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The results of an exploratory study of patterns of purchase influence in the metalworking industry are reported. The data set used was a representative sample of 2151 purchase influencers in the metalworking industry. Respondents reported their involvement or noninvolvement in each of seven phases of the purchasing decision process. The authors show the presence of identifiable patterns of reported involvement in the organizational buying process and suggest an approach for analyzing those patterns.

An Exploratory Investigation of the Structure of the Buying Center in the Metalworking Industry

For effective marketing and communication to organizations, an understanding of the way organizations buy is essential. Organizational buying reflects a complex set of activities, pursued by many members of a buying organization, which result in a commitment to purchase goods and services. The activities include information acquisition and search processes, developing choice criteria, and the actual choice among alternatives.

Organizational and consumer buying behavior have two attributes in common: a purchase is the usual outcome of the process and the decision is the result of human decision-making activities. Organizational buying, however, must be studied differently than consumer buying because, among other reasons, more than one and often many individuals are involved in the purchasing decision process. As Wind (1970) points out, purchasing managers rarely make a buying decision independently of the influence of other members of the organization. In addition, because of the high dollar volume often involved, the number of individuals affected, and the technical nature of the product under consideration, the organiza-

tional purchasing process may take a long time and go through distinct phases.

Effective use of industrial marketing resources requires an understanding of (1) *who* is involved in the purchasing process (who are the purchase influencers) and (2) *how* they buy, i.e., what stages the process goes through and how the individuals involved influence the process. Our study investigates patterns of decision-process involvement across a range of product categories in the metalworking industry. The objective is to describe how the level of decision-process involvement relates to the type of product, the decision phase, the individual job category, and the characteristics of the buying firm.

GROUP INFLUENCE IN ORGANIZATIONAL BUYING: BACKGROUND

Several empirical studies (Buckner 1967; *Scientific American* 1970) have demonstrated that there is no single decision maker in industrial purchasing situations. Rather, a number of individuals influence the purchase decision. A survey by *Purchasing Magazine* (1965) of 603 chemical industry purchasing executives showed that the purchasing agent alone chose the source of supply in only 13% of the cases. Across this sample, the number of buying influentials averaged about five but ranged up to 50 in a few cases. Empirical results discussed by Harding (1966) and O'Rourke, Shea, and Sulley (1973) generally support this view.

Because of the number of individuals involved and the resultant complexity of the buying process, several re-

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searchers have tried to structure organizational buying according to phases of the process and the roles of individuals in the process. Those phases generally range from "need recognition" through several stages of "search and information acquisition" to "final approval" (Bradley 1977; Brand 1972; Kelley 1974; Ozanne and Churchill 1971; Robinson and Faris 1967; Webster and Wind 1972; Wind 1978).

The multiperson nature of the buying process has led to the concept of the *buying center* (Webster and Wind 1972). The buying center includes all organizational members involved in a purchase situation. It is an "informal, cross-sectional decision-unit in which the primary objective is the acquisition, importation and processing of relevant purchasing-related information" (Spekman and Stern 1979, p. 56). The composition of the buying center may change from one purchasing situation to the next, evolves during the purchasing process, and differs among firms.

Fisher (1969) proposed a simple model to integrate the factors influencing the buying process and the degree of involvement of different functional areas of the firm, with product complexity and commercial uncertainty as the main factors affecting the process. Another widely held view of the purchasing process was developed by Robinson and Faris (1967), who have labeled buying situations as "new task," "straight rebuy," and "modified rebuy." The specific individuals involved in the buying decision process are likely to depend on the type of purchase situation (Brand 1972).

Although much research has helped produce a general understanding of the nature of industrial buying behavior (see Bonoma, Zaltman, and Johnston 1977 or Johnston 1981 for a review), the applications of this knowledge to specific product situations are few and the results unclear (see Moriarty 1982 for an exception). Webster and Wind (1972) talk about users, gatekeepers, influencers, etc. Brand's (1972) categorization consists of general management, technical personnel, etc. These conceptual categories are not easy to operationalize.

THE DATA

The objective of our research is to determine and measure whether (and how) the pattern of decision influence relates to characteristics of the product and the buying firm. In particular, we are interested in the possibility of deducing patterns of decision-process involvement by product type, decision phase, and job category within a buying firm.

The data we use were collected by Chilton Research Services for the publication, *Iron Age*, in 1978. The study, reported in detail by Oldach, was entitled, "How Metalworking Buys III: A Study of Executives in Metalworking Industries." We chose this data set because it represents purchase influences in six different two-digit SIC codes (33-38) for a total of 19 product categories. Because the data set was not collected expressly for our study, our analysis must conform to its limitations.

The sample represents the responses to 2151 telephone interviews in 878 sampled plants. The purpose of the original study was to develop a representative sample of purchase influencers in the metalworking industry. To that end, a two-stage interview procedure was employed.

Stage I. A sample of industry plants was selected so that the distribution of industry and establishment size (in terms of employment) matched industry statistics. In each of these sample plants a list of managerial and professional personnel having the title of foreman or higher, classified by job title category, was obtained by telephone interviews with the plant manager, personnel director, or other qualified respondent at each location.

Stage II. In this stage the actual interviewing took place. The sampling procedure, within each SIC, aimed at securing the following numbers of interviews—locations with 20-99 employees, per SIC code: 60—locations with 100-999 employees, per SIC code: 120—locations with 1000+ employees, per SIC code: 180

for a total target of 360 interviews per SIC code and 2160 overall. Earlier studies (1953, 1969) by the same organization showed that sales, advertising, and marketing executives had minimal participation in the purchasing process, and no stage II interviews were conducted with respondents in those job functions.

The sample frame for stage II thus consisted of all titled executives above the rank of foreman, less those in sales, advertising, and marketing. The probability of an executive in a given job category being selected was proportional to the reported number of executives holding such a title within the sample stratum (given in the stage I interview). The specific person (or persons) to be interviewed was selected at random from the list of

Table 1
PRODUCT CATEGORIES STUDIED

1. Ferrous metals
2. Nonferrous metals
3. Nonmetallic materials and components
4. Cutting-type machine tools
5. Forming machine tools
6. Machine tool accessories
7. Inspection and testing apparatus
8. Mill and foundry equipment
9. Fastening, joining, and assembly equipment
10. Heat treating equipment and supplies
11. Metal cleaning and finishing equipment
12. Cleaning materials, finishes, and coatings
13. Materials handling equipment
14. Electrical and mechanical power transmission and control equipment and components
15. Hydraulics and pneumatic equipment and components
16. Plant service equipment and supplies

names of individuals with that job title, also collected during the stage I interview. An original call and up to three additional calls were made to attempt to complete an interview with each designated respondent; 98.6% of interviews were finished on or before the fourth call. The overall completion rate was 62%. The 38% nonresponse consisted of 21% refusals and 17% not available during the interview period (March 27–May 12, 1978).

The consultation section of the Advertising Research Foundation validated and verified the study and reported: "In the opinion of the Technical Council the research design [and] data collection . . . conform . . . to the standards set forth in ARF's Criteria for Marketing and Advertising Research" (Oldach 1978, p. ii).

For our study we used, for each respondent, the associated number of plant employees, the SIC code, and the individual's job responsibilities. The key decision-influence data were involvement or noninvolvement (a binary variable) for *each* of 19 product categories for *each* of seven phases of the decision-making process.

Preliminary data analysis showed no apparent response patterns for three categories of products: manufactured parts, business services, and control instrumentation. After discussion with analysts at Chilton Research Services and at *Iron Age*, we concluded that those three product categories were overly general and may have been misinterpreted by the respondents. We therefore eliminated them from the analysis; the 16 product categories retained are listed in Table 1. We considered the decision process to have seven phases, as listed in Table 2.

Nine primary and five secondary job responsibilities were included as possible combinations in the questionnaire. Eight of the 45 primary-secondary job responsibility combinations accounted for 68% of the sample. These 1462 respondents represented 1462/878 or 1.7 respondents per plant, on average. The job responsibilities included in this analysis are listed in Table 3.

Before we proceed, it is important to stress several limitations on the analysis caused by the data set.

1. The data set is five years old and was collected for descriptive purposes. We have no way of knowing whether the results are still relevant. The measures and the data themselves, at best, conform roughly to our research needs.
2. The measure of purchase process involvement is questionable. The survey measured only involved/not in-

Table 2
BUYING DECISION PHASES

Phase 1. Initiating the purchase
Phase 2. Determining the type of equipment or material to be purchased
Phase 3. Drawing up detailed specifications for the product
Phase 4. Evaluating sources of supply
Phase 5. Selecting specific suppliers
Phase 6. Determining the amount of expenditure
Phase 7. Giving final authorization for the purchase

Table 3
JOB RESPONSIBILITY CATEGORIES RETAINED FOR ANALYSIS

Category	Frequency count
1. Corporate management or proprietorship (no adm. duties)	146
2. Corporate management or proprietorship (with adm. duties)	139
3. Production-related personnel (no adm. duties)	44
4. Production-related personnel (with adm. duties)	178
5. Engineers (no adm. duties)	263
6. Engineers (with adm. duties)	68
7. Purchasing (no adm. duties)	194
8. Purchasing (with adm. duties)	53
Total*	1462

*Respondents whose job responsibilities did not fit any of the categories were excluded from the study.

- involved in the decision-making process, not degree of involvement or level of responsibility.
3. No convergent measure of involvement is available to test the level (if any) of self-reporting bias (Corey 1971; Patchen 1963).
4. The product categories are rather vague and data for many products are collected together. Kelley (1974) recommends collecting data for one well-defined product at a time.
5. Only SIC code and size of establishment (via number of employees) are available as buying company descriptors. We would like to know much more about the buying organization, especially about its organizational structure (centralized or decentralized buying).

Several points can be raised in support of using this data set, however. First, a clear, operational definition of degree of purchase influence does not exist. In fact, several researchers (Grashof and Thomas 1976; Silk and Kalwani 1982) have argued that the measurement of involvement/noninvolvement of participants in the purchasing process leads to more reliable results than the measurement of relative influence.

Second, the *Iron Age* study covers a broad set of organizations. In 1976, metalworking (Statistical Abstract of U.S. 1977) accounted for 30% of all manufacturing establishments, 49% of manufacturing employment, 54% of value added by manufacture, and 45% of the value of shipments of manufactured goods. Therefore, the results of this study should provide a valid representation of how at least a major portion of U.S. industry buys.

Third, any data set collected for another purpose will necessitate compromise, and any data collection activity must balance cost and value. Multiple measurements within buying organizations (to ensure convergent validity of purchase process involvement measures), measurements on one product market at a time, and measurements of level of involvement in the purchase process all add significantly to cost. An ideal study would not have a budget constraint; in practice any study does.

Though we believe use of the high-quality, rare set of data from the *Iron Age* study is worthwhile, our results must be interpreted in terms of the limitations of that data set and our study should be considered exploratory.

ANALYSIS

Our analytic approach consists of the following four phases.

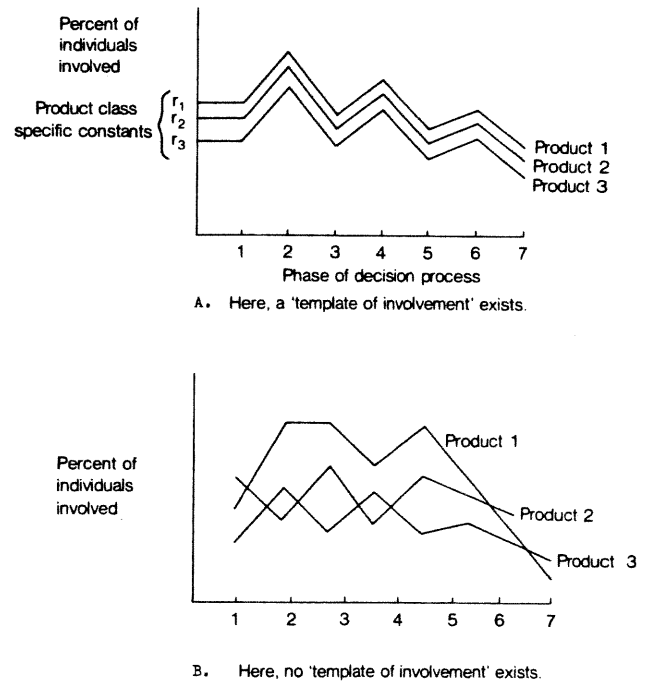
- Phase 1. Measurement of aggregate involvement* in the decision process. We seek to describe, on an overall basis for each product, the likelihood that an individual job category will be represented in the decision process.
- Phase 2. Identification of product groups.* We group products that have similar decision-making structure in the aggregate and try to describe the dimensions of the differences between the groups.
- Phase 3. Analysis of aggregate involvement.* On an aggregate basis, we consider the relationship between purchase influence, job category, decision phase, and product group.
- Phase 4. Analysis of individual involvement.* We study how an individual's involvement in the decision process relates to process phase, size of firm, job category, and product category.

In the following analysis we consider several conjectures derived from the literature cited in preceding sections.

Conjecture 1. The inclusion of "administration" as a secondary job function implies possible involvement in many buying center roles (Webster and Wind 1972, p. 77-80). We conjecture that administration as a secondary job function will be associated with greater involvement in all stages of the decision process.

The second conjecture is based on the concept of a "template of involvement." We say that a template of decision process involvement exists for a given job cat-

Figure 1
THE CONCEPT OF "TEMPLATE OF INVOLVEMENT"



egory, *i*, if the likelihood of purchase-process involvement can be decomposed as follows.

$$p_{ijk} = q_{ij} + r_k$$

where:

- p_{ijk} = probability that job category *i* is involved in purchase decision phase *j* for product type *k*,
- r_k = product-class-specific constant, and
- q_{ij} = "template" of involvement.

Intuitively, the idea of template of involvement is as

Table 4
DECISION MATRIX FOR FERROUS METALS

Decision phase	Job category							
	Corporate management		Production		Engineering		Purchasing	
	No adm.	Adm.	No adm.	Adm.	No adm.	Adm.	No adm.	Adm.
Initial	0.03	0.18	0.20	0.22	0.35	0.35	0.38	0.47
Determine type	0.07	0.23 ^a	0.28	0.28	0.55	0.62	0.21	0.28
Draw up specs	0.03	0.13	0.17	0.19	0.49	0.60	0.12	0.13
Evaluate source	0.12	0.42	0.26	0.36	0.37	0.43	0.56	0.64
Select supplier	0.06	0.39	0.20	0.31	0.34	0.28	0.55	0.60
Determine amount	0.10	0.42	0.23	0.35	0.31	0.32	0.38	0.51
Final authority	0.12	0.42	0.21	0.35	0.24	0.31	0.52	0.55

^aRead: 23% of corporate managers with administrative responsibilities reported involvement in the "determine type" phase of the decision process for ferrous metals. (See Lilien and Wong 1981 for a complete set of decision matrices.)

sketched in Figure 1. In Figure 1A, a template of involvement is present; for each product category, a pattern seems to hold that moves up and down with the product category. In Figure 1B, no pattern is present; the level of involvement goes up at times for one product while going down for another. (Note that the template concept is akin to profile parallelism in multiple profile analysis; Morrison 1976).

Conjecture 2. We conjecture that each job category will have a template of involvement defined across phases of the decision process and that the template will shift up and down depending on product group.

Conjecture 3. The smaller the firm, the higher we expect to find the level of everyone's involvement in the decision process, especially top management's. (This is a corollary of procurement centralization as described by Corey 1978 and is hypothesized specifically by Sheth 1973.)

We also expect the data to show some other results of lesser importance. We continue to label these notions "conjectures" for reference in the analysis.

Conjecture 4. There will be groupings of products that have similar decision-making processes. These groupings should be explainable by two product dimensions, product complexity and commercial uncertainty.

Conjecture 5. Users will be involved earlier in the process and general managers/administrators will be involved later in the process.

Analysis Phase 1. Measurement of Aggregate Decision-Process Involvement

Our objective is to determine, for each product category, job category, and decision phase, the fraction of individuals who say they are involved in the decision process. We summarized the data in a set of decision matrices, giving the fraction of individuals reporting involvement by product type, job category, and decision phase. A total of 16 decision matrices were constructed, one for each product category. Table 4 is an example. We see that 23% of corporate managers (with administrative duties) in the *Iron Age* sample claim they are involved in "determining the type to be purchased" in purchasing ferrous metals.

Figure 2
SAMPLE GRAPHIC REPRESENTATION OF TWO DECISION MATRICES

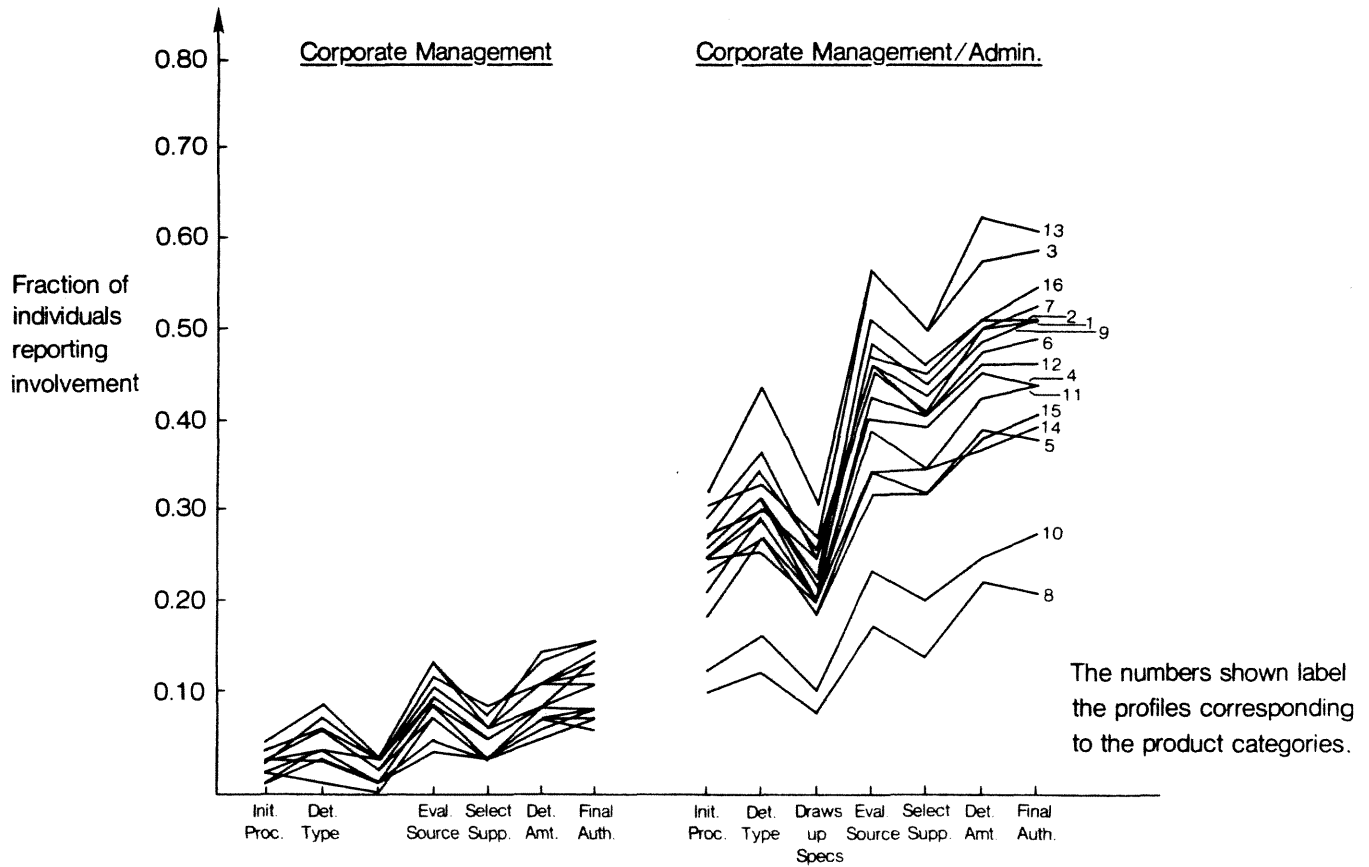


Table 5
KEY DECISION-PROCESS INFLUENCES BY DECISION PHASE

Decision phase	Prime influence	Secondary influence
1. Initial	Engineering	Purchasing
2. Determine type	Engineering	Production
3. Draw up specs	Engineering	Production
4. Evaluate sources	Purchasing	Production
5. Select supplier	Purchasing	Corporate management
6. Determine amount	Corporate management	Purchasing and production
7. Final authority	Corporate management	Purchasing

Johnston (1981) and Grashof and Thomas (1976) raised the question of exaggeration (reporting bias) of individuals' involvement in all stages of the process. One can imagine that the variation in the data in the decision matrices is an artifact of this overstatement. If so, the most likely result would be that a given fraction of the population, say p , that is not involved reports involvement in each decision phase. Thus, we might imagine that all of the figures are inflated artificially by that proportion, p .

The only direct way of measuring such bias at the individual level is to compare self-reported involvement with a report by other members of the firm, which was not possible in our study. On an overall basis, the constant term in the analysis of variance described subsequently should give an indication of this effect. That estimate (2.1%, Table 7) suggests the contamination may not be large. Recognizing the problem of bias, however, we focus our attention in the following discussion on the relative level of decision-process involvement rather than the (potentially biased) absolute level.

To cross-validate the decision-matrix entries, we randomly separated the 1462 respondents into two subgroups and computed 16 pairs of decision matrices, each with 731 respondents. Correlation coefficients between elements in each pair of these decision matrices ranged from .85 to .93. Average absolute deviations between ele-

ments in these paired matrices ranged from .024 to .043 or from one third to one seventh of the level of variation across full matrices.

One way to summarize the information in each of the decision matrices is in the form of a linear profile, which illustrates the concept of "template of involvement." Figure 2 is a linear profile for corporate managers with and without administrative responsibility. To read it, consider the point in the northeast corner of Figure 2; this indicates that for product 13 (materials handling equipment) 52% of corporate managers with administrative responsibility are involved in final purchase authorization. (See Lilien and Wong 1981 for a more nearly complete set of profile plots.)

Though we do not show profiles for other products because of space limitations, we can make the following observations.

- Observation 1.* For job categories with the same primary job function, the templates are apparently similar and there appears to be a consistent (and nearly constant) upward step in level of involvement whenever "administrative duties" is added as a secondary job function. This observation is generally consistent with conjecture 1.
- Observation 2.* For each job category there is a template for the level of involvement across the

Table 6
SOURCES OF VARIATION IN ANALYSIS OF VARIANCE OF DECISION-PROCESS STRUCTURE

Source of variation	Sums of squares	Degrees of freedom	Mean square	F-ratio
1. Product group	2.630	4	0.6575	306.96 ^a
2. Decision phase	1.580	6	0.2633	122.92 ^a
3. Job category	3.240	3	1.0800	504.20 ^a
4. Adm. vs. nonadm.	2.888	1	2.8880	1348.28 ^a
5. Product group × decision phase	0.084	24	0.0035	1.63
6. Product group × job category	1.135	12	0.0946	44.16 ^a
7. Decision phase × job category	3.690	18	0.2050	95.71 ^a
8. Job category × adm. vs. nonadm.	1.518	3	0.5060	236.23 ^a
9. Residuals	1.765	824	0.0021	
Total	18.530	895 ^b		
$R^2 = 0.905$				

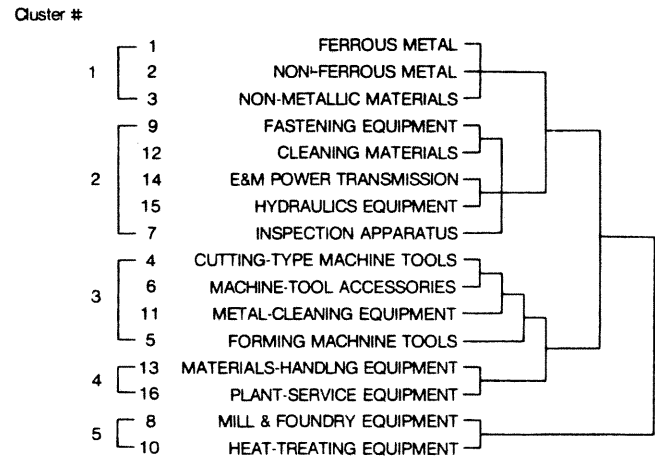
^aSignificant at .05 level.

^bNote that 16 decision matrices (like Table 4), each 8 × 7, yield 56 × 16 or 896 data elements, giving 895 degrees of freedom.

Table 7
ANOVA PARAMETER ESTIMATES

Parameter	Estimate	S.E.
<i>Main effects</i>		
INT	0.021	0.013
A(2)	-0.031	0.015
A(3)	-0.023	0.014
A(4)	0.025	0.018
A(5)	-0.095	0.018
B(2)	0.039	0.018
B(3)	-0.0097	0.017
B(4)	0.13	0.017
B(5)	0.076	0.017
B(6)	0.12	0.017
B(7)	0.14	0.017
C(2)	0.14	0.015
C(3)	0.36	0.015
C(4)	0.35	0.015
D(2)	0.24	0.0062
<i>Interaction effects</i>		
A(2).B(2)	-0.011	0.018
A(2).B(3)	-0.011	0.018
A(2).B(4)	-0.031	0.018
A(2).B(5)	-0.0088	0.018
A(2).B(6)	0.0024	0.018
A(2).B(7)	-0.016	0.018
A(3).B(2)	-0.0014	0.017
A(3).B(3)	-0.0037	0.017
A(3).B(4)	-0.030	0.017
A(3).B(5)	-0.0083	0.017
A(3).B(6)	-0.0052	0.017
A(3).B(7)	-0.028	0.017
A(4).B(2)	-0.015	0.021
A(4).B(3)	-0.035	0.021
A(4).B(4)	-0.022	0.021
A(4).B(5)	0.005	0.021
A(4).B(6)	0.017	0.021
A(4).B(7)	-0.0046	0.021
A(5).B(2)	-0.014	0.021
A(5).B(3)	0.021	0.021
A(5).B(4)	-0.06	0.021
A(5).B(5)	-0.036	0.021
A(5).B(6)	-0.015	0.021
A(5).B(7)	-0.03	0.021
A(2).C(2)	0.045	0.013
A(2).C(3)	-0.17	0.013
A(2).C(4)	-0.06	0.013
A(3).C(2)	0.061	0.013
A(3).C(3)	-0.03	0.013
A(3).C(4)	-0.037	0.013
A(4).C(2)	0.056	0.016
A(4).C(3)	-0.18	0.016
A(4).C(4)	-0.014	0.016
A(5).C(2)	0.015	0.016
A(5).C(3)	-0.13	0.016
A(5).C(4)	-0.13	0.016
B(2).C(2)	0.035	0.016
B(2).C(3)	0.076	0.016
B(2).C(4)	-0.14	0.016
B(3).C(2)	-0.036	0.016
B(3).C(3)	0.088	0.016
B(3).C(4)	-0.19	0.016
B(4).C(2)	-0.041	0.016
B(4).C(3)	-0.069	0.016
B(4).C(4)	0.061	0.016
B(5).C(2)	-0.039	0.016
B(5).C(3)	-0.087	0.016
B(5).C(4)	0.095	0.016

Figure 3
PRODUCT CLUSTERS VIA AVERAGE LINKAGE CLUSTERING



seven phases. In other words, the levels of involvement in the various phases follow the same general pattern for all 16 different product categories, separated by a nearly constant amount. This observation is *consistent with conjecture 2*.

Observation 3. For different job functions, the templates are very different, indicating that the influence of the job functions varies among the decision-process phases (observation 5 is one specific illustration).

Observation 4. No consistent pattern of decision-process involvement emerges across the eight job categories.

Observation 5. Users (production and engineering personnel) are more involved in earlier phases of the decision process (determining type and drawing up specifications) whereas purchasing agents and managers are more involved in the later phases (selecting

Table 7 (continued)

Parameter	Estimate	S.E.
<i>Interaction effects (continued)</i>		
B(6).C(2)	-0.047	0.016
B(6).C(3)	-0.13	0.016
B(6).C(4)	-0.079	0.016
B(7).C(2)	-0.098	0.016
B(7).C(3)	-0.19	0.016
B(7).C(4)	-0.023	0.016
C(2).D(2)	-0.12	0.0087
C(3).D(2)	-0.2	0.0087
C(4).D(2)	-0.2	0.0087

Scale parameter taken as 0.021

A = product groups.
B = decision phases.
C = job categories.
D = w or w/o adm. duties.

Table
LOGIT

Variable	Decision					
	Initial		Determine type		Draw up specs	
SIC 34	-.42	(-2.24)	-.28	(-1.53)	-.54	(-2.61)
SIC 35	-.88	(-4.32)	-.73	(-3.74)	-.69	(-3.32)
SIC 36	-.89	(-4.40)	-.60	(-3.09)	-.72	(-3.35)
SIC 37	-.27	(-1.40)	-.37	(-1.90)	-.65	(-2.96)
SIC 38	-.98	(-4.54)	-.74	(-3.68)	-.83	(-3.79)
EMP	-1.19×10^{-4}	(-2.90)	-1.07×10^{-4}	(-2.82)	-1.18×10^{-4}	(-2.26)
Job 1 ^b	-.99	(-3.36)	-.081	(-.33)	-.81	(-2.78)
Job 2	-.14	(-.76)	.16	(.91)	-.42	(-2.19)
Job 3	.12	(.54)	.57	(2.68)	-.065	(-.28)
Job 4	.27	(1.36)	.69	(3.58)	.42	(2.10)
Job 5	.33	(1.048)	1.047	(3.59)	.65	(2.15)
Job 6	.49	(2.26)	-.18	(-.79)	-.74	(-2.79)
Job 7	.70	(2.13)	.23	(.66)	-.52	(-1.25)
Cluster 2	-.57	(-3.11)	-.67	(-3.94)	-.33	(-1.79)
Cluster 3	-.57	(-3.15)	-.92	(-5.16)	-1.093	(-5.21)
Cluster 4	-.64	(-3.47)	-.54	(-3.18)	-.65	(-3.33)
Cluster 5	-1.089	(-5.45)	-1.54	(-7.69)	-1.039	(-4.96)
Log likelihood	-752		-802		-669	
U ²	.257		.207		.339	

Number of attributes 17, number of observations 1460.

*t-statistics in parentheses.

^bJob 1, corporate manager with administration

Job 2, production

Job 3, production with administration

Job 4, engineering

Job 5, engineering with administration

Job 6, purchasing

Job 7, purchasing with administration

supplier and determining amount). This observation is consistent with conjecture 5.

Table 5 summarizes level of influence by job category across all products.

Analysis Phase 2. Identification of Product Groups

Our objective is to cluster product categories that have similar decision matrices. The grouping is done by agglomerative or hierarchical cluster analysis (Hartigan 1975). All elements in the matrix are proportions and, hence, range only from zero to one. The problem of scaling, which is important in cluster analysis, therefore does not arise. Under these circumstances, the choice of dissimilarity measure is likely to affect the grouping marginally at most. As a dissimilarity measure between pairs of product categories we used the Euclidean distance between selected¹ entries in the corresponding pairs of decision matrices.

¹Only the following entries in the decision matrix were used to compute dissimilarities between product categories. These entries are the ones in which the decision participants belonging to the job category

The results of several clustering algorithms were compared (Everitt 1974) and the results were found to be consistent. Figure 3 is the dendrogram from the average

are most heavily involved. This yields a distance metric that most closely reflects the variation in the key decision phases:

Job category	Decision phase
1. Corporate management (with adm.)	× Evaluate source of supply
2. Corporate management (with adm.)	× Select specific supplier
3. Corporate management (with adm.)	× Determine amount
4. Corporate management (with adm.)	× Final authorization
5. Production (no adm.)	× Determine type
6. Production (no adm.)	× Determine amount
7. Production (with adm.)	× Determine type
8. Production (with adm.)	× Determine amount
9. Engineering (no adm.)	× Determine type
10. Engineering (no adm.)	× Draw up detailed specs
11. Engineering (with adm.)	× Determine type
12. Engineering (with adm.)	× Draw up detailed specs
13. Purchasing (no adm.)	× Evaluate source of supply
14. Purchasing (no adm.)	× Select supplier
15. Purchasing (no adm.)	× Determine amount
16. Purchasing (no adm.)	× Final authorization
17. Purchasing (with adm.)	× Evaluate source of supply
18. Purchasing (with adm.)	× Select supplier
19. Purchasing (with adm.)	× Determine amount
20. Purchasing (with adm.)	× Final authorization

8 ANALYSIS RESULTS

<i>process phase^a</i>							
<i>Evaluate source</i>		<i>Select supplier</i>		<i>Determine amount</i>		<i>Final authorization</i>	
-.47	(-2.58)	-.71	(-3.68)	-.42	(-2.25)	-.33	(-1.73)
-.58	(-3.14)	-.54	(-2.88)	-.53	(-2.84)	-.41	(-2.16)
-.94	(-4.82)	-.66	(-3.46)	-.61	(-3.21)	-.58	(-2.98)
-.31	(-1.63)	-.46	(-2.35)	-.27	(-1.43)	-.44	(-2.19)
-.65	(-3.33)	-.87	(-4.22)	-.62	(-3.14)	-.32	(-1.64)
-0.79×10^{-4}	(-2.23)	-1.02×10^{-4}	(-2.86)	-0.51×10^{-4}	(-1.60)	-0.99×10^{-4}	(-2.71)
.39	(1.72)	.17	(.72)	.18	(.78)	.23	(.99)
.037	(.21)	-.34	(-1.86)	-.43	(-2.45)	-.38	(-2.15)
.63	(3.087)	.47	(2.20)	.35	(1.70)	.37	(1.75)
.30	(1.54)	.27	(1.37)	-.14	(-.70)	-.30	(-1.46)
.24	(.78)	.22	(.73)	.31	(1.0804)	-.39	(-1.19)
1.23	(6.024)	1.21	(5.90)	.23	(1.15)	.68	(3.35)
1.12	(3.51)	1.17	(3.64)	.65	(2.059)	.69	(2.14)
-.58	(-3.47)	-.53	(-3.07)	-.29	(-1.74)	-.45	(-2.67)
-.76	(-4.40)	-.93	(-5.065)	-.88	(-4.90)	-.88	(-4.85)
-.77	(-4.53)	-.31	(-1.83)	-.31	(-1.83)	-.40	(-2.35)
-1.31	(-6.98)	-1.25	(-6.49)	-1.062	(-5.75)	-1.36	(-6.87)
-836		-797		-826		-795	
.174		.213		.184		.214	

linkage clustering procedure (Hartigan 1975, p. 220 ff.).

We now can address the question of whether there are product characteristics that lead to these differences in decision structures within buying organizations. To investigate this issue, we asked the manager in charge of product classification at *Iron Age* to evaluate each of the 16 products listed in Table 1 on 10 scales, as suggested by Fisher (1969). The results of that exercise (Lilien and Wong 1981) suggested that a single underlying dimension called "product complexity" could explain the differences between the product groupings. This finding indicated a continuum from complex purchasing (new task) to a more routine purchase (straight rebuy), closely akin to Robinson and Faris' (1967) and Brand's (1972) conceptualization. Work with a more tightly defined set of products and with more than one evaluator is needed to clarify the resulting dimension and to test the dimensionality of the underlying space.

Analysis Phase 3. Analysis of Aggregate Involvement

To test the adequacy of a linear model to relate aggregate level of involvement to product group, decision phase, and job category, we use a four-factor linear model with interaction.

$$(1) \quad \begin{aligned} \text{Level of involvement} &= \mu + P_i + D_j + C_k + A \\ &+ P_i D_j + P_i C_k + D_j C_k \\ &+ C_k A + \text{error} \end{aligned}$$

where:

- P_i ($i = 1, \dots, 5$) are product groups,
- D_j ($j = 1, \dots, 7$) are decision phases,
- C_k ($k = 1, \dots, 4$) are job categories, and
- A ($= 1, 2$) are inclusion/exclusion of administrative duties.

The analytical approach is to use four-way analysis of variance to test the significance of the various terms in the model. Table 6 reports the details.

Several observations should be made.

Observation 6. The significant difference between product groups is expected as the groupings are obtained by a clustering method and the F -ratio is artificially inflated.

Observation 7. The significance of all other terms in the model is *not* due to the clustering process and is important to note (as all but one are significant).

Observation 8. The cross-product term is nonsignificant which reflects the presence of a template of decision-process involvement across the decision phases. *This finding is consistent with conjecture 2.*

Observation 9. The level of fit ($R^2 = .905$) is good and indicates that the model fits these data well.

Parameter estimates for the main and interaction effects, with their standard errors, are included in Table 7.

Note the following additional observations.

Observation 10. The inclusion of administrative duties adds .24 (coefficient $D(2)$, Table 7) to the level of involvement (*conjecture 1*).

Observation 11. The interaction term is *consistent with conjecture 5* (users involved early, purchasing agents and managers later). This finding can be translated into observing B-C interactions:

Hypothesized (-)	Sign of interaction coefficient	Actual significant coefficients of same sign as hypothesized
$C(2 \text{ or } 3) \times B(5 \text{ or } 6 \text{ or } 7)$ $C(4) \times B(2 \text{ or } 3)$		8 of 8
Hypothesized (+)		
$C(2 \text{ or } 3) \times B(2 \text{ or } 3)$ $C(4) \times B(5 \text{ or } 6 \text{ or } 7)$		3 of 4

Eleven of 12 significant interaction terms correspond to conjecture 5.

Analysis Phase 4. Analysis of Individual Involvement by Decision Phase

We examine decision-process involvement on a decision phase by decision phase basis. We perform this analysis to incorporate firm-level variables (size of firm, in particular) whose effects are obscured by aggregation over individuals. We use logit analysis and develop a different model for each phase of the decision process.

$$(2) \quad Y_h = \frac{1}{1 + e^{-f(x)}}$$

where $f(x)$ is a linear combination of the independent variables and Y_h is the probability that an individual with the characteristics given by the independent variables will state that he/she is involved in purchase decision phase h , $h = 1, \dots, 7$ (only involved/not involved, 0-1, is observed and an MLE procedure is used).

The independent variables are SIC code, number of employees, job category, and product category. In performing the logit analysis, we used each individual only once; data from the first respondent were used for product group K (K chosen at random), data from the second respondent for product $K + 1$, and so on (recycling to product 1 after product group 5). Table 8 reports the logit model results.

The logit model results are good. All likelihood ratio statistics are significant at the .001 level and most coefficients are significant. The results are consistent with our preceding observations; there appear to be differences by SIC code, job category, product category, and decision phase in the involvement of an individual in the purchasing decision process. In addition, we note one more observation.

Observation 12. The coefficient of EMP (number of employees) is negative in all cases, suggesting that as firm size increases, likelihood of decision-process involvement decreases (*conjecture 3*).

EVALUATION AND CONCLUSION

The analyses and results must be kept in the perspective of exploratory research with an existing data set. Our objective was to determine whether identifiable patterns of purchase-process involvement are present across a range of industrial product markets. The data from the *Iron Age* study provided an opportunity for such an investigation.

We were able to establish that such models could be built. We also were able to provide descriptive information about the structure of the buying center and to evaluate and largely support a series of conjectures about buying center structure found in the organizational buying literature. Like most studies using data collected for other purposes, our study has a series of limitations.

A good next step might be to combine the breadth of our study with the depth possible with specific product markets, using convergent measurement procedures with multiple respondents in the same firm. A series of such single-company buying-influence studies would provide a great depth of product/market-specific information. If such studies were both comparably designed and pooled for cross-product analyses later, considerable additional important knowledge would be available about the structure of the organizational buying process.

REFERENCES

- Bonoma, T. V., G. Zaltman, and W. Johnston (1977), *Industrial Buying Behavior*, Marketing Science Institute Report 77-117 (December).
- Bradley, M. F. (1977), "Buying Behavior in Ireland's Public Sector," *Industrial Marketing Management*, 6 (August), 251-8.
- Brand, Gordon T. (1972), *The Industrial Buying Decision*. New York: John Wiley & Sons, Inc.
- Buckner, Hugh. (1967), *How British Industry Buys*. London: Hutchinson & Co.
- Choffray, Jean-Marie and Gary L. Lilien (1980), *Market Planning for New Industrial Products*. New York: John Wiley & Sons, Inc.
- Corey, Lawrence G. (1971), "People Who Claim to be Opinion Leaders: Identifying Their Characteristics by Self Report," *Journal of Marketing*, 35 (October), 48-53.
- Corey, Raymond (1978), *The Organizational Context of Industrial Buying Behavior*. Cambridge, MA: Marketing Science Institute.

- Everitt, B. S. (1974), *Cluster Analysis*. London: Halsted Press.
- Fisher, L. (1969), *Industrial Marketing*. London: Business Books.
- Grashof, John F. and Gloria P. Thomas (1976), "Industrial Buying Center Responsibilities: Self Versus Other Members' Evaluation of Importance," in *Marketing: 1776-1976 and Beyond*, K. L. Bernhardt, ed. Chicago: American Marketing Association.
- Harding, Murray (1966), "Who Really Makes the Purchasing Decision," *Industrial Marketing*, 51 (September), 76-81.
- Hartigan, John A. (1975), *Clustering Algorithms*. New York: John Wiley & Sons, Inc.
- Johnston, Wesley J. (1981), "Industrial Buying Behavior: A State of the Art Review," in *Review of Marketing 1981*, B. Enis and K. Roering, eds. Chicago: American Marketing Association, 75-88.
- Kelley, Patrick J. (1974), "Functions Performed in Industrial Purchasing Decision with Implications for Marketing Strategy," *Journal of Business Research*, 2 (October), 421-34.
- Lilien, Gary L. and M. Anthony Wong (1981), "Modeling the Structure of the Buying Center: Some Empirical Results," Penn State Working Series in Marketing Research, No. 115 (August).
- Moriarty, Rowland T. (1982), *Industrial Buying Behavior*. Lexington, MA: D. C. Heath.
- Morrison, Donald F. (1976), *Multivariate Statistical Methods*, 2nd ed. New York: McGraw-Hill Book Company.
- Oldach, William H. (1978), "How Metalworking Buys III: A Study of Executives in Metalworking Industries," produced for *Iron Age* (June).
- O'Rourke, Mary, James M. Shea, and William Sulley (1973), "Survey Shows Need for Increased Sales Calls, Advertising and Updated Mailing Lists to Reach Buying Influences," *Industrial Marketing*, 58 (April).
- Ozanne, Urban B. and Gilbert A. Churchill (1971), "Five Dimensions of the Industrial Adoption Process," *Journal of Marketing Research*, 8 (August), 322-8.
- Patchen, Martin (1963), "Alternative Questionnaire Approaches to Measurement of Influence in Organizations," *The American Journal of Sociology*, 69 (July), 41-52.
- Purchasing Magazine* (1965), "Purchasing Magazine Readers Have Something to Tell You About Chemicals," Report No. 10A. New York: Purchasing Magazine.
- Robinson, Patrick J. and Charles W. Faris (1967), *Industrial Buying and Creative Marketing*. Boston: Allyn and Bacon.
- Scientific American* (1970), *How Industry Buys/1970*. New York: Scientific American.
- Sheth, Jagdish N. (1973), "A Model of Industrial Buyer Behavior," *Journal of Marketing*, 37 (October), 50-6.
- Silk, Alvin J. and Manohar U. Kalwani (1982), "Measuring Influence in Organizational Purchase Decisions," *Journal of Marketing Research*, 19 (May), 165-81.
- Spekman, Robert E. and Louis W. Stern (1979), "Environmental Uncertainty and Buying Group Structure: An Empirical Investigation," *Journal of Marketing*, 43 (Spring), 54-64.
- Webster, Frederick E., Jr. and Yoram Wind (1972), *Organizational Buying Behavior*. New York: Prentice-Hall, Inc.
- Wind, Yoram (1970), "Industrial Source Loyalty," *Journal of Marketing Research*, 7 (November), 45-57.
- (1978), "Organizational Buying Behavior," in *Review of Marketing 1978*, G. Zaltman and T. Bonoma, eds. Chicago: American Marketing Association, 160-93.