual models of man, both the British and Swedish samples reported that the people in their organizations, for whom they designed jobs, tended to be responsible, skilled, and capable individuals, able to take initiative and to control their work environment. Both samples also stated however, that these same employees want a well-defined job which they could stick to most of the time. This last aspect of their view could be interpreted as self-serving -- a justification of the design purpose of the systems analysts function.

Although Hedberg and Mumford do not confirm the findings of Davis, Canter, and Hoffman, their finding that jobs should be carefully defined and monitored is suggestive of the 1955 study. In addition, Mumford and Hedberg contribute the additional finding that technical designers may be working in a system which requires them to design jobs whose content conflicts with their personal values. The question of whether this possible dilemma results from the policies of their employing organizations or from the design conventions they acquire during their professional training remains unanswered.

The evidence from the Davis, et. al. study, and the Hedberg and Mumford research suggests that technical systems designers in general meet the criteria of cost performance by detailed specification and definition of job content. That this is viewed as a short-term solution, and that it may be inconsistent with the designers' personal models of

man is also possible. Despite these tentative findings, little is actually known about the status of job design criteria among engineers and systems analysts today. We also know little about the dilemmas and role conflicts that organizations create for their technical designers.

The Study

The present study examines these issues among American work system designers. It assesses current criteria for job design, examines the constraints technical designers might experience, and presents their models of man. In measuring these aspects of designers' perceptions, it takes into account the similarities and differences between those who design industrial production systems (production engineers) and those who design computer information and decision-making systems (information systems analysts). The two samples were drawn to ensure representation from both manufacturing and information systems.

Following the approach taken by Davis et al. and Hedberg and Mumford, a questionnaire survey was developed, which asked engineers and systems analysts about various aspects of their design experience and some of their attitudes and feelings. The questions themselves form five general sets or classes. The results reported below are presented in the order of those five sets of items.

The first four classes of questions are intended to parallel those asked in the Davis et. al. study. Their original survey had posed questions referring to twenty four different specific manufacturing operations. This methodology was appropriate for their original sample of manufacturing organizations. For the joint sample of manufacturing designers and informations systems designers in the present study, however, a general questionnaire format was considered more useful. Although this study is therefore not a literal replication of the 1955 Davis et. al study, the essential content of their examination is carefully paralleled in the present questionnaire instrument.

The content of the first set of questions deals with seven major considerations (criteria) for breaking work system designs into separate tasks. The second set of questions assesses five practices followed in combining separate tasks into jobs for people. The third set of questions identifies the parties responsible both for choosing tasks to be assigned to people, and for combining these tasks into jobs. Set Four assesses the impact of five constraints in the organizational environment, while the fifth set of questions replicates those in the Hedberg and Mumford study. In this fifth set, one group of eight pairs of statements deals with the favored form of job design and work organization; and the other set of nine pairs with the characteristics of the average job holder in the respondents' companies.

Sample

During 1976, the questionnaire was mailed to a total of 240 technical designers employed in California. One half (120) of this number was randomly drawn from the production engineers and engineering managers identified in the subscription list of a widely circulated manufacturing journal (Factory). The other half (120) of the sample was similarly drawn from the systems analysts and EDP managers appearing in the subscription list of a popular computer and information systems magazine (Datamation). Ninety-five completed questionnaires were returned (a useable response rate of 40%). In all, 53 systems analysts and 42 engineers responded.

Results

In Table 1, seven considerations for breaking technical processes into human tasks that result in greatest product quality at lowest cost are ranked in order of their perceived importance to those questioned. They were drawn primarily from the set developed in the 1955 study. The first two criteria in Table 1, "throughput per unit time" and "uses of machine resources,"

TABLE 1

Importance of Seven Considerations
in Breaking Jobs into Operations for People

"Jobs Which Will Result in Greatest
Product Quality at Lowest Cost"

	Rank Order	
	Engineers	Systems Analysts
Maximizing throughput per unit of time	1	1
Efficent use of machine resources	2	2
Making jobs as simple to perform as possible	3	4
Reducing manpower	4	5
Providing management with better information	5	3
Providing more job satisfaction	6	6
Minimizing floor space requirements	7	7

are ranked highest by both groups. These criteria are well known in engineering practice and values. In 1955, Davis and his colleagues reported that these two criteria also ranked at the top of their list. In the present case, systems analysts ranked "management information systems" third -- not surprisingly, since a valued product of computer systems is the creation of additional or better information. Thus, a major factor in breaking EDP systems down into tasks for people should be management control information of the arrangement.

Both systems analysts and engineers give a relatively high rank importance to "making jobs simple to perform" (rank "4" for the former; "3" for the latter), and a low rank to "improving job satisfaction" ("6" in both samples). This finding is in substantial agreement with that of Davis et. al. for job designers in the earlier study. Davis and his colleagues interpreted that finding as an attempt by designers to minimize total costs of production: to minimize immediate costs by minimizing skills, and deemphasizing job satisfaction in design. Making work simple and jobs satisfying are usually considered contradictory goals, illustrating the thesis that simplified work primarily reduces short-term costs, while satisfaction does not. It follows that the choices made in the present study suggest that designers are more preoccupied with immediate benefits than with total costs, an attitude which confirms the central finding of Davis, Canter, and Hoffman.

Table 2 presents various ways in which tasks are assigned to workers. The question asks the engineers and systems analysts to rate each of six procedures (listed in Table 2) on a five point scale, ranging from "used to a very little extent" (1), to "used to a very great extent" (5). The results in Table 2 are remarkably like those obtained by Davis, Canter, and Hoffman in response to a similar question on combining tasks into jobs in assembly operations. Both studies report that the

TABLE 2

Combining Tasks into Jobs for People

Methods for Combining Tasks into Jobs	Average Extent to Which the Methods are Used (Higher Score = Greater Extent)	
	Engineers	Systems Analysts
Assign each employee a specific group of tasks as a full time job.	3.8	3.8
Assign each employee one particular task as a full time job.	3.1	2.7
Assign each employee one particular task and rotate employees at intervals.	2.5	1.9
Assign each employee a whole production process as a full time job.	2.1	2.5
Assign groups of employees to specific groups of tasks allowing them to assign the individual tasks informally among themselves.	1.9	2.1

two methods most frequently employed to combine tasks into specific jobs are (a) assigning an employee a specific operation (a specific set of tasks, but not a whole production process) as a full time job, and (b) assigning an employee one particular task as a full time job. These results can be taken as additional evidence that companies continue to limit the content of individual jobs to a great extent, which further explains the high ranking given to specialization of work, in Table 1 above.

Table 3 presents the results of two items dealing with responsibility for performing job design functions. Davis et. al. had found that first line supervisors, as well as the various engineering departments, were reportedly involved in specifying the task content and job content. In fact, the present findings in Table 3 resemble the earlier results very much. The foreman or supervisor is frequently cited as "always involved" in specifying the content of tasks (51% for engineers, and 36% for systems analysts).

First line supervisors are also seen as specifying the content of jobs in impressive proportions (49% for engineers; 43% for systems analysts). Both engineering and system analyst samples agree that production (manufacturing) engineers are heavily involved in specifying task content (33% and 39% report them to be "always involved.") They disagree about the job design responsibility of the systems analyst which may well reflect real differences between that designer's role in computer-based technologies and his role in more conventional technologies. The findings in Table 3 suggest the definition of designers (engineers and systems analysts) in the present study may be an unecessarily narrow one, given the prominent role played by first line supervision. This replication of earlier findings by Davis et. al. confirms the thesis that job design is the outcome of a complex system of interrelated disciplines, duties, and techniques, for which no one is solely responsible. This further suggests

TABLE 3

Responsibility for Job Design

Percent of Instances

(Reported by Engineers - Engr.
and reported by Systems Analysts - Sys. An.)

Responsibility of:	Task Content (Chooses or Orders Tasks in the Production Process)						Job Content (Combines Separate Tasks into Jobs)					
	Always		Sometimes		Rarely or Never		Always		Sometimes		Rarely or Never	
	Engr	Sys. An.	Engr.	Sys. An.	Engr.	Sys. An	Engr.	Sys. An.	Engr.	Sys. An.	Engr.	Sys. An.
Supervisors or Foremen	51%	36%	36%	52%	13%	12%	49%	43%	36%	48%	10%	10%
Production Engineers	33%	39%	47%	50%	19%	11%	22%	11%	54%	67%	24%	22%
Systems Analysts	32%	49%	29%	40%	39%	11%	16%	27%	32%	51%	51%	22%
Industrial Engineers	12%	11%	50%	74%	39%	16%	19%	16%	44%	68%	37%	16%
Personnel Analysts	6%	8%	0	20%	94%	73%	5%	4%	33%	15%	62%	81%

that the generally observed design criteria of minimizing immediate costs by making jobs as simple as possible to perform (Tables 1 and 2), may not be personally or individually held by those involved in the process of job design. The following data will shed additional light on the issue.

Both the Davis et. al., and Hedberg and Mumford studies recognized the potential effect of influences other than the designer on ultimate job content. While the latter study acknowledged the probable impact of top management values, time constraints, technical and financial constraints, the former study actually examined a variety of restrictions. Davis and his colleagues reported that respondents found training requirements most restricted job design -- with union agreeements also exerting considerable influence.

Table 4 shows present respondents' reports of the actual effects of five posited constraints on their ability to design jobs. The questions required the respondent to rate each constraint according to actual effect on a five-point scale, from "restricts to a very little extent (1) to "restricts to a very great extent" (5). These questions are intended to explore the extent to which these technical systems designers are free to specify the content of jobs. The earlier study by Davis et. al. had reported that training requirements greatly influenced specification of job content. Where they existed, union agreements also imposed restrictions. As Table 4 indicates, the engineering sample reports that union contracts, federal or state legislation, and training requirements exert the greatest restrictions on assigning tasks to jobs. The engineering sample results appear similar to the 1955 study results, while the systems analysts tend to see a stronger hand coming from top management policy.

The final items reported here reveal some attitudes regarding the favored

TABLE 4

Reported Effects of Five Potential
Restrictions on Ability to Design Jobs

Potential Constraints Of:	Average Extent of Restriction (Higher Score = Greater Restriction) Reported By:	
	Engineers	Systems Analysts
Union Management Agreements	2.1	1.7
Physical Requirements, Training Requirements, Working Conditions	3.1	1.4
Federal or State Legislation	2.8	1.9
Top Management Policies	2.4	2.8
Centralized Personnel Policies	3.0	2.5

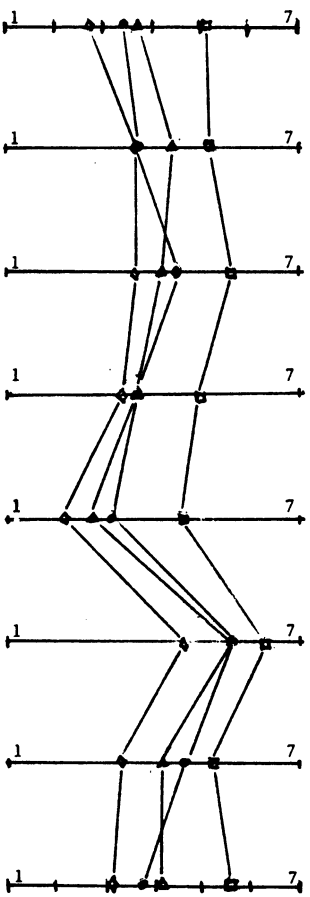
form of job design (the organizational model of man) and opinions about job holders (the individual model of man). Tables 5 and 6 present these "models of man" profiles for the two samples in the present study, together with the profiles for the Swedish and British samples of computer-based systems designers reported in the Hedberg and Mumford study.

The shape of the profiles in Table 5 -- preferred structure of work -- are remarkably similar for the four samples. In fact, they are statistically indistinguishable in terms of profile shape, although there are significant differences in absolute levels between the highest and lowest scores on some of the items A through H. This shared profile shape reveals that all of these technical systems designers prefer that the jobs they design be well-defined (item A), and that these jobs be monitored (item E), while at the same time, they favor some delegation of authority to lower levels (item B), the creation of challenging jobs (item C), and general access to relevant information (item F). That both the present study and the study by Mumford and Hedberg report this internal inconsistency, supports the observation made earlier: What designers say they do and what they want to do are not altogether the same. Likely sources of this inconsistency are the complexity and multiple responsibility found in job design (Table 3), and the variety of constraints on job design (Table 4).

Table 6 presents technical designers' views and opinions of the people who fill the jobs they design. Once again, the sample profiles are quite similar in shape. The location of the profiles in the middle range of the scale strongly suggests an individual model of man which is at variance with the short-term perspective implied by the use of mass-production precepts of specialized jobs, repetitive work, and assignment of simple, low-skilled jobs to workers. In general, these designers agree that the people in their organizations who fill the jobs they design, are capable of doing a variety of tasks (item B), have considerable skill

TABLE 5

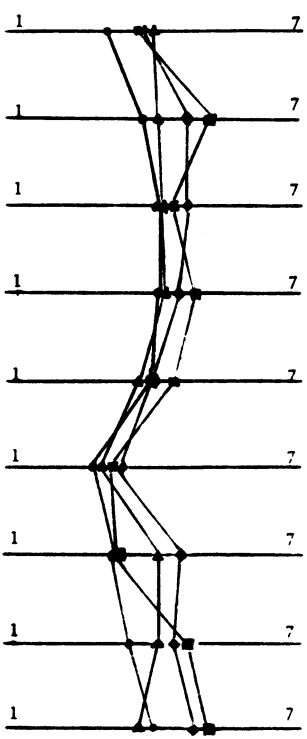
The Preferred Structure of Jobs and Work

A. Jobs should be clearly defined, structured and stable.		Jobs should be flexible and permit group problem solving.
B. There should be a clear hierarchy of authority with the person at the top carrying ultimate responsibility for all aspects of work.		There should be a delegation of authority and responsibility to those doing the job regardless of formal title and status.
C. The most important motivators should be financial e.g. high earnings and cash bonuses.		The most important motivators should be non-financial e.g. work challenge, opportunity for team work.
D. Job methods should be carefully defined by systems and procedures specialists, management services, or supervision.		The development of job methods should be left to the group and individual doing the job.
E. Targets should be set by supervision and monitored by supervision.		Targets should be left to the employee groups to set and monitor.
F. Groups and individuals should be given the specific information they need to do the job but no more.		Everyone should have access to all information which they regard as relevant to their work.
G. Decisions on what is to be done and how it is to be done should be left entirely to management.		Decisions should be arrived at through group discussions involving all employees.
H. There should be close supervision, tight controls and well maintained discipline.		There should be loose supervision, few controls and a reliance on employee self discipline.

◇ Engineers
● UK Systems Analysts
△ U.S. Systems Analysts
□ Swedish Systems Analysts

TABLE 6

Characteristics of the Average Non-Specialist, Non-Supervisory Employee in Company for Whom the Jobs and Work Described Above are Designed.



(item 1), and demand interesting work (item D). However, the designers also report that these same workers leave decisions to others (item A), and want well-defined work (item F). Achieving tight control and highly structured jobs on the one hand, may well undermine efforts to encourage application of greater skill, interesting challenging work, and democratic methods on the other.

In conclusion, it seems clear that twenty years of technological progress and innovation have had little corresponding effect on the professional values of design practitioners. The data presented in this paper suggest that both production engineers and systems analysts select job design criteria remarkably similar to those chosen by their predecessors in the 1950's. They still prefer to maximize the immediate costs of production rather than to optimize a longer-term approach to job design which recognizes the economic costs of worker frustration and emphasizes employee satisfaction and motivation. The data also suggest that these criteria run counter to their professed view of the worker -- "the individual model of man." In short, systems analysts and engineers appear to be caught between what they believe to be employees' needs and potential, and what they, as designers, are obliged to deliver.

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