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TECHNOLOGY, HUMAN INTERACTION, AND ORGANIZATIONAL STRUCTURE

by

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Introduction

The effects of technology on the structure of formal organizations have received a great deal of attention in the recent literature [4], [6], [7], [8], [9], [13], [16], [20]. However, inspite of the heightened interest in the technological underpinnings of organizational structure, behavior, and performance, there is nothing approaching general agreement regarding the nature of the impact of technology. Findings have all too frequently been inconsistent, if not contradictory [9], [11]. Indeed, a number of writers have found little reliable evidence that technology materially affects structure, and have called the "technological imperative hypothesis" to serious question [8], [13].

The lack of agreement regarding the extent and nature of the influence of technology on organizational structure springs largely from the fact that different writers have focused on different dimensions of technology and structure. In her pioneering work on the subject, Woodward [23] used as independent variable the degree of technological complexity which she trichotomized into unit or small batch production, large batch or mass production, and continuous flow or process production. In contrast, Harvey [7] grouped his sample on the basis of the degree of technological diffuseness, or the extent to which technological processes are adaptable to a wide range of continually changing products. In addition to technological adaptability, Thompson and Bates [20] considered the degree of concreteness of goals as described in terms of output, along with the extent to which technology is lodged in human as against nonhuman resources. Klatzky [9] chose as the relevant technology dimension the

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degree of automation which he measured by the extent of computerization, while Hage and Aiken [6] focused on the degree of routine as the technological characteristic which bears on organizational structure. In what could well be the most comprehensive investigation of the impact of technology on structure, Hickson and his colleagues [8] included the following technology dimensions as independent variables: (a) the degree of automation, (b) the extent of "workflow rigidity" (or the degree of task interdependence), and (c) "continuity of units of throughput," which corresponds roughly to Woodward's classification. The structural characteristics treated as dependent variables in these studies ranged from the number of administrative levels, through the variants of the span of control, to various measures of the degree of centralization of decision-making.

The confusion brought about by the extremely wide range of choice of appropriate dependent and independent variables is compounded further by differences in the workings of these variables. Consequently, the findings of empirical studies on the effects of technology on structure are seldom comparable and therefore provide little basis for theoretical generalization.

The arbitrary choice of technology dimensions to serve as independent variables may yield insignificant, if not conflicting, results because the impact of each technology variable may depend in large measure on the values of all the other relevant aspects of technology. The relationship between the degree of automation and centralization of decision-making for instance may be positive in one context and negative in another, the direction (and strength) of association depending perhaps on the nature of task interdependence and other facets of technology. Clearly, a sweeping technological imperative principle cannot be generalized from any number of extremely fragmented and partial observations. By and large, the current discussions on the impact of technology on structure have been in the nature of what economists call "partial equilibrium" analysis, and have assumed far too many factors to be given.

The purpose of this paper is to develop better insights into the nature of the influence of technology on structure by reconceptualizing the problem and employing a somewhat different research strategy. Controlling for both organizational size and socio-cultural factors, an attempt is made to determine the extent to which organizations employing widely disparate technologies differ in terms of a number of structural and bureaucratic characteristics. The major thrust of the analysis is to infer the impact of a *cluster* of techno-

logical characteristics on the nature and intensity of human interaction in the organization which, in turn, determines the structural and other characteristics of organizations.

Model and Hypotheses

Recent organizational research has identified three major determinants of the structure of organizations: size as measured by the number of people in the organization [3], socio-cultural, economic and other external environmental factors [17], and technology. Seldom, if at all, do these variables affect structure directly, however. The structural impact of size, the external environment, and technology is, as a general rule, facilitated by an important set of intervening variables, especially those reflecting the nature and intensity of human interaction within the organization.

Figure 1 schematically illustrates a model of the determination of organizational structure which serves as the conceptual framework for this study. It shows structure as being determined by variables describing the nature and intensity of interaction among organizational members. This pattern of interrelationship is shaped by the size of the organization, technology, and socio-cultural factors. According to this model, the choice of technology is determined by the type of organizational output as specified by organizational goals, and the relative prices of inputs, especially the cost of various types of physical capital in comparison to inputs in terms of human skills.

A major deficiency of current research on the impact of technology on structure is its failure to explicitly consider the interactional variables that intervene between technology and structure. Perhaps a more promising tack in attempting to identify the constellation of technological characteristics that bear on structure is to focus attention on the catalytic role of these mediating variables.

There appears to be three general aspects of technology that potentially exert an important influence on human interaction in organizations, and hence on organizational structure. These are: (1) the nature of inputs and outputs, (2) the resource in which technology is predominantly lodged, and (3) the relative extent of man-machine interaction. Organizations vary in terms of the nature of inputs and outputs, from those that process information and knowledge to those that transform physical inputs into physical outputs. Techno-

logy may be predominantly embedded either in people or in nonhuman resources. Task-related interaction in organizations ranges from that which is predominantly among people to that which is mainly between people and nonhuman resources.

Organizational technologies may be classified in terms of these broad dimensions into those predominantly "people-centered" to those that are "tool-centered". Organizations with people-centered technologies generally process knowledge or information. In this type of organizations, technology is lodged primarily in people, and interaction is mainly among people rather than between people and nonhuman resources. Included in this category are universities, financial institutions, and most government agencies.

Tool-centered technologies characterize organizations which process material things. In this type of organizations, technology is embodied largely in machines and apparatuses, and task-related interaction is fundamentally between people and machines. Manufacturing plants fall under this category.

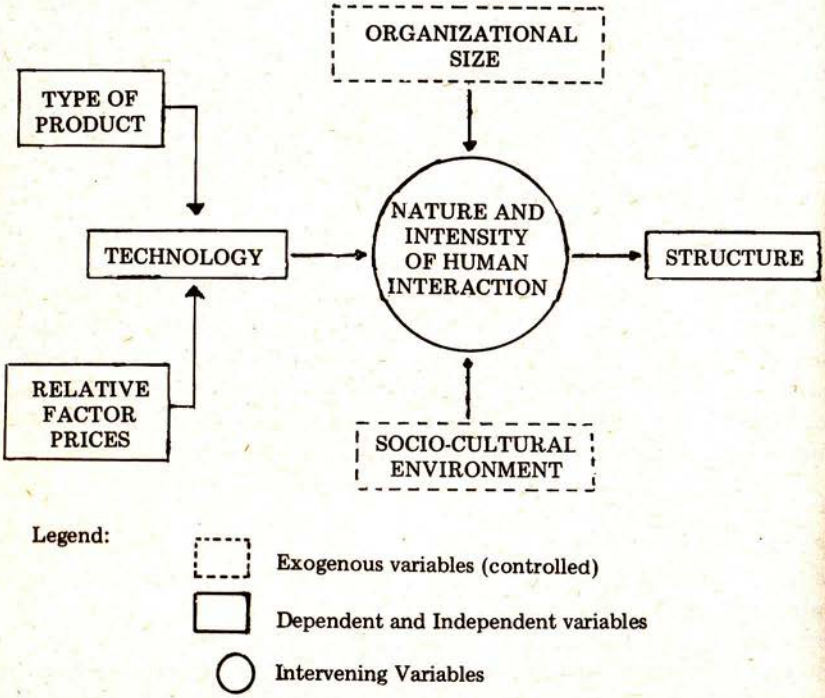

Figure 1. A Model of the Determination of Organizational Structure

The contrasts between these two extreme types of organizational technologies are summarized in Table 1.

Table 1
Characteristics of People-Centered and Tool-Centered Organizational Technologies

	People-Centered Technologies	Tool-Centered Technologies
Nature of Inputs and Outputs	Knowledge or information service	Physical
Resource in which Technology is predominantly lodged	People	Equipment
Relative Extent of Man-Machine Interaction	Low	High

Organizations with people-centered technologies tend to be characterized by a multiplicity of statuses and a high degree of status differentiation. Skills are also more highly differentiated, and there typically exists a high degree of vertical and horizontal division of labor. In this type of organizations, problems are generally unprogrammable and activities tend to require more extensive monitoring. Control mechanisms, moreover, are likely to be personal or administrative in nature. Task interrelationships and communication flows in organizations with people-centered technologies tend to approximate an all-channel net where production may start and end at several and widely scattered points in the organization. This type of interrelationship is what Thompson calls "pooled interdependence" [21].

In contrast, organizations characterized by tool-centered technologies typically have fewer statuses and a low degree of differentiation. Problems are more readily programmed and there is less need for personal monitoring of task performance. In this type of organizations, moreover, there frequently is ample opportunity for installing automatic mechanical control devices. Finally, in organizations with tool-centered technologies, task interdependence is generally *serial* in nature, with production starting at one definite point in the production line and ending at another.

Clearly, human interaction tends to be more intense and complex in organizations with people-centered technologies. The structural implications also seem to be fairly obvious. We would expect, for example, that monetary rewards will be less equally distributed in organizations characterized by people-centered technologies. The average span of control will tend to be higher in organizations with tool-centered technologies, which we would also expect to be more highly centralized in decision-making. The hypotheses advanced in this study are summarized in Table 2.

Table 2
Hypotheses of the Study

Structural and Bureaucratic Characteristics	Type of Technology Hypothesized to have Higher Value
Structure of Rewards	
Equality of Distribution of Monetary Rewards	tool centered
Structure of Authority	
Managers and Supervisors as a Proportion of Total Personnel	people centered
Number of Administrative Levels	people centered
Number of Ranks (Statuses)	people centered
Centralization of Decision Making	tool centered
Bureaucratic Characteristics	
Degree of Functional Differentiation	tool centered
Degree of Formalization	people centered
Degree of Status Orientation	people centered

Methodology

This paper seeks to answer the basic question: to what extent do formal organizations employing widely divergent technologies differ in terms of their structural and bureaucratic characteristics? In finding the answer to this question, cross-sectional data on a number of variables were developed from organizations belonging to two industries representing extreme points along the technology spectrum. One group consists of commercial banks which obviously employ people-centered technologies, while the other group is made up of cement manufacturing firms whose technologies are clearly of the other variety.

The model sketched above shows that the nature and intensity of human interaction in organizations is determined by size, technology, and the external, socio-cultural environment. Since we are here concerned solely with the effects of technological factors, both size and socio-cultural variables must be controlled. We will isolate the impact of size by limiting our study or organizations that fall within specific size ranges. We have accordingly stratified our sample organizations into two size categories, one consisting of banks and cement manufacturing firms employing between 100 and 299 workers, and the other with total employees ranging from 300 to 700.

The influence of socio-cultural factors posed no problems inasmuch as all the organizations studied are located in a more or less socio-culturally homogeneous portion of one country — the Philippines. Care was taken, however, to insure that all the organizations in the sample are owned and managed by native Filipinos in order to put within reasonable limits the influence of foreign values and attitudes. For this reason, foreign-owned and managed organizations (e.g., the Manila branch of the First National City Bank of New York) were excluded from the sample.

The dependent (structural and bureaucratic) variables in this study are the following:

(1) an index of the degree of equality of distribution of monetary rewards;
(2) measures of the "length" of the administrative hierarchy;
(3) variants of the span of control;
(4) measures of centralization of decision-making;
(5) a measure of the extent of internal differentiation;

(6) a formalization index; and
(7) an index of status orientation.

The manner in which these measures and indices were constructed is described in detail in the appendix.

The sample of the study consists of 20 responding banks and 13 cement manufacturing firms. These organizations were drawn by the saturation sampling of all commercial banks and cement companies in the Greater Manila area and the remote provinces that satisfied our size and ownership criteria. The size and composition of the sample is shown in Table 3.

Table 3

Size and Composition of the Sample

Size Strata	Banks	Cement Firms	Total
Stratum I; 100-299 Employees	7	6	13
Stratum II: 300-700 Employees	13	7	20
Totals	20	13	33

Findings

Structure of Rewards

The degree of equality of distribution of monetary rewards was measured in terms of what we call the reward concentration index which shows the percentage of total wages and salaries accruing to a given proportion of employees (see appendix for a precise definition of this index). Wage and salary data developed in this study show that the distribution of monetary rewards is more highly concentrated in commercial banks than in cement manufacturing companies. The highest paid 10 per cent of the employees in the smaller-sized banks received 35 per cent of total wages and salaries paid per year[1], as against 30 per cent for the cement firms in this size cate-

[1] The data used throughout this study are annual averages covering the four-year period 1969-1972.

gory. However, the observed difference between the average values of the reward concentration index among the smaller-sized organizations is not statistically significant at any acceptable level of confidence. The corresponding figures for the larger organizations are 26 and 17 per cent, respectively, a difference which is significant at the 2.5 per cent level.[2] It is worth noting that for both types of organizations, the reward concentration index is substantially larger among the smaller firms.

The data on the structure of rewards among the banks and cement firms surveyed are summarized in Table 4.

Table 4

Ratio of Salaries of the Top 10 Per Cent* of Total Employees to Total Wages and Salaries in the Philippine Commercial Banks and Cement Manufacturing Firms (In Per Cent)

	Cement Companies		Banks	
Size Strata	Sample Means	Sample Variances	Sample Means	Sample Variances
Stratum I: 100-299 Employees	30.0	0	35.0	61.0
Stratum II: 300-700 Employees	17.0[a]	0.4	26.0	26.0[a]

*Top 5 per cent for Stratum II organizations.

[a] $p < .025$

Structure of Authority

By and large, the data on the structure of authority support our hypotheses about the comparative structures of commercial banks

[2] The level of significance for the difference of means were determined by using the usual t-test (one tailed) for small samples.

Table 3a.

Measures of Authority Structure in Philippine Commercial Banks and Cement Manufacturing Companies — Stratum I

Measures of Authority Structure	Sample Means			Sample Variances		
	Cement Companies			Cement Companies		
	Firm	Plant	Banks	Firm	Plant	Banks
1. Number of Administrative Levels	6.17	4.8[b]	6.14	.567	.400	1.810
2. Officers and Supervisors as a Percentage of Total Employees	20.00[b]	17.7[a]	28.86	.003	.002	.350
3. Officers as a Percentage of Total Employees	5.70[a]	3.6[a]	19.7	.001	.0004	.180
4. Chief Executive's Span	3.67[c]	6.5	6.43	6.27	6.94	4.29
5. Number of Rank Levels	7.17[a]	n.a.	9.29	.567	n.a.	.570
6. Lowest Relative Rank Appointed by the Chief Executive	.56	.73	.63	.037	.117	.054
7. Relative Administrative Level at which Lowest-Level Personnel are Hired	n.a.	.16	.26	n.a.	.035	.030

[a] $p < .005$; [b] $p < .01$ [c] $p < .05$; [d] $p < .10$

Measures of Authority Structure in Philippine Commercial Banks and Cement Manufacturing Firms — Stratum II

Measures of Authority Structure	Sample Means			Sample Variances		
	Cement Companies		Banks	Cement Companies		Banks
	Firm	Plant		Firm	Plant	
1. Number of Administrative Levels	6.83	5.33[b]	7.08	2.966	.333	1.076
2. Officers and Supervisors as a Percentage of Total Employees	14.30	13.00[a]	23.23	.002	.0004	.240
3. Officers as a Percentage of Total Employees	3.20[a]	.70[a]	16.50	.0005	0	.330
4. Chief Executive's Span	8.67	5.67	8.08	27.87	6.33	14.58
5. Number of Rank Levels	8.17	n.a.	9.08	6.27	n.a.	1.41
6. Lowest Relative Rank Appointed by the Chief Executive	.52	.60	.62	.033	.320	.031
7. Relative Administrative Level at which Lowest-Level Personnel are Hired	n.a.	.20[c]	.40	n.a.	.080	.012

a b c d

and cement manufacturing firms. This can be gleaned from Tables 5a and 5b which show the sample means of the different measures of authority structure, along with their respective variances among the two groups of organizations in both size ranges. Data for both the *plant*, which consists only of production units, and the entire *firm* (i.e., the plant along with sales, administrative and other divisions) were developed for the cement companies. For obvious reasons, we would expect to find sharper contrasts between banks and cement plans than between banks and whole cement firms. Should this be the case, as indeed the data seem to indicate, the evidence regarding the impact of the relevant dimensions of technology on structure will be all the more convincing.

Among the smaller-sized organizations, there appears to be no appreciable difference in terms of number of administrative levels between cement firms and commercial banks. However, a significant difference in terms of this structural variable is observed when stratum I banks are compared with cement *plants* of comparable sizes. Table 5a shows that cement plants in the smaller size category have an average of 4.8 levels of administration, as compared with 6.14 among the banks in this size range. This difference is significant at better than the one per cent level. The findings among the larger sized organizations lead to essentially the same conclusions except, of course, that the number of administrative levels is higher.

On the whole, stratum I cement operations at both the firm and the plant levels proportionately have far smaller managerial components than commercial banks in this size category. As to be expected, the proportion of officers and supervisors is considerably smaller among cement plants than among whole cement companies. Note, for example, that officers and supervisors, on the average, comprise 20 per cent of all employees of the small-sized cement firms as compared with 28.86 per cent among the banks in this size classification. The corresponding figure for cement plants in the same size range is 17.7 per cent. The differences of means in terms of this organizational characteristic between the smaller-sized cement firms and cement plants on the one hand, and the corresponding banks on the other, are significant, respectively, at the .01 and .005 levels.

The data show that managerial personnel designated as officers are proportionately even fewer, and again more so at the plant level, among the smaller-sized cement manufacturing organizations in comparison with banks in this size range.

Stratum II data also confirm our hypothesis regarding the relative size of the managerial component in the two types of organizations. It is interesting to note, moreover, that the administrative component is substantially smaller among the larger-sized organizations, and especially so among the cement manufacturing plants. For example, among the cement plants employing between 300 and 700 persons, only 0.7 per cent, or less than one person out of every 100, enjoys officer status. This would suggest that technology is an important set of variables that influences the impact of size on structure.

On the average, the chief executives of stratum I cement firms have less than four subordinates (excluding secretaries and receptionists) reporting directly to him, as compared to nearly 6-1/2 among his banking counterparts. This finding is somewhat surprising considering the general observation that the average span of managerial control is higher among cement operations than among banks. The small span of control of the chief executives of the smaller-sized cement firms (which differs significantly from the corresponding average figure for banks at better than the .005 level) is due largely to the fact that small cement companies typically have only two or three major divisions whose heads reporting directly to chief executive, and only a small number of high level staff positions. Moreover, the marketing operations among these firms are frequently carried out by other corporations. By contrast, the average manager of small cement plants, as expected, has a larger span of control than chief executives of banks of comparable sizes. The difference, however, is not statistically significant.

The chief executive's span among stratum II cement firms, on the average, is somewhat larger, but not significantly so, than the corresponding figure for commercial banks of the same size. Quite surprisingly, however, the data indicate that managers of the larger-sized cement plants have smaller spans of control than the chief executives of banks in this size category, a finding which contradicts our hypothesis. Even more perplexing is the observation that managers of the larger cement plants, on the average, actually have smaller spans of control than their opposite numbers among the smaller plants. The only plausible explanation is that the larger plants are more systematically organized and differentiated, with departments grouped into larger plant divisions whose heads, and not the department foremen, report directly to the plant manager. At any rate, the difference between the average span of control of the managers of the larger-sized cement plants and that of their banking counterparts is significant at only the 15 per cent level.

Stratum I data appear to substantiate our hypothesis regarding the difference between the two groups of organizations in terms of the number of rank levels. On the average, the smaller cement firms have 7.17 major rank classifications as against 9.29 among the banking organizations in the same size range, a difference which is significant at the .005 level. However, the corresponding data among the larger-sized organizations provide only weak support.

The data on our two measures of centralization of decision making yield somewhat unconvincing, even contradictory, results. At the firm level, it would appear that in both size categories, cement operations are less highly centralized than commercial banks in terms of the hiring authority of the chief executive, contrary to what we have hypothesized. The data shows that the appointive power of chief executives of cement firms extend up to about halfway down the administrative hierarchy, while their banking counterparts exercise such authority up to about 2/3 down the entire length of the managerial pyramid. This observation is probably due to the reluctance of presidents of cement companies to take an active hand in the appointment or promotion of middle- and lower-managers owing to the highly technical nature of these jobs. However, the differences between banks and cement companies in terms of this measure of centralization are not statistically significant.

Managers of cement plants in the smaller size category appear to enjoy relatively greater hiring prerogatives than the chief executives of banks in this size range. Again, however, the difference is not significant. Stratum II banks and cement plants seem to be just about even in terms of this measure of centralization of decision-making.

In both small and large cement plants, the "relative level" at which the "major decision" (see appendix for definitions of these terms) to hire rank-and-file employees is made, is lower than in the banks in the corresponding size ranges. This is interpreted to mean that in terms of this particular measure, cement plants are more centralized than commercial banks, just as we have hypothesized. The difference between banks and cement plants in the smaller size category in terms of this variable is not statistically significant, but the same t-test applied to the larger organizations yielded a p-value of better than .10.

Bureaucratic Characteristics

The data show a number of interesting points of contrast between

banks and cement plant operations in terms of a number of bureaucratic characteristics. On the average, cement plants in both size categories have more operational line and staff departments than commercial banks. The larger-sized banks and cement plants differ in terms of this measure of internal differentiation at a significance level of better than 10 per cent.

As we might expect, cement plants were found to be characterized by a substantially higher degree of formalization (see appendix for operational definitions of these variables) than commercial banks. The differences between the two types of organizations in terms of this variable in both size strata are significant, respectively, at the 0.5 and 5 per cent levels.

In both size categories, commercial banks exhibited considerably higher status orientation than cement firms, their differences in terms of this characteristic being significant at the 0.5 per cent level.

The data on the three selected bureaucratic characteristics of the banks and cement companies surveyed are summarized in Tables 6a and 6b.

Summary and Conclusion

By and large, the data indicate that cement manufacturing companies and commercial banks differ substantially in terms of the selected structural and bureaucratic characteristics. Monetary rewards were shown to be more heavily concentrated among commercial banks than among cement firms thus reflecting, among other things, the high status and role differentiation and the relative importance of the coordinative and integrative function of management in banking organizations.

The results of the study show that banks have proportionately more managerial and supervisory personnel in comparison with cement plant operations, again reflecting the greater need for personal control and supervision in banks. Unlike the data on the *average* span of control, however, the findings regarding the chief executive's span are rather inconclusive. Quite surprisingly, it was noted that chief executives of the smaller-sized cement firms, on the average, have significantly fewer direct subordinates than their banking counterparts. This finding seemingly contradicts our hypothesis regarding this variable. We attributed this to factors associated with the size of cement manufacturing organizations.

Table 6a.

Selected Bureaucratic Characteristics of Commercial Banks and Cement Companies — Stratum I

Bureaucratic Characteristics	SAMPLE MEANS			SAMPLE VARIANCES		
	Cement Companies		Banks	Cement Companies		Banks
	Firm	Plant		Firm	Plant	
1. Degree of Functional Differentiation	NA	10.2	9.43	NA	12.40	1.95
2. Degree of Formalization	NA	4.0[a]	2.86	NA	0	.81
3. Status Orientation Index	3.83[a]	NA	7.43	2.17	NA	.62

[a] $p < .005$

Table 6b.

Selected Bureaucratic Characteristics of Commercial Banks and Cement Companies — Stratum II

Bureaucratic Characteristics	SAMPLE MEANS			SAMPLE VARIANCES		
	Cement Companies			Cement Companies		
	Firm	Plant	Banks	Firm	Plant	Banks
1. Degree of Functional Differentiation	NA	14.67[c]	11.77	NA	30.33	5.36
2. Degree of Formalization	NA	4.0[b]	2.85	NA	0	1.14
3. Status Orientation Index	3.50[a]	NA	6.00	3.50	NA	2.83

[a] $p < .005$; [b] $p < .05$; [c] $p < .10$

As hypothesized, cement plants were found to have significantly fewer levels of administration than commercial banks of comparable sizes. This is of course due to the fact that bank personnel, in comparison with cement plant workers, require more detailed *personal* supervision by superiors, and this invariably leads to greater *vertical* differentiation. However, no statistically significant difference was observed between banks and cement *firms* in terms of this measure of the length of the administrative hierarchy, although the data for the larger sized organizations showed a noticeable difference in the hypothesized direction of the inequality.

Considering the high degree of status orientation in commercial banks, it is not surprising to find that banks in both size categories have far more rank classifications than cement firms.

In view of the relatively high degree of routine characterizing cement manufacturing, and the commonly known fact that self-adjusting mechanical or electronic control devices are more frequently found in material processing rather than in information generating operations, it was hypothesized that cement companies are more centralized in decision-making than commercial banks. However, the data do not support this hypothesis. Quite surprisingly, only in terms of one measure of centralization — the relative level in the administrative hierarchy at which rank-and-file personnel are hired — did the data seem to suggest a higher degree of centralization among cement plants. Even then, only among the larger-sized organizations was the difference statistically significant (at the 5 per cent level). Obviously, a number of other measures of centralization in decision-making which are comparable across technologies should have been used in the study.

The bureaucratic differences between cement companies and commercial banks are more straightforward. Cement plants in both size categories were found to be more highly differentiated than commercial banks. This is only to be expected considering that tasks tend to be more clearly defined and interrelationships more precisely delineated in manufacturing operations than in offices and bureaus. Thus, natural groupings of tasks are more obvious in cement plants than in banks.

Activities in most manufacturing operations tend to fall into repetitive routine patterns. It is therefore not surprising to find that more activities and relationships in cement plants are governed by formal rules than in commercial banks.

The data strongly suggest a much higher status orientation among commercial banks than among cement firms. Considering that technology in banks is lodged mainly in people, we would expect a high degree of differentiation in terms of types of manpower input. In comparison with cement plant operations where manpower input is relatively homogeneous in terms of skill requirements, banks will tend to exhibit a higher degree of role, and hence, status differentiation.

It is generally accepted that technology is a multi-dimensional variable. Yet, researches on the impact of technology on organizational structure have treated it as though it were a variable that can be scaled along a single-dimensioned continuum, or one that can be factored into a number of *independent* dimensions. As a consequence, empirical researches on the subject have failed to come up with consistent findings from which theoretical generalizations may be derived. This study suggest that perhaps a more effective approach is to consider the combined effects on the organization of a *cluster* of *interdependent* technological variables. It suggests, moreover, that the relevant set of technological dimensions can more readily be identified by first determining the effects of technology on the nature of interpersonal and intergroup relations in formal organizations.

APPENDIX

Indices of Structural and Bureaucratic Characteristics of Formal Organizations

I. Degree of Equality of Distribution of Monetary Rewards Reward Concentration Index

$$\frac{\text{Total salaries received by the top 5 or 10\% of total employees}}{\text{Total wages and salaries}}$$

Total wages and salaries include, in addition to the basic rate, all types of bonuses. Excluded, however, are fringe benefits and similar items that are typically subsumed under cost classifications other than "wages and salaries."

The top 5 or 10% of total employees was determined on the basis of rank in the organization (i.e., size of annual salary). The larger percentage was applied to the smaller organizations in order to avoid summing over a small number of company officials.

II. "Length" of the Administrative Hierarchy

1. Number of Administrative Levels

   By administrative level is meant "... a formally delimited zone of responsibility along the organizational hierarchy bounded, at the lower limits, by the delegation of authority... and, at the upper limits, by the necessity of 'reporting to' a higher level..."*

2. Number of Rank Levels

   The term rank as used here means, in effect, a salary scale or range of scales. At the senior officer level, ranks and administrative levels more or less coincide (that is, the highest administrative level corresponds to the highest rank, the second highest administrative level corresponds to the second highest rank, etc.). At the middle and lower echelons, how-

*E. Harvey, "Technology and the Structure of Organizations," *American Sociology Review*, 33 (1968), 247-259.

ever, ranks tend to be more finely defined and clearly delineated, especially in commercial banks.

III. Variants of the Span of Control

1. Officers and Supervisors as a Percentage of Total Employees

2. Officers as a Percentage of Total Employees

   Total employees include part-time (but regular) employees (e.g., part-time computer programmers), but exclude workers hired on a contractual basis from other organizations, such as security and janitorial service companies.

   The criteria for awarding office status varied among the cement companies and banks surveyed. Only those who were officially designated as such were counted as officers.

   Supervisors are nonofficer personnel who have at least one subordinate working directly under them.

3. Chief Executive's Span — the number of subordinates (excluding secretaries, receptionists, etc.) reporting directly to the chief executive (or plant manager).

IV. Measures of Centralization of Decision Making

1. The Lowest Relative Rank in the Appointment or Promotion to which the Chief Executive Makes the Major Decision

   The *relative* position of a particular rank in the organization is defined by the ratio

$$\frac{\text{Number of Ranks Higher}}{\text{Total Number of Ranks Minus 1}}$$

   Where two or more persons participate in the decision, a decision is regarded as *major* if it carries a weight of more than 50% of the joint decision.

2. Relative Administrative Level at which the Major Decision to Hire Rank and File Personnel is Made

The *relative* position of an administrative level is given by the ratio

$$\frac{\text{Number of Administrative Levels Higher}}{\text{Total Number of Administrative Levels Minus 1}}$$

V. Bureaucratic Characteristics

1. Degree of Functional Differentiation — the number of major subdivisional units (i.e., departments).

2. Degree of Formalization — The value of this index is the number of aspects of bank and cement plant operations among the following which are governed by formal (i.e., written) rules:

   (a) personnel behavior and conduct;
   (b) penalties for various types of offenses;
   (c) safety and/or security; and
   (d) recruitment and/or promotion.

3. Status Orientation Index — The composite status orientation index is the sum of index points for (a) the number of officers and supervisors as a percentage of total employees and (b) the number of rank levels. The number of index points was determined as follows:

   (a) Number of officers and supervisors as a percentage of total employes

Range of Values (in %)	Index Points
15 and under	1
16 — 20	2
21 — 25	3
26 — 30	4
31 and above	5

   (b) Number of rank levels

Number of Levels	Index Points
7 and under	1
8	2
9	3
10	4
11 and over	5

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