TECHNOLOGY AND THE STRUCTURE OF ORGANIZATIONS *

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Data on 43 industrial organizations point to the existence of relationships between an organization's technology and aspects of its internal structure, including the number of specialized sub-units, the number of levels of authority, the ratio of managers and supervisors to total personnel, and the degree of program specification within the organization. A primary finding is that the less changeful an organization's technology, the more likely the foregoing aspects of structure are to increase. The findings hold with size and a number of other organizational variables controlled. The importance of considering technology in the comparative analysis of formal organizations is emphasized. It is also suggested that the technology variable, in connection with other aspects of organizational structure, serves to establish a rudimentary typology of sociotechnical organization and that the use of the typology may provide a useful analytic tool for the investigation of a number of organizational processes, including those of decision-making and patterns of intra-organizational conflict.

THERE have been a few sociological analyses of formal organizations which have suggested the importance of taking into account organizational technology.[1] This paper seeks to develop this orientation further by systematically exploring relationships between different kinds of organizational technology and selected properties of organizational structure. By organizational technology is meant the mechanisms or processes by which an organization turns out its product or service. Organizational structure refers to properties essentially internal to an organization, such as levels of authority, as contrasted with essentially external or "setting" factors, such as an organization's location or environment. The analysis is based on a recently concluded comparative analysis of 43 industrial organizations.[2]

Although it will not be possible here to make statistical statements such as "variations in organizational technology explain or predict 60 percent of variations in organizational structure," we nonetheless undertake to show that the technological factor is one of the most important to consider when formulating explanatory and/or predictive propositions about variations in organizational structure. It is also contended that relationships between an organization's technology and internal structure fall into distinct patterns which we refer to here as types of sociotechnical organization. We shall later attempt to show that a focus on an organization's sociotechnical structure may provide a useful analytic tool for the investigation of a number of organizational processes, including those of decision-making and patterns of intra-organizational conflict.

The decision to focus on organizational technology, however, does not mean that we shall henceforth ignore the possible implications for organizational structure of other factors such as size, geographical location, organizational environment and so on.

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[1] See, for example, James D. Thompson and F. L. Bates, "Technology, Organization, and Administration," *Administrative Science Quarterly,* 1 (1957–1958), pp. 325–343; F. C. Mann and L. R. Hoffman, *Automation and the Worker,* New York: Henry Holt, 1960; I. R. Hoos, *Automation in the Office,* Washington, 1961; M. Janowitz, *Sociology and the Military Establishment,* New York: Russell Sage Foundation, 1959, esp. Chapter 2; Charles Perrow, "A Framework for the Comparative Analysis of Organizations," *American Sociological Review,* 32 (April, 1967), pp. 194–208; Joan Woodward, *Management and Technology,* London: H.M.S.O., 1958. A more expanded version of Woodward's report is to be found in *Industrial Organization: Theory and Practice,* London: Oxford University Press, 1965.

[2] Edward Harvey, *Structure and Process in Industrial Organizations,* unpublished Ph.D. dissertation, Princeton University, 1967.

Clearly, any critical evaluation of relationships between organizational technology and organizational structure would require that these other variables be carefully controlled. Neither does our focus on organizational technology mean that we are determinists in the sense of viewing technology as an invariant factor somehow "out there." The subsequent discussion of our concern with controlling other factors hopefully reflects the sense in which we approach technology, that is, as a factor to be identified and explored and not as an omnipotent causal force. We now turn to an evaluation of some existing evidence which suggests relationships between organizational technology and organizational structure and which will serve as a guide to the development of our own research hypothesis.

TECHNOLOGY AND ORGANIZATIONAL STRUCTURE

Some Findings. Of the writers concerned with organizational technology, Joan Woodward has been by far the most concerned to explore systematically the relationships between this variable and variations in organizational structure. Woodward's major contribution to date is based on an analysis of 100 manufacturing firms in the South East Essex area of England.[3] Woodward grouped these firms along a scale of "technical complexity," the latter term being defined as "the extent to which the production process is controllable and its results predictable." [4] We will not take up a detailed analysis of Woodward's scale at this time other than to say that she is particularly concerned to focus on three basic modes of production. These are: (1) unit or small batch production; (2) large batch or mass production; and (3) continuous flow or process production. In terms of Woodward's scale, process production is the most technically complex, mass production is less complex than process, and unit production is the least technically complex of all. In empirical terms, the manufacture of one locomotive at a time or a custom-made suit are good examples of unit production. The automobile industry is probably one of the clearest examples of mass production, while oil refineries illustrate what is meant by process production.

After so classifying the firms, Woodward proceeded to investigate a number of organizational characteristics from the perspective of different technological modes. Some of her findings that are of particular interest to the present study are:

(1) There is *no* significant relationship between technological mode and organizational size; [5]

(2) The number of levels of authority in an organization increased with increasing technical complexity; [6]

(3) The ratio of managers and supervisors to total personnel increased with technical complexity.[7] It should be noted that the last two relationships held with size controlled.

(4) Woodward also seeks to incorporate Burns' distinction of "organic" and "mechanistic" management systems in her research.[8] In Burns' general terminology, the "organic" system is considered to be characterized by such features as less formal definition of jobs, greater emphasis on adaptability, and communications along the hierarchy tending more to take the form of consultations rather than commands. The "mechanistic" system is the polar opposite and is characterized by the rigid breakdown of jobs into functional specialisms and precisely defined duties. The latter system is also characterized by a well-developed command hierarchy along which communication takes the form of orders rather than consultations. In connection with this distinction of two modes of organization, Woodward found that firms at both ends of the scale of technical complexity were more likely to be characterized

[3] Woodward, *op. cit.*, 1965.

[4] Woodward, *Management and Technology, op. cit.*, p. 12.

[5] *Ibid.*, p. 20.

[6] *Ibid.*, p. 16.

[7] *Ibid.*, pp. 16–17.

[8] Tom Burns and G. M. Stalker, *The Management of Innovation,* London: Tavistock Publications, 1961. See also Woodward, *Industrial Organization, op. cit.*, pp. 23–25.

by organic systems than firms in the middle range of the scale.[9]

We have already said that Woodward chooses to see unit, mass, and process modes of production as being arranged on an ascending scale of technical complexity. It is surely possible, however, that this sequence could be viewed as a move toward technical simplicity rather than complexity. It is, after all, the frequent emergence of problems calling for innovation that characterizes unit rather than process production.[10] In this connection, we would prefer to group our cases along the continuum from technical diffuseness to technical specificity. A precise operational definition of this continuum is given below. For the present, technical diffuseness implies a firm in which a number of technical processes yield a wide range of products. Furthermore, the actual products included in this range are more likely to vary from year to year as a result of model changes and changes in technological production processes. The more technically diffuse a firm, then, the greater the degree of "made to orderness" in its products. In this sense, the technically diffuse production mode would correspond most closely to Woodward's distinction of "unit production." The electronics industry, with its characteristically high rates of innovation and technical change, is a good example of the latter. Some firms, however, such as oil refineries, are characterized by much less product variation and change. The move in this direction we refer to as increasing technical specificity, and consider as closely parallel to Woodward's distinction of "process production." As for Woodward's distinction of "mass production," this would most closely correspond to the mid-range of our continuum, which, in our terminology, is referred to as technically intermediate.

As all of our firms could have simply been classified in terms of Woodward's typology, the question arises as to why a modification of this typology is desirable. Our primary concern in this paper is to relate organizational technology to organizational structure and, later, to suggest some implications of this linkage for organizational decision-making. In this connection we would argue that it is not only important to take into account the *form* of technology, as Woodward has done, but also to consider the amount of change *within* a given form. It is conceivable, for example, that a unit production firm might produce the same kind of product or products more or less all the time. Such a firm might well exhibit organizational characteristics generally associated with technical specificity rather than technical diffuseness.[11] Our modification of Woodward's approach is an attempt to provide a scheme which would provide for such contingencies.

Selected Aspects of Organizational Structure. The foregoing discussion has reviewed some evidence for positing relationships between organizational technology and organizational structure. The second major stage in our argument is to identify and define four aspects of organizational structure which we take to be influenced by organizational technology. The four particular aspects in question were originally selected because they were regarded as strategic to research aims of the larger study which are, for reasons of space, left undiscussed here.[12] However, the aspects in question, while by no means exhaustive of organizational characteristics, will serve to illustrate the relatedness of technology and structure we seek to examine here. The selected aspects are:

1) Sub-unit specialization in organizations. The division of work found in each of the organizations studied could be analysed at different levels of generality. At a relatively high level of generality one could examine the basic specializations established within the organization, such as production, research and development, and accounting. More specifically, one would of course find in any such single division further differentiation of tasks by small groups and in-

[9] Woodward, *Industrial Organization, op. cit.*, esp. p. 64.

[10] Evidence on this point is presented in Edward Harvey, *op. cit.* See especially Chapter 5.

[11] See the discussion of deviant cases in Edward Harvey, *op. cit.*, especially pp. 117–119, 125, 127.

[12] The four particular aspects of organizational structure referred to were selected because it was felt that they exerted considerable influence over the organizational decision-making processes, the latter being a major research focus in the larger study. See Edward Harvey, *op. cit.*, especially pp. 66–75.

dividuals. Our concern here, however, is with the basic specializations within the organization, and it is in this sense that we conceive of sub-units. A sub-unit, then, is defined as a group of individuals within the organization charged with a formally defined set of responsibilities directed toward the attainment of a basic but circumscribed goal of the organization, such as research and development, or the maintenance of fiscal records.

2) Levels of authority within organizations. A level of authority is defined as a formally delimited zone of responsibility along the organizational hierarchy bounded, at the lower limits, by delegation of authority to a lower level and, at the upper limits, by the necessity of "reporting to" a higher level in the organization.

3) The ratio of managers and supervisors to total personnel. A manager or supervisor is defined as an incumbent of the organization charged with the responsibility of overseeing and co-ordinating the work of others in the organization.

4) Program specification in organizations. Programs are defined as the mechanisms or rules in terms of which an attempt is made to give direction to organizational activity.[13] Specification refers to the variable extent to which such programs are detailed or spelled out. In this connection, we would identify three major areas of organizational programming: (a) Role programming, by which is meant the formalization of duties and responsibilities as in sets of job specifications. (b) Output programming, by which is meant the formal delineation of steps through which raw materials pass in the course of becoming the organization's outputs. The automobile assembly line is a particularly good example of how such programming can be built into organizational technology. Such programming can also be observed in very different kinds of organization. In a university, for example, the earning of a Bachelor's degree precedes the Master's degree which in turn may precede the Doctor of Philosophy degree. (c) Communication programming, by which is meant the formal specification of the structure, content, and timing of communication within the organization. Thus, for example, certain organizations specify these processes very closely through the establishment of standard letters or memoranda, the use and timing of which is specified by code numbers. This conceptualization of program specification is intended as a more precise equivalent to the distinction between organic and mechanistic organization derived from Burns' work and subsequently used by Woodward. In our view, as firms increase in the degree of specification on all three dimensions, they approach what these authors have termed "mechanistic" organization.

Research Hypothesis. Following from the discussion of technology and structure we now propose to link these variables in terms of the following hypothesis:

> As technical specificity increases,
> (1) the number of specialized sub-units in the organization increases;
> (2) the number of levels of authority in the organization increases;
> (3) the ratio of managers and supervisors to total personnel in the organization increases;
> (4) The amount of program specification in the organization increases.

Parts (2) and (3) of the hypothesis posit relationships in accord with earlier findings by Woodward. Part (1) is not directly comparable as Woodward does not make use of the variable "number of sub-units." Most important, however, is the considerable departure from Woodward's position represented by the last part of our hypothesis.

Concerning the implications of technology for program specification, Woodward presents some rather weak evidence to suggest that organization at both ends of the scale of technical complexity is more flexible and less subject to formal specification than it is in the middle range of the scale.[14] Apart from questions about the quality of evidence, Woodward's finding in this connection seems questionable on at least another count. It will be remembered that Woodward found that the ratio of managers and supervisors to total personnel and the number of levels

[13] For a similar approach, see J. G. March and H. A. Simon, *Organizations,* New York: Wiley, 1958, p. 142.

[14] Woodward, *Industrial Organization,* p. 64.

of authority both increased with increasing technical complexity. It would seem reasonable to infer from this a trend toward increasing bureaucratization. If this inference is reasonable, the proposition which emerges is that the least bureaucratized and most bureaucratized firms are characterized by the most flexible, least specified, mode of organization. The first part of this proposition appears as plausible as the last part appears doubtful; the literature would suggest that increasing inflexibility is concomitant with increasing bureaucracy.[15] It may well be, of course, that the data on which Woodward bases her contentions are somehow unrepresentative, a general risk which emerges from the difficulties associated with the frequent necessity of employing nonprobability sampling techniques in research on industrial organizations.[16]

DATA AND METHODS

Control Procedures. We suggested earlier that there is no reason to assume that technology is the only factor influencing organizational structure, although there is evidence to suggest that it is important. A list of other potentially relevant variables which we are concerned to control includes: (1) Organizational size, defined as the total number of persons employed by the organization; (2) Organizational history, defined as the general background of the organization from its inception to the time of the study; (3) Organizational ownership and control, e.g., whether the organization is absentee owned or owner managed, whether the organization is autonomous or a member of a group of organizations, and so on; (4) Organizational location, i.e., the social characteristics of the organization's milieu. For example, is the organization in a rural or urban location? If the latter, is the center one of large or small population? (5) The nature of the relationship between the organization and its environment. By environment we mean the broader network of social and economic relations in which the organization must exist. (6) Organizational charter, i.e., the formal statement as to why or for what purpose the organization has been set up.

We have attempted to eliminate the problem of variations in organizational charter entirely by restricting our sample of firms to those engaged in some form of industrial manufacturing process.[17] We have also attempted to avoid the inclusion in the sample of firms with essentially incomparable ownership and environmental patterns which might influence organizational structure.[18] It has been impossible, however, to eliminate this type of variance entirely and we shall consequently control for these and other factors when testing hypotheses. Finally, with regard to organizational size, it was clearly impractical to restrict our sample to firms of comparable size; in consequence, size will also be controlled in the subsequent test of the research hypothesis.

Selection of Sample. Although clearly desirable, probability sampling techniques were simply not practicable in the present study. Gaining admission to industrial organizations for the purposes of sociological research is difficult at best. The author was dependent to a large extent on the efficacy of personal contact networks for the purposes of gaining admission. Even with various guarantees and letters of introduction, about 30 percent of firms contacted declined to participate in the project, leaving us with the 43 cases upon which the subsequent analysis is based. Under the circumstances, it is clear that probability sampling would not represent a viable method of proceeding. It follows from this, then, that the findings reported here cannot in any way be interpreted as representative of industrial manufacturing in general. On the other hand,

[15] See, for example, R. K. Merton *et al.* (eds.), *Reader in Bureaucracy,* Glencoe: The Free Press, 1952, especially pp. 396–418.

[16] This point is developed below in connection with the selection of the sample.

[17] The firms in the sample include electronics equipment manufacturers, specialty plastics manufacturers, firms involved in special-order metals and machinery production, oil refineries, continuous flow food production, and chemical manufacturers.

[18] These attempts to increase the comparability of our data were carried out in a number of ways. In the matter of ownership, we have avoided including in our sample firms under the control of a parent company. Regarding environmental factors, we have avoided including in our sample firms which were subject to regulation by external agencies. We have also avoided the inclusion of firms operating under conditions of monopoly.

however, a comparison of the firms we have studied with other firms with which we are familiar, and with published reports in the literature dealing with similar industries, suggests that the group studied is not atypical.[19] But, regardless of this debate, there is no reason why a study such as this cannot be used as a means of generating theory about organizations which can subsequently be put to further test.

Measurement Procedures. We have introduced a number of concepts including organizational technology, sub-units, levels of authority, the ratio of managers and supervisors to total personnel, and program specification. We shall now set forward the procedures used for measuring these variables [20] and the classifications in terms of which the data have been grouped.[21]

In the case of organizational technology, the continuum from technical diffuseness to technical specificity has been measured by obtaining the following information from the production records of each firm: (1) The number of product changes [22] during the last ten years. (2) The average of the number of different kinds of products offered during the last ten years. It was found that these two measures were highly correlated (0.94), i.e., those firms which changed their products more frequently also offered a wider range of products at any given time. We decided to use the first criterion, number of product changes, as our measure of technical-diffuseness/technical-specificity. Thus, those firms with the greatest number of product changes are the most technically diffuse, and those with the fewest product changes the most technically specific. In terms of the chosen measure, the firms in our sample range from one product change in 10 years to 145 product changes in 10 years. An inspection of the distribution in terms of this measure reveals that the data fall into three rather distinct modes, the ranges of which are 1 to 8 (mean=4), 20 to 43 (mean=29), and 72 to 145 (mean=101). The data have accordingly been classified as follows:

Number of product changes in last ten years	Technical Classification
1) 1 to 8	Technically Specific
2) 20 to 43	Technically Intermediate
3) 72 to 145	Technically Diffuse

[19] For example, although there are areas of divergence, there are nonetheless a number of areas of similarity between our findings and those reported in Joan Woodward's investigation of similar production technologies. See Joan Woodward, *Industrial Organization: Theory and Practice,* London: Oxford University Press, 1965. Also, Arthur L. Stinchcombe finds that bureaucratic organization is more characteristic of mass production than the construction industry, in part because of the instability in the volume and product mix of the latter. In our terms, the construction industry would be more technically diffuse. See A. L. Stinchcombe, "Bureaucratic and Craft Administration of Production," *Administrative Science Quarterly,* 4 (September, 1959), pp. 168–187.

[20] The remaining control variables of organizational history, ownership and control pattern, location, organizational environment, and organizational charter proved less amenable to fairly precise measurement and are consequently left undiscussed in this section. Efforts were made, however, to assess the implications of these variables for the relationships reported here. In particular, the reader is referred to the section on control procedures and to footnote 18.

[21] When originally confronting the question of grouping the data, the possibility of simply dichotomizing each variable was considered but subsequently rejected, on the basis that this procedure would obscure the potentially valuable middle range of data on technically intermediate firms. We have consequently followed the procedure of trichotomizing each variable, attempting wherever possible to employ equal intervals. The data were run in terms of the dichotomization, with results sufficiently similar to those reported later in the paper to suggest that our procedure of trichotomizing our variables does not prejudice the test of the research hypothesis.

[22] Our concern here is with major product changes as opposed to mere adjustments of the productive machinery which yield slightly altered products. However, what constitutes a "major" as opposed to a "minor" change is a relatively undefined area of industrial engineering. Among the factors which would have to be taken into account in an attempt to differentiate major product changes from minor ones would be the following: (1) whether the material used in the product was changed; (2) whether a re-tooling of the production machinery was required; (3) whether a change in the design or purpose of the product was involved. Clearly there is some possibility of overlap in these categories; for example, a change in material may imply a change in purpose. Our attempt to distinguish major from minor product changes has taken the following form: re-tooling must always be involved in some measure, in addition to the presence of either number (1) or number (3) of the other criteria referred to above.

Definitions of organizational size, levels of authority, sub-units, and the ratios of managers and supervisors to total personnel have already been set forward. Size, and the ratio of managers and supervisors to total personnel, were measured in terms of the earlier definitions through the analysis of organizational records. These procedures presented relatively little difficulty inasmuch as the firms generally had very complete records on number of employees and the number of individuals in managerial and supervisory roles. The measurement of levels of authority and the number of sub-units presented more difficulty in view of differences in how these structural features are defined from firm to firm. Although organizational charts were used for obtaining this information in terms of our definitions, it was at no point assumed that such charts were necessarily reliable or valid indicators of actual arrangements within the firms considered. Instead the charts were discussed with members of management in an attempt to identify significant discrepancies between formal and informal arrangements. In addition we were unable to identify any sources of systematic bias which would have led to more or fewer levels of authority, and sub-units being counted in organizations of one technical type as opposed to another. In this sense, then, although different definitions of hierarchy and sub-units would have no doubt affected the absolute number counted in any given firm, it is nonetheless argued that the relative differences in number of levels and sub-units between firms of different technical type would remain much the same. Each of the above variables was trichotomized in terms of the following classifications:

Size

(1) 100– 499 employees
(2) 500– 999 employees
(3) 1000–1800 employees

Sub-units

(1) 4 or less sub-units
(2) 5 to 7 sub-units
(3) 8 or more sub-units

Levels of Authority

(1) 3 or fewer levels of authority
(2) 4 to 6 levels of authority
(3) 7 or more levels of authority

Ratio of Managers and Supervisors to Total Personnel[23]

(1) 2 or fewer per 45 employees
(2) 3 to 4 per 45 employees
(3) 5 or more per 45 employees

Three modes of program specification were identified and defined earlier. These variables were measured in the following way. The researcher evaluated each firm on each of the three dimensions of programming and decided whether the degree of specification in each case was high, medium or low. In order to check the reliability of this judgment, 20 cases were selected at random from the sample of 43. Two qualified judges[24] were given 10 cases each and instructed as to what was meant by organizational program specification, role programming, output programming, and communication programming. On the basis of case protocols, the judges were asked to rate each case on each dimension and to decide, in each case, whether the firm rated high, medium, or low in the degree of specification. The judges were kept ignorant of the hypotheses being tested. Comparisons were then made between (1) our rating of the first set of ten cases and Judge A's rating of the same ten cases, and (2) our rating of the second set of ten cases and judge B's rating of the same ten cases. In the first ten cases Judge A classified eight of the organizations on each of the three dimensions in the same way as the author. Of the two remaining cases Judge A classified one organization as "high" on communication programming and the other organization as "high" on role programming. The author had classified both these firms as "medium" in the two areas mentioned. In the second ten cases Judge B classified seven of the organizations on each of the three dimensions in the same way as the author. Of the remaining three cases Judge B classified two organizations as "high" on role programming where the author had classified the firm as "medium." On this basis it is argued that, for the majority of cases, all three judges classified the firms

[23] The figure of 45 has been selected because it represented, in terms of the entire sample, the largest number of employees controlled by a single manager or supervisor.

[24] Both judges were Ph.D. candidates in sociology.

on the three dimensions in the same way. It would appear that the classification imposed on the data has a reasonable degree of reliability.

Calculation of Organizational Structure Score. Each of the organizational factors we have identified is a dimension, that is to say, there can be more or less of it. In terms of our trichotomized operational measures, each factor has the value span given below: [25]

1) Sub-unit specialization	1	2	3
2) Levels of authority	1	2	3
3) Ratio of managers . . .	1	2	3
4) Program Specification			
(a) Role Programming	1	2	3
(b) Output Programming	1	2	3
(c) Communication Programming	1	2	3
Totals: Organizational Structure Score	6	12	18

We shall classify each firm in terms of the scale set forward above. As may be seen from the scale, the lowest score a firm could have would be 6, and the highest score 18. Between these polar alternatives, of course, a number of scoring combinations are possible. The hypothesis resting behind our scale, however, is that a firm which is, for example, high on any given dimension will also be high on all other dimensions. The same of course holds for the low and medium positions on a dimension. In any event, this contention will shortly be evaluated in terms of the data. It will be noted that we treat these variables as independent and as of equal weight. With regard to the first matter, we have attempted to illustrate the independence of these factors in the course of our earlier discussion and definition of them. It is quite possible, however, that subsequent evaluation of the factors will suggest reconceptualization; we shall be concerned to look for such possibilities. With regard to the second matter, the absence of weighting, there is no available evidence to suggest that any one of the factors "carries more weight" than any other. In the absence of such evidence we have preferred not to prejudge the matter but instead wait to see if the data suggest reformulation of the suggested scale. The following classification of firms will be used:

(1) low structure score—6 (minimum score);
(2) medium structure score—7 to 12;
(3) high structure score—13 to 18

[25] Technology, size, and the other control variables referred to are not, as conceptualized in this study, organizational factors, and are therefore excluded from this scale.

FINDINGS

The hypothesis we seek to test is that, as technical specificity increases, the following organizational characteristics also increase: the number of specialized sub-units, the number of levels of authority, the ratio of managers and supervisors to total personnel, and the amount of program specification. As may be seen from Table 1, all these organizational characteristics do show a tendency to increase with technical specificity.[26] There was generally a high degree of consistency on all six items in each of the firms studied; for example, a firm which had a greater number of levels of authority would also tend to be higher on all other dimensions. The finding that each of these variables vary in the same direction (including the three dimensions that comprise program specification) lends support to our earlier contention that they may be used to form an index or scale. The scale is used here in terms of the organizational structure scores which serve as a summary.

We next attempted to discover if the effects to organizational structure could be attributed to variables other than technology, such as variations in size, location, environment, form of ownership and control and general historical factors. As may be seen from Table 2, no relationship is apparent between size and organizational structure score. In view of the close association between organizational structure score and technology (see Table 1), it also follows that there is no relationship between organizational technology and size. This finding was also arrived at by Woodward.[27]

[26] The use of statistical tests of significance in connection with our findings would of course be inappropriate in view of the nonprobability sampling procedure we have necessarily followed. For a discussion of this point, see Hubert M. Blalock, *Social Statistics,* New York: McGraw-Hill, 1960, especially pp. 410–411.

[27] Woodward, *Industrial Organization, op. cit.* p. 40.

TABLE 1. TECHNOLOGY AND ORGANIZATIONAL STRUCTURE

Organizational Structure		Technology: Technically Diffuse	Technically Intermediate	Technically Specific
Number of Sub-Units	4 or fewer	9	2	..
	5–7	5	9	4
	8 or more	..	5	9
Levels of Authority	3 or fewer	9	3	..
	4–6	5	7	5
	7 or more	..	6	8
Ratio of Managers and Supervisors to Total Personnel	2 or fewer Managers per 45 employees	11	1	..
	3–4 (per 45)	3	10	4
	5 or more (per 45)	..	5	9
Program Specification	low (1–3)	10	1	..
	medium (4–6)	3	13	3
	high (7–9)	1	2	10
Organizational Structure Score	6 (low)	10	2	..
	7–12 (medium)	3	10	3
	13–18 (high)	1	4	10
	(N=)	14	16	13

The firms included in our sample were located in centers ranging in population from about 100,000 to over five million. Controlling for this factor, however, produced no noteworthy variation in the relationships discovered between technology and organizational structure. As we pointed out earlier, firms with unusual or incomparable environmental or ownership and control patterns have been eliminated from the sample. In addition to these attempts at control, we have also inspected the data and find no evidence to suggest that the remaining variations in environmental and ownership and control patterns significantly affect the relationships reported here. The combination of technology and the organizational factors considered has yielded three dominant forms of sociotechnical organization, that is, tech-

TABLE 2. ORGANIZATIONAL STRUCTURE SCORE AND SIZE

Size (in employees)	Organizational Structure Score: 6 (low)	7–12 (medium)	13–18 (high)
0– 499	4	5	5
500– 999	4	6	5
1000–1800	4	5	5
(N=)	12	16	15

nically diffuse firms with the lowest degree of internal structure, technically intermediate firms with a moderate degree of internal structure, technically specific firms with the greatest degree of internal structure. The possible further implications of this conception of sociotechnical organization will be discussed later in the paper.

Finally, inspection of the data does indicate that in a small number of deviant cases, aspects of a firm's general history exerted some influence on the relationships presently under consideration. For example, we have said that a low degree of organizational structuring was typically associated with technical diffuseness. In three cases which deviated somewhat from this pattern, however, traditional bureaucratic arrangements within the organization prevailed, with a resultant higher degree of internal structuring. Conversely, in the case of two technically specific firms with rather less internal structure than typically found in such firms, it was discovered that a long-standing management policy opposing the development of too great a degree of differentiation was largely responsible for variation from the usual pattern.[28]

DISCUSSION

The findings reported clearly reflect the presence of a relationship between organizational technology and a number of aspects of organizational structure. Three dominant forms of sociotechnical organization have emerged. Further questions, however, remain to be explored. Thus, how does a certain mode of organizational structure come to be associated with a mode of technology, and what are the implications of this sociotechnical structure for the theory and analysis of formal organizations?

We first approach the task of considering how a certain mode of organizational structure comes to be associated with a particular mode of technology. In this connection, the findings show that the more changeful an organization's technology, the less likely that a considerable amount of internal differentiation and program specification will obtain. Although all the firms studied established some internal specializations, the typically changeful nature of technically diffuse production limited the number and duration of these. The frequency with which product development problems typically occurred in technically diffuse firms tended to generate a common point of reference for incumbents of the organization and, in so doing, also reduced the amount of internal differentiation developing.

Technically specific production systems were quite the opposite. Here the infrequency of product change appeared to be conducive to the establishment of stable divisions. These divisions, in turn, appeared to provide a basis for further specialization and differentiation. Typically, change in the usually well-established performance programs took the form of further refinement rather than simplification.

The majority of technically intermediate firms share certain characteristics associated with both technically diffuse and technically specific firms. This sharing is not random, but rather follows a repeated pattern. The basis on which this pattern rests is the fact that while many aspects of technically intermediate production are routinized there is also a certain amount of product change.[29] In consequence, in the typical technically intermediate firm studied by us, those sub-units most involved in product development and change tended to be the most unstructured. Certain other organizational sub-units, such as personnel, marketing, and routine aspects of production, were less affected by such changes. These sub-units tended in their general structure to be much closer to the patterns found in technically specific firms. This disparity of interests between sub-units of course generated a conflict situation unique to technically intermediate firms.

We turn next to the second general question raised earlier, that is, what implications the relatedness of technology and structure holds for the theory and analysis of formal organizations. In this connection, it is suggested that the findings reported here argue strongly for the addition of technology to

[28] For a detailed discussion of the deviant cases, see Edward Harvey, *op. cit.*, especially pp. 117–119, 125, 127.

[29] The automotive industry is a good example, because periods of model change are followed by periods of stable production.

the growing list of "base variables" for the comparative analysis of organizations.[30] Granted our sample of organizations was limited, by design, to those engaged in some form of industrial manufacturing process. Nonetheless, the types of industrial firms included were considerably varied. In comparative analysis by means of the technology variable, we found that firms with highly variable industrial functions and differing sizes were, in terms of their organizational structure, much the same. The focus on technology, then, served to uncover similarities which, in terms of other perspectives, were by no means readily observable. The work of others already suggests that the perspective of technology may well yield comparative analyses of unprecedented scope.[31] The particular conception of technology used here arose from its utility for the comparative analysis of industrial organizations. Theoretical and operational conceptions of technology can clearly be expanded and reformulated as the frame of comparison grows to include a more diverse sampling of organizations.

We would further suggest that the sociotechnical orientation developed here may well prove of value in reconciling certain theoretical controversies in the field of formal organizations, two of which controversies we now suggest.

Organizational Decision Making. Cyert and March have proposed that theories of organizational choice fall into two broad classes.[32] There are, on the one hand, theories particularly concerned with the normative aspects of decision making. Typically, these theories have been developed by economists, and have been concerned with the enhancement of rationality in organizational choice.[33] There is, however, another class of theories offering a competitive view of the dynamics of decision making. These theories are behavioral rather than normative. There is, in the whole approach, a concern with the empirical characteristics of decisions, a concern with what actually happens rather than what is ideally expected to happen.[34]

In terms of the first orientation, an image emerges of organization as essentially rational, well regulated and predictable. The second orientation has been much more ready to point to rather contrary aspects of organizational decision making. In fact, they may describe different aspects of the same organization or disparities between different kinds of organizations. In other words, it may be that the decision-making processes of certain types of organizations are best characterized in terms of a model emphasizing rationality, routine choice, and predictability while the processes of other organizations are best described in terms of the alternative model.[35]

Assuming that one model may "fit" certain types of organizations better than other types, the question arises as to what are the *differentia specifica* of such organizations. Reviewing the evidence presented above, there would appear to be a case for proposing the existence of three distinct types of sociotechnical organization, that is, each of the three major types of technical production and the form of organizational structure characteristically associated with it. We have elsewhere shown in detail that variations in the sociotechnical structure of organizations are closely associated with dif-

[30] For example, A. Etzioni's focus on compliance, in *A Comparative Analysis of Complex Organizations,* New York: The Free Press, 1961; also T. Parsons' focus on the different social functions performed by organizations, in *Structure and Process in Modern Societies,* Glencoe Ill.: The Free Press, 1960.

[31] For example, the already cited work of Woodward; also, Charles Perrow, *op. cit.* The Perrow article contains references to much of the work done with the technology variable in the field of formal organizations.

[32] R. M. Cyert and J. G. March, "A Behavioral Theory of Organizational Objectives," in Mason Haire (ed.), *Modern Organization Theory,* New York: Wiley, 1959.

[33] See, for example, Cyert and March, *op. cit.* Also, see W. W. Cooper *et al.,* "Economics and Operations Research: A Symposium," *Review of Economics and Statistics,* 40 (1958), pp. 195–229.

[34] See, for example, the procedure of H. A. Simon and D. B. Trow in "Observation of a Business Decision," in A. H. Rubenstein and C. J. Haberstroh (eds.), *Some Theories of Organization,* Homewood: Dorsey, 1960. R. M. Cyert, W. R. Dill and J. G. March offer further accounts of actual decision processes in "The Role of Expectations in Business Decision Making," *Administrative Science Quarterly,* 3 (1958–1959), pp. 307–340.

[35] This distinction between technology and routine/non-routine decision-making is also made in Perrow, *op. cit.,* p. 204.

ferent patterns of organizational decision-making.[36] We have found, for example, that technically specific firms with high structure scores tend to have a much higher ratio of routine decisions to innovative decisions. Conversely, technically diffuse firms with low structure scores tend to have a relatively larger number of innovative decisions. Of course both routine and innovative decisions were to be found in all the organizations studied. In this connection, however, findings we have reported elsewhere indicate that technically diffuse firms with low structure scores tend to make innovative decisions in less time, with less conflict and with more economic success than technically specific firms with high structure scores. The evidence gathered consistently suggests that firms characterized by the sociotechnical mode of "technical diffuseness—low internal structure" tend to exhibit flexibilities of organization and general readiness for change which facilitated innovation when the need for it arose. Such flexibilities were much less evident in "technically specific—high structure" firms although, it should be noted, the structural characteristics of the latter tend to facilitate routine, day-to-day decision making. In short, we would suggest that the models of decision-making referred to here are not antithetical orientations but, rather, refer to decision-making under different conditions. The question is not one of rational decision making versus non-rational decision making, but rather a question of identifying the kinds of technical and organizational conditions which serve to enhance rationality in some circumstances and to impede its operation in others. The greater theoretical synthesis of these models will follow, we contend, from further studies of decision making which employ the sociotechnical orientation.

Intra-Organizational Conflict. A certain amount of post-Weberian work has emphasized those features of formal organizations which would justify calling them "cooperative systems," that is, systems characterized by equilibrium and identity of interests. Barnard, for example, has written thus of organizations, particularly in his emphasis on the executive's role in maintaining the processes of communication thought to be essential to continued equilibrium and cooperation.[37] Selznick's attempt to specify further the foundations of the theory of organizations clearly follows in this tradition, in its emphasis on such "organizational imperatives" as security, stability, and homogeneity.[38] Parsons, too, would appear to adhere to this position on formal organizations, especially in his contention that centralized decision-making by leaders of organizations is legitimized in the eyes of followers ". . . by the expectation that management will be competent and that there will be an identity of interest between management and other employees in giving management the power it needs to do the job effectively subject to fair treatment of employees."[39]

Such views of formal organization are contested, or at least questioned, by a considerable amount of research pointing to the emergence of specific individual or departmental interests in organizations at the expense of general organizational goals.[40] Gouldner has carried the argument further by questioning the necessary utility of stability, security and homogeneity for organizational effectiveness. He points, for example, to the possible dangers of ossification which may result from an excess of security.[41]

It is proposed here, however, that it is important to supersede the juxtaposition of such alternative models and attempt to discover the conditions or types of organization under which a given model may or may not hold. Here, Litwak's paper on "Models

[36] See Edward Harvey, *op. cit.*, and "Decision Makers in Conflict," *Business Quarterly,* 32 (Autumn, 1967), pp. 23–27.

[37] C. Barnard, *The Functions of the Executive,* Cambridge: Harvard University Press, 1938.

[38] P. Selznick, "Foundations of the Theory of Organization," *American Sociological Review,* 13 (February, 1948), pp. 25–35.

[39] T. Parsons, "Suggestions for a Sociological Approach to the Theory of Formal Organizations—II," *Administrative Science Quarterly,* 1 (1956–57), pp. 234–5.

[40] In particular, refer to the case studies reported in Chapter 2 of Edward Harvey, *Structure and Process in Industrial Organizations, op. cit.*

[41] A. Gouldner, "Metaphysical Pathos and the Theory of Bureaucracy," *American Political Science Review,* 49 (1955), pp. 496–507.

of Bureaucracy which Permit Conflict" [42] represents an important and suggestive move in the direction of linking different kinds of organization and differential possibilities for conflict. The approach, we contend, can be fruitfully extended through the identification and analysis of differences in sociotechnical organization. To date, we have only been concerned to examine differences in the amount of conflict in different kinds of sociotechnical systems during periods of decision-making. There is no evidence to suggest, however, that the approach cannot be used to analyze other organizational patterns—for example, do differences in sociotechnical organization have implications for the ability of the "professional in bureaucracy" to adjust, or not adjust, to the salaried role? [43] The systematic investigation of questions such as these will serve to evaluate the earlier stated claim as to the importance of technology as a central variable in the comparative analysis of organizations.

[42] E. Litwak, "Models of Bureaucracy Which Permit Conflict," *American Journal of Sociology,* 67 (September, 1961), pp. 177–184.

[43] W. Kornhauser, for example, has pointed out that structural accommodations can be made in organizations such that employed professionals are less afflicted by role conflict. See *Scientists in Industry: Conflict and Accommodation,* Berkeley: University of California Press, 1962. We are presently engaged in a further analysis of the data referred to in the present paper in order to assess, in particular, the implications of organizational technology for adjustment patterns of salaried professionals.

COMMUNITY LEADERSHIP, EDUCATION, AND POLITICAL BEHAVIOR

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Measures of political involvement, perceptions of political cleavages, and political beliefs are developed from interviews conducted in 1962 with formal leaders and voters in four middle-sized Wisconsin cities. Leaders and voters are divided into those with some college education and those with less than college. The relative effect of holding a leadership position versus having some college education upon political attitudes and behavior is the key problem of the paper. Both leadership and education are found to be independently related to all attitudes and behavior analyzed. Leadership is more important than education with regard to the "quantity" of political involvement; education is more important than leadership with regard to the "quality" or "direction" of political beliefs.

STUDIES of the impact of socioeconomic status and leadership position upon political behavior in America have rarely been able to take *both* factors into account simultaneously. Thus we are faced with three basic, yet highly interrelated, findings. First, the higher the status of the individual the greater the probability that he is highly politically interested, informed, active, and ideological (including tolerance of political deviance). Second, leaders—whether governmental position-holders, officers or participants in voluntary organizations, political activists, or however defined—are most frequently drawn from those highest in status (whether measured by formal education, occupational status, or income); thus Bell and his associates have summarized, "The fact that public leadership in America is commonly supplied by people of at least middle-class status and college education is repeatedly demonstrated by the studies cited in this chapter." And, third, leaders, more than nonleaders, are also more highly politically interested, informed, active, and ideological (including tolerant), whether examined at the community (Stouffer) or the national (McClosky) levels.[1]

[1] On the first finding cited in this paragraph, see the cumulative voting studies by Angus Campbell and associates, and by Paul F. Lazarsfeld and associates, as summarized in Robert E. Lane, *Political*