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科技改變、競爭、組織規模對管理會計組成問題之影響：以美國製造業公司爲證

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摘要

科技的改變嚴重地影響到製造業營運的本質。同時，貿易障礙的解除（如：歐洲共同體、北美自由貿易協定）更增加了全球市場的競爭。爲確保管理會計系統能夠幫助管理者有效地面對環境改變的挑戰，因而了解科技改變及競爭之如何影響管理會計問題是很重要的。本研究乃在探討上述關係的本質，主要目的並非在於發展改進式的管理會計系統，而是提供在這個新環境中，如何努力俾能增進管理會計的有效性。

本研究調查了美國56家高、低科技的製造業公司，研究結果包括三項。第一、科技改變及競爭環境交互影響了企業所面對的管理會計組成問題。第二、兩個主要的組織特性一資本密集與規模，並非獨立地影響著管理會計之問題。第三、在管理會計程序中，各問題之大小具有顯著性的差異，其中最大的問題在於營業預算及經營績效的衡量與評價。上述發現，引申出未來有關改善管理會計有效性的研究必須將焦點放在科技改變及競爭的情況，及管理會計程序的選擇上。

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Technological Change, Competition, Organizational Size and the Mix of Management Accounting Problems: Evidence from U.S. Manufacturing Firms

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Abstract

Technological change is dramatically affecting the nature of manufacturing operations. At the same time, the dismantling of trade barriers (e.g., European Community, North America Free Trade Agreement) is increasing the competitiveness of global markets. To ensure that management accounting systems can assist managers to meet effectively the challenges of this changing environment, it is important to understand how technological change and competition affect the mix of management accounting problems. This study explores the nature of this relationship. The objective is not the development of improved management accounting

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systems, per se. Rather, it is to provide a basis for identifying research topics and developmental efforts most likely to enhance management accounting effectiveness in this new era.

A survey of 56 U.S. manufacturing firms in high tech. and low tech. industries yielded three major results. First, technological change and competition interacted to affect the mix of management accounting problems encountered by firms. Second, capital intensity and size, two key organizational characteristics, did not independently affect management accounting problems. Third, problem size differed significantly across management accounting processes. The two largest problem areas were operating budgeting, and measuring and evaluating operating performance. These findings suggest that future research to improve management accounting system effectiveness does need to focus on the effects of technological change and competition and to be selective with respect to management accounting processes.

1. Introduction

In recent years, the scope of available manufacturing technologies has expanded greatly. The development of new technology fields has profoundly affected both the nature of, and markets for, the inputs and outputs of many manufacturing firms. In addition, the nature of production processes — the transformation of inputs into outputs — is undergoing rapid change. Manufacturing firms can now be more capital intensive as they automate their production processes (e.g., computer integrated manufacturing, flexible manufacturing, robotics, and programmable machines) (Ettlie, 1988; Hayes, Wheelwright and Clark, 1988). These technological advances have raised concerns that traditional management accounting practices may no longer be adequate to serve management (Berliner and Brimson, 1988; Cooper and Kaplan, 1991; Gosse, 1993; Kaplan, 1983, 1984).

Empirical research has investigated the effects of technology on management accounting systems (Brownell and Merchant, 1990; Bruns and Waterhouse, 1975; Jones, 1985a, 1985b; Merchant, 1984; Rockness and Shields, 1984). However, this literature has focused on how technology affects the perceived use or importance of management accounting systems — particularly budgets — by managers. It has not addressed how technological change affects the mix and magnitudes of firms' management accounting problems. As such, the extant literature is insufficient to indicate where further research and developmental efforts are most likely to enhance management accounting system effectiveness. This study aims to fill in this gap by exploring empirically the effects of technological change and competition on the composition of management accounting problems faced by manufacturing firms. The effects of organization size are also considered.

The rest of this paper is organized as follows. First, a framework is provided for this analysis by presenting a taxonomy of management accounting processes and activities and a definition of a problem. Then the literature on technological change, competition and organizational size is reviewed, followed by a discussion of how these factors may affect management accounting problems. The survey and results are reported next. The paper ends with a discussion and summary.

2. Literature Review

A Taxonomy of Management Accounting Processes and Activities

Since the aim of this study is to cover the spectrum of management accounting problems, we constructed a taxonomy of management accounting areas and their component activities based on common characterizations of the management process. The latter is often represented as having two dimensions: time frame and management activity. The former usually is dichotomized between short- and long-run, while the latter is considered to encompass planning, coordinating, communicating and controlling (including monitoring, evaluating and rewarding) (Flamholtz, Das and Tsui, 1985; Rockness and Shields, 1984, 1988). Using this two-dimensional structure, we developed eight management accounting process areas:

I. Designing cost accumulation systems
II. Estimating costs
III. Annual operating budgeting
IV. Capital budgeting
V. Measuring and evaluating operating performance
VI. Controlling capital projects
VII. Transfer pricing
VIII. Implementing accounting information systems

We disaggregated each area into design and implementation activities. The result is a taxonomy of eight management accounting areas containing 37 specific activities (Table 1).

Definition of A Problem

Prior organizational research on management accounting and control has focused on either the perceived importance or frequency of use of such systems or their subsystems (Khandwalla, 1972; Bruns and Waterhouse, 1975; Merchant, 1981, 1984; Gordon and Narayanan, 1984; Rockness and Shields, 1984, 1988; Chenhall and Morris, 1986; Brownell and Merchant, 1990). We maintain that these two foci provide incomplete measures of the magnitude of a management accounting problem. To be a problem, an activity must have positive values on three dimensions: importance, frequency and difficulty. For example, a difficult management accounting activity would not be a problem if it never occurs. Thus, we treat problem size as a multiplicative function of importance, frequency and difficulty.

Cross-sectional Variation in Management Accounting Systems

Following prior organizational research which is based on the contingency theory of organizations, management accounting problems are

TABLE 1

DESCRIPTIVE STATISTICS FOR PROBLEM SIZE*

	AREA ACTIVITY	PROBLEM $\bar{X}$	SIZE S	ACTIVITY RANK	AREA RANK
I	DESIGNING COST ACCUMULATION SYSTEMS	166.04	116.16		6
	1. Select cost accumulation systems	139.02	181.02	23	
	2. Use cost accumulation systems	416.50	285.89	1	
	3. Decide number of cost centers	136.68	148.05	25	
	4. Select methods to allocate indirect costs to cost centers	163.04	152.36	18	
	5. Select bases to allocate indirect costs to cost centers	123.13	134.59	28	
	6. Select level of aggregation to allocate overhead costs to products	122.41	144.28	29	
	7. Select bases to allocate overhead to products	130.21	155.93	26	
	8. Select methods to allocate joint costs	97.30	134.78	33	
II	ESTIMATING COSTS	183.54	148.38		4
	9. Select methods to estimate cost behavior	138.34	159.47	24	
	10. Apply methods to estimate cost behavior	187.32	190.72	16	
	11. Account for effects of changes in technology, efficiency and prices	224.96	201.00	13	
III	ANNUAL OPERATING BUDGETING	303.01	187.42		1
	12. Administer budget process, procedures, and time frame	259.70	193.93	8	
	13. Estimate budgeted revenues	396.14	287.13	2	
	14. Estimate budgeted costs and expenses	292.82	200.96	5	
	15. Coordinate and review budgets from subunits of firm	263.38	204.12	7	

(continued on next page)

IV	CAPITAL BUDGETING	168.59	146.37		5
	16. Administer capital budgeting process, procedures, and time frame	155.73	141.56	19	
	17. Estimate economic lives of projects	114.79	134.82	31	
	18. Estimate cash inflow time patterns	241.52	254.94	10	
	19. Estimate cash outflow time patterns	214.54	235.79	14	
	20. Coordinate and review capital budgets from subunits of firm	116.36	113.88	30	
V	MEASURING AND EVALUATING OPERATING PERFORMANCE	282.13	226.58		2
	21. Select aspects of managerial performance to measure	271.77	250.80	6	
	22. Measure managerial performance	314.05	256.16	3	
	23. Measure effects of non-controllables on performance	235.25	258.30	12	
	24. Interpret managerial performance	307.46	262.62	4	
VI	CONTROLLING CAPITAL PROJECTS	97.08	118.36		8
	25. Select projects for individual monitoring during implementation	91.36	115.56	34	
	26. Select methods to monitor implementation of capital projects	107.02	136.07	32	
	27. Apply methods to monitor implementation of capital projects	143.42	180.29	22	
	28. Select projects for individual post-completion review	79.40	119.57	36	
	29. Select methods to perform post-completion review	75.26	128.86	37	
	30. Apply methods to perform post-completion review	86.00	140.63	35	
VII	TRANSFER PRICING	139.12	162.83		7
	31. Select methods to set transfer prices	143.96	191.51	21	
	32. Apply transfer pricing methods	149.69	170.45	20	
	33. Resolve transfer pricing disputes	123.69	210.48	27	

(continued on next page)

VII IMPLEMENTING ACCOUNTING INFORMATION SYSTEMS	218.21	155.13		3
34. Obtain acceptance and use of existing accounting systems	235.77	208.56	11	
35. Identify desirable changes to existing accounting systems	245.54	198.83	9	
36. Obtain top management approval for changes to accounting system	176.67	151.81	17	
37. Obtain cooperation in implementing changes to an accounting system	209.23	198.89	15	

*N ranges from 52 to 56.

Note: X=mean of problem size.
S=standard deviation of problem size.

modeled as functions of technological change and its correlate: capital intensity, competition, and organizational size. The core of the arguments and prior findings related to each variable is reviewed below.

Technological change refers to the rates of change in the nature of, or markets for, inputs, production processes and/or outputs. Prior empirical research has found that the perceived use or importance of management accounting systems is associated with the nature of the firm's technology (Brownell and Merchant, 1990; Bruns and Waterhouse, 1975; Jones, 1985b; Merchant, 1984; Rockness and Shields, 1984). This literature has suggested that as technology becomes more complex or uncertain, problems of communication, planning, coordination and control increase. The result is an increased demand for formal information systems and controls, including management accounting systems.

These prior studies have operationalized technology using a variety of definitions and measurements (Ford and Slocum, 1977; Gerwin, 1981; Hall, 1987; Khandwalla, 1977; Rousseau, 1979). The most commonly used approach is based on Perrow (1967), which represents technology as the process of transforming inputs into outputs. Perrow's (1967) approach is used here. For expositional convenience, consider technological change to have two levels: low and high (more commonly referred to as low tech. and high tech.). Low tech. firms experience slow rates of change in inputs (e.g., rocks), production processes (e.g., rock crushers) and/or outputs (e.g., gravel). In contrast, high tech. firms experience much faster rates of change in inputs (e.g., computer chips), production processes (e.g., robotics) and/or outputs (e.g., computer software and hardware). These differences are expected to affect the relative emphasis on R&D activities and the demands for management accounting information. R&D is expected to be more important for high tech. firms because they face more rapidly evolving markets (e.g., genetically engineered pharmaceuticals) and production processes (e.g., programmable machine tools).

A correlate of technological change is the capital intensity of the production process. *Capital intensity* is defined as the mix of physical resources used to transform inputs into outputs. This mix can range from primarily machine-hased (i.e., a relatively high proportion of fixed assets) to primarily labor-based (i.e., a relatively low proportion of fixed assets). The proportion of fixed assets directly affects the proportion of fixed costs in the cost structure, hence operating leverage.

Competition

Prior empirical research has shown that competition affects the perceived frequency of use or importance of management accounting systems (Khandwalla, 1972; Jones, 1985b). The reason offered for this association is that more intensive competition increases the demand for controls that enhance the efficiency of the organization. In the current era of intensifying global competition, this demand is likely to be increasingly acute (Cooper and Kaplan, 1991; Kaplan, 1984). Hence, competition is included both to specifically assess its effect and to facilitate isolating the unique effect of technological change on management accounting problems.

Organizational Size

Empirical studies have found organizational size to be associated with the perceived use or improtance of the management accounting system (Jones, 1985a; Merchant, 1981, 1984; Rockness and Shields, 1988). Studies in organizational behavior (Hall, 1987; Kimberly, 1976) and economics (Foster, 1986) also have found that it explains variation in both organizational structure (such as accounting and control systems) and performance. As organizational size increases, it becomes more difficult for a firm to communicate and coordinate through the use of social control, such as direct supervision and oral communication. Thus, while a small firm may be adequately managed by social control, managing a large firm may require more formal information and control systems.

Organizational size has been defined and measured in a variety of ways (Kimberly, 1976; Ford and Slocum, 1977; Hall, 1987). This study uses a combination of the three most frequently used measures: total assets, total sales and number of employees.

Technological Change, Competition, Organizational Size and Management Accounting Problems

While the extant literature has supplied reasons for anticipating relationships between (a) the importance and use of management accounting processes and (b) technological change, competition and organizational size, it is insufficiently developed for deriving directional hypotheses about specific effects of these contextual factors on the composition of firms' management accounting problems. Nevertheless, some broad inferences are possible.

Since this study is aimed at exploration, rather than hypothesis testing, only illustrative examples for technological change are presented. Two management accounting areas that technological change probably affects are annual operating budgeting and measuring and evaluating operating performance. As technological change increases, the operating environment becomes more uncertain and the focal time frame may decrease to be a series of short-runs. Accordingly, both annual operating budgeting and measuring and evaluating operating performance are likely to become more important and difficult as well as occur more frequently. All of these would imply a larger problem size.

Another probable impact of technological change is shorter and more uncertain market lives of products and economic lives of manufacturing assets. To the extent that firms focus on a shorter time frame for their capital budgeting decisions, such decisions are likely to be smaller problems. This effect, however, may be counterbalanced by a reduced ability to accurately estimate market and economic lives, such that the net impact of technological change on problem size is indeterminate.

3. Empirical Method

Sample

To control for the effects of geography and local regulatory environment (Foster, 1986), the sample was limited to U.S. manufacturing firms headquartered in California. To ensure that the sample contained variation on the technological change dimension, firms were selected from high tech. and low tech. industries. Following Galbraith (1985) and the Joint Economic Committee (1982) study, high tech. industries were assumed to include these Standard Industrial Classification (SIC) codes: 28 (chemicals), 35 (machine except electrical), 36 (electronics), 37 (transportation), 38 (instruments, controls, optics), 7372-7379 (computers) and 7391 (R&D laboratories). The SIC codes used for low tech. were 20-27 (food processing, textiles, clothes, wood and paper products, furniture, and publishing). Within each industry, all firms with more than 100 employees were identified. Out of these, 400 were randomly selected (200 each of high and low tech.).

The survey instrument was mailed to the corporate controller of each firm. Corporate controllers were selected because of their comprehensive knowledge of all aspects of the management accounting systems in all parts of their firms. Managers were not chosen for two reasons. First, while a manager may know a lot about some management accounting processes (e.g., operating performance measurement), he or she may not know about others if he or she is not directly involved with them (e.g., transfer pricing). Second, a manager may only know about management accounting processes which occur within or nearby his or her scope of operation.

A second mailing was made to all 400 sample firms three weeks later. Twenty five surveys were returned undelivered. Out of the remaining 375, 56 usable responses were received (30 from high tech. and 26 from low tech. firms).

Measures Management Accounting Problems

For each of the 37 management accounting activities, a ten-point scale was used to measure: (1) its importance to the firm's success (1=extremely unimportant; 10=extremely important); (2) the difficulty of conducting the activity successfully (1=extremely easy; 10=extremely difficult); and (3) the frequency with which the activity occurs (1=extremely infrequent; 10=extremely frequent). For each activity, problem size was the multiplicative combination of importance, difficulty and frequency. The theoretical range for this scale was one to 1,000. A measure of problem size was computed for each of the eight processes as the mean of the problem sizes of its component activities. The reliabilities (Cronbach alpha) of these eight scales ranged from 0.73 to 0.93. All were above the minimum value (about 0.50 to 0.60) which indicates that a scale is reliable (Nunnally, 1967).

Technological Change

Technological change was measured by aggregating the responses to four questions:

1. The percentage of total revenues from products introduced within the preceding three years;

2. The average market life (years) of major products;
3. The average expected economic life (years) of the fixed manufacturing assets acquired in the preceding three years; and
4. The percentage of the firm's total annual operating expenses that was for R&D.

The responses to these questions were standardized (i.e., the sample mean was subtracted from each response and the difference was divided by the sample standard deviation). Each response was scaled such that a larger value indicated more technological change. Then the four standardized values were summed. The reliability of this scale (Cronbach alpha) was 0.70.

Capital Intensity

This was measured as the percentage of total assets that was long-term fixed assets used to manufacture the firm's primary products.

Competition

This measure was the response to the question: "How much competition is there in the markets that your firm sells its primary products? " (1=extremely uncompetitive; 10=extremely competitive).

Organizational Size

This was the sum of the standardized values of total assets, total sales and total number of employees. The reliability of this scale (Cronbach alpha) was 0.92.

4. Results

Overview of the Independent Variables

Table 2 provides descriptive statistics for the 56 firms as a whole and separately for the firms classified as high and low tech. For the entire sample, the mean values for the organizational size measures were: sales, US$137,000,000; total assets, US$107,000,000; and number of employees, 1,256. For each of these measures and their standardized aggregate, there was no statistically significant difference between the low and high tech. firms ($ts < 1.00$, $ps > 0.40$). The low tech. firms did have significantly higher mean levels of capital intensity (30.35% vs. 20.23%, $t = 2.31$, $p = 0.03$) as well as competition (8.73 vs. 7.70, $t = 2.21$, $p = 0.03$).

As expected, the firms classified as low and high tech. had significantly different mean values on all four items constituting the technological change scale (Table 2). The high tech. firms had a higher mean percentage of revenues from products introduced within the preceding three years (50.07% vs. 23.22%, $t = 2.98$, $p < 0.01$), shorter average market life of products (5.69 years vs. 23.05 years, $t = 3.99$, $p < 0.01$), shorter average economic life of fixed manufacturing assets acquired within the preceding three years (6.25 years vs. 9.35 years, $t = 3.17$, $p < 0.01$) and spent proportionally more of their operating expenses on R&D (mean = 12.29% vs. 2.65%, $t = 5.01$, $p < 0.01$).

TABLE 2

DESCRIPTIVE STATISTICS

Varibles		Low Technology (n=26)	High Technology (n=30)	All Firms (N=56)
SIZE MEASURES				
Sales (x 1000)	$\overline{X}$	\$110,000	\$161,000	\$137,000
	s	\$172,000	\$354,000	\$283,000
Total Assets (x 1000)	$\overline{X}$	\$ 88,700	\$124,000	\$107,000
	s	\$169,000	\$205,000	\$188,000
Employees	$\overline{X}$	1,100	1,395	1,256
	s	2,161	2,556	2,361
Aggregate (Z)	$\overline{X}$	-0.26	0.23	0.00
	s	2.40	3.14	2.80
CAPITAL INTENSITY	$\overline{X}$	30.35%	20.23%	24.93%
	s	17.86	14.46	16.77
TECHNOLOGICAL CHANGE MEASURES				
% of revenue from products introduced within last three years	$\overline{X}$	23.22%	50.07%	37.96%
	s	29.55	34.75	34.91
Average life of products (years)	$\overline{X}$	23.05	5.69	13.45
	s	19.62	4.05	15.89
Average expected economic life of fixed manufacturing assets acquired in last three years	$\overline{X}$	9.35	6.25	7.74
	s	3.45	3.73	3.89
% of operating expenses for research and development	$\overline{X}$	2.65%	12.29%	7.94%
	s	4.02	9.15	8.70
Aggregate (Z)	$\overline{X}$	-2.31	1.75	0.09
	s	2.41	2.03	2.96
COMPETITION	$\overline{X}$	8.73	7.70	8.18
	s	1.46	2.02	1.84

Table 3 presents an intercorrelation matrix for the independent variables across the 56 firms. The only significant correlation was between technological change and capital intensity (r=-0.41, p < 0.01). Two other correlations were marginally significant; these were between technological change and competition (r=-0.24, p=0.06) and technological change and organizational size (r=0.24, p=0.06).[1]

TABLE 3
PEARSON CORRELATIONS

	Capital Intensity		Competition		Size	
	r	p	r	p	r	p
Technological Change	-0.41	0.003	-0.24	0.06	0.24	0.06
Capital Intensity			0.13	0.17	0.02	0.46
Competition					0.12	0.20

Overview of the Dependent Variable

Spearman rank correlations among importance, frequency and difficulty indicated that problems which were rated as occurring more frequently also were rated as being more important (r=0.88, p<0.01) and more difficult (r=0.86, p<0.01). On the whole, problem size was larger for those management accounting processes which occur more frequently. The eight process areas had the following ordering by problem size:

Annual operating budgeting ($\bar{X}$=303)

Measuring and evaluation operating performance ($\bar{X}$=282)

Implementing accounting information systems ($\bar{X}$=218)

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[1]The signs of these correlations suggest interesting dynamics within and between industries as well as firms. Future studies that explore the nature and causes of these correlations will be worthwhile. Such studies might explore, for example, what factors account for the negative correlation between technological change and capical intensity. One possible finding is that the observed patterns of correlations are specific to this study's sample. This finding still would be worthwhile because it would indicate limitations to the generalizability of this study's findings.

Estimating cost ($\bar{X}=184$)
Capital budgeting ($\bar{X}=169$)
Designing cost accumulation systems ($\bar{X}=166$)
Transfer pricing ($\bar{X}=139$)
Controlling capital projects ($\bar{X}=97$).

Table 4 presents the means and standard deviations of problem size for each management accounting process by cell. (The total numbers of observations do not always equal 56 due to missing data.) There is considerable variation in problem size both across management accounting processes and across levels of capital intensity, competition and technological change. For example, in designing cost accumulation systems, the smallest problem size (106.5) occurs in the high capital intensity/low competition/low technological change combination, while the largest problem size (260.7) is observed in the high capital intensity/high competition/low technological change combination. Across management accounting processes, problem size varies from a low of 12.8 for estimating costs to a high of 416.8 for measuring and evaluating operating performance.

TABLE 4
DESCRIPTIVE STATISTICS FOR MANAGEMENT ACCOUNTING PROCESS PROBLEMS BY CELL

Capital Intensity		Low				High			
Competition		Low		High		Low		High	
Technological Change		Low	High	Low	High	Low	High	Low	High
Areas	N	2	9	6	6	5	4	9	3
Designing Cost Accumulation systems	$\bar{X}$	191.7	141.8	126.1	155.7	106.5	160.1	260.7	151.5
	s	92.4	46.3	109.8	114.6	63.5	57.4	184.9	47.9
Estimating Costs	$\bar{X}$	12.8	215.4	251.2	150.6	141.4	116.3	234.9	125.3
	s	16.7	153.9	168.5	139.8	166.9	45.0	169.6	106.7
Annual Operating Budgeting	$\bar{X}$	254.5	312.3	409.8	345.2	185.8	216.9	264.0	272.6
	s	140.7	118.2	157.0	285.6	76.3	106.8	138.9	41.4
Capital Budgeting	$\bar{X}$	107.3	153.3	227.0	84.7	127.5	121.7	194.5	211.9
	s	26.2	100.2	212.3	165.4	88.0	53.7	131.2	68.3
Measuring and Evaluating Operating Performance	$\bar{X}$	221.3	277.4	321.6	105.1	189.8	203.3	416.8	255.3
	s	207.5	236.9	258.0	95.8	124.5	81.7	344.5	73.9
Controlling Capital Projects	$\bar{X}$	21.6	83.3	123.8	20.3	67.1	81.8	182.0	64.3
	s	19.0	67.5	108.2	38.8	73.7	83.5	153.6	20.2
Transfer Pricing	$\bar{X}$	204.8	96.1	150.1	110.1	150.7	105.3	314.4	29.3
	s	237.8	87.3	136.1	112.3	155.3	119.0	263.6	25.4
Implementing Accounting Information Systems	$\bar{X}$	181.0	133.6	274.2	249.8	133.3	114.4	246.7	130.7
	s	171.1	149.0	129.3	186.2	135.8	16.7	148.0	70.0

Table 5 presents the means and standard deviations for problem size for high vs. low levels of technological change, capital intensity, and competition. This table also reveals substantial variation both across management accounting process areas and within area across the independent variables.

TABLE 5
DESCRIPTIVE STATISTICS FOR MANAGEMENT ACCOUNTING PROCESS PROBLEMS BY MARGINAL

Management Accounting Areas		Technological Change		Capital Intensity		Competition	
		Low	High	Low	High	Low	High
	N	22	22	27	29	26	30
Designing Cost Accumulation systems	$\bar{X}$	182.7	150.3	155.4	176.0	129.8	197.4
	s	148.3	68.5	99.9	130.5	57.8	143.2
Estimating Costs	$\bar{X}$	197.9	167.5	194.0	173.8	144.8	217.1
	s	168.7	129.9	158.9	140.0	135.3	153.2
Annual operating Budgeting	$\bar{X}$	285.1	298.5	363.2	247.0	285.8	318.0
	s	149.5	169.1	207.3	149.6	176.0	198.5
Capital Budgeting	$\bar{X}$	180.2	136.9	169.9	167.4	133.7	198.8
	s	143.8	113.7	180.4	109.0	99.7	173.3
Measuring and Evaluating Operating Performance	$\bar{X}$	321.4	214.0	278.3	285.7	238.6	319.9
	s	273.9	174.4	231.1	226.3	175.3	260.2
Controlling Capital Projects	$\bar{X}$	122.8	63.3	86.5	107.3	74.6	117.2
	s	124.4	62.4	123.7	114.3	82.9	141.4
Transfer Pricing	$\bar{X}$	218.2	94.5	127.1	150.7	98.9	175.1
	s	207.0	93.2	123.2	195.3	115.4	190.8
Implementing Accounting Information Systems	$\bar{X}$	222.2	161.4	238.0	199.1	169.7	258.6
	s	142.7	142.6	175.9	132.6	157.1	143.8

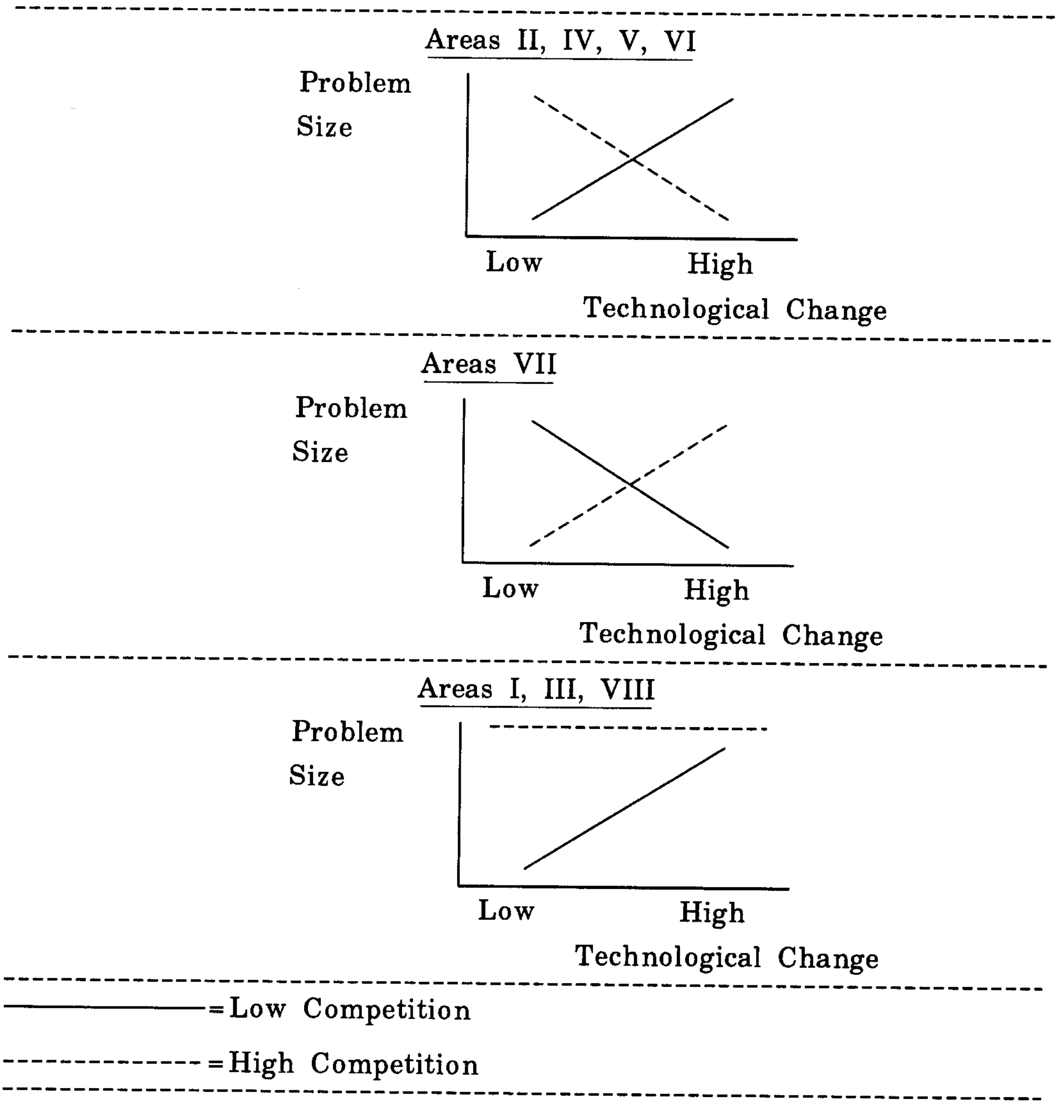
An inspection of Table 1 yielded several additional insights into the sizes and mix of management accounting problems. Table 1 indicated that, of the 17 management accounting activities with a mean problem size greater than or equal to 200, six were for annual operating budgeting, six were for measuring and evaluating operating performance, and three were for implementing accounting information systems. In contrast, of the five activities with a mean problem size of less than 100, three were for controlling capital projects and the other two involved transfer pricing. Descriptively, these results indicated that the two biggest problems were the short-run processes of operating budgeting, and measuring and evaluating operating performance, and the smallest problems were long-run budgeting and control.

Inferential Tests

A $2 \times 2 \times 2 \times 8$ repeated measures multivariate analysis of covariance (MANCOVA) was conducted with organizational size as a covariate. The three between-subjects factors were technological change (low, high), capital intensity (low, high) and competition (low, high). Each independent variable's median value was used to dichotomize the sample. In addition there was an eight-level within-subject variable for the eight management accounting process areas. Statistical significance was defined to be an alpha probability less than or equal to 0.05.

The MANCOVA revealed a significant technological change main effect ($\underline{F}=5.28$, $\underline{p}=0.03$) and a technological change by competition interaction ($\underline{F}=4.49$, $\underline{p}=0.04$). Neither capital intensity nor organizational size was significant ($\underline{p}<0.10$). There was a significant main effect due to management accounting process area ($\underline{F}=6.88$, $\underline{p}<0.01$), but none of the interactions between it and the other independent variables was significant ($\underline{p}<0.10$). Thus, some management accounting areas were bigger problems than others regardless of the organizational characteristics included in this study. Relating to the nature of the technological change by competition interaction, Figure 1 indicates that for four of the management accounting areas, this was of the "X" form (areas II, IV, V, and VI), one (area VII) was of the opposite "X" form, and three (areas I, III, and VIII) were of the "V" form.

Figure 1
Forms of Interactions Between
Technological Change and Competition



5. Discussion and Summary

Technological change and competition are having dramatic impacts on the nature of manufacturing operations. For management accounting systems to help managers meet effectively the challenges of this new environment, it is important to understand the effects of these variables on the composition of firms' management accounting problems. This paper has explored empirically the effects of technological change, competition and a technology correlate – capital intensity – on the management accounting problems experienced by manufacturing firms. Its aim was to identify areas where research and development efforts are most likely to enhance management accounting effectiveness in this era of new technologies.

A sample of U.S. manufacturing firms headquartered in California yielded three major results. First, technological change, both independently and interactively with competition, significantly affected the size of management accounting problems. Second, capital intensity, competition and organizational size did not independently affect management accounting problem size. Third, problem size differed significantly across the eight managemnt accounting areas.

A particularly noteworthy finding is the lack of a significant interaction between management accounting area and the technology and competition variables. Within the sample of firms studied, certain management accounting areas were consistently bigger problems regardless of a firm's technological change or degree of competition. The short-run activities were bigger problems, particularly operating budgeting and measuring and evaluating operating performance. This finding suggests that while future research and developmental efforts to improve management accounting system effectiveness should consider both the effects of technological change and competition, it also should be selective with respect to management accounting process. Future research also should explore whether the relatively larger problem sizes for the more frequently occurring processes are due to management paying attention to what is currently happening (e.g., "putting out brush fires"), or such processes being inherently more of a problem. For example, it could be that this time-frame effect is induced by the nature of firm's compensation and promotion policies.

It is important to note that the current study was conducted in the U.S. which, when compared to most Asian countries, has relatively well-developed management accounting systems for use in manufacturing firms which pursue technology-intensive competitive strategies. There is need for research to examine how the management accounting problems confronting firms in many Asian countries differ from those in the U.S., and how these problems are changing as these firms move towards technology-intensive manufacturing strategies.

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