ADVANCES IN MANAGEMENT ACCOUNTING

VOLUME 11

MARC J. EPSTEIN
JOHN Y. LEE
Editors

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Advances in Management Accounting is to be an annual publication of quality applied research in management accounting. The series will examine areas of management accounting, including performance evaluation systems, accounting for product costs, behavioral impacts on management accounting, and innovations in management accounting. Management accounting includes all systems designed to provide information for management decision-making. Research methods will include survey research, field tests, corporate case studies, and modelling. Some speculative articles and survey pieces will be included where appropriate.

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INTRODUCTION

This volume of *Advances in Management Accounting* begins with an article by C. J. McNair, Lidija Polutnik, Holly H. Johnston, Jason Augustyn and Charles R. Thomas on shifting perspectives involving accounting, visibility, and management action. The article attempts to determine whether or not the accounting abstraction appears to dominate the manager's perceptions of the physical reality of the firm's utilization of its physical assets. The article then looks at whether changes in the accounting abstraction (e.g. the addition of capacity cost management reports and measurements) lead to changes in how managers perceive and use their physical assets. Using a cognitive decision-making structure developed by Wagenaar et al. (1995), this study explores the interplay between the structure and nature of capacity reporting (the surface structure of the decision) and the subsequent analysis and choice of managers within the firm (the deep structure of the decision).

A five-site field research methodology was used to gather data from companies across a multitude of industry contexts and situations. Results suggest that the nature of capacity measurement and reporting does shape manager's perceptions of current and potential future performance (the cognitive surface structure), with major implications for the nature and type of decisions and trade-offs made (the deep structure). Specifically, managers appear to make decisions that are illogical when considered in light of the physical reality of their operations based on the representations of this reality (e.g. the capacity measures and reports). The authors conclude that what accounting makes visible appears to drive decision-making and performance in organization.

This volume continues with another article on perspectives. John Y. Lee's study examines the nature of the researchers' perspectives used in analytical and empirical cost system research published in the 1990s in an attempt to better understand current cost system research. The conceptual framework used for the evaluation is based on the research perspectives that have influenced the selection of different approaches in cost system research in the last three decades and reflects assumptions made in the research models and useful empirical implications. The taxonomy used in the article deepens our understanding of current cost accounting research and what a "better" cost system really means.

In the third article, Robert C. Kee looks at operational planning and control involving activity-based costing (ABC). Kee modifies ABC to reflect separate flexible and committed cost driver rates for an activity. This enables the model to reflect the difference in the behaviour of an activity's flexible and committed costs needed for operational planning decisions. The modified ABC facilitates determining the resources required to produce the product mix developed from the firm's strategic plan and the excess capacity that will result. The modifications made to ABC aid in determining an optimal product mix when the firm has excess capacity, while the traditional ABC may not. It facilitates measuring the financial implications of the resource allocation decisions that comprise the firm's operational plan.

The fourth article by Adam S. Maiga and Fred A. Jacobs examines the effects of benchmarking and incentives on organizational performance. Using data collected from manufacturing units, this article reports the results of an investigation into the interactive effect of benchmarking and incentives on manufacturing unit performance. Based on a mail questionnaire sent to a sample of manufacturing units within U.S. electronic industry, the results of this article provide evidence of significant interaction effect of benchmarking and incentives resulting in product cost improvement and product quality performance.

Next, Khim Ling Sim and James A. Carey report on an empirical analysis on organizational control and work team empowerment. They start with the issue of whether most writing on empowerment often fails to recognize that empowerment requires greater control. They investigate the type of control via rewards and punishment systems, which fits best in the context of empowered work teams. They hypothesize that empowerment will lead to improvement in manufacturing performance *only* when rewards are based on group performance, i.e. a situation where the collective benefit of both individual team members and those of the firm are maximized. Using a survey methodology, four compensation types were examined, including fixed pay, fixed plus non-monetary incentives, individual-based incentives, and group-based incentives. Results show that the favorable effect of work team empowerment was not observed under fixed-pay, fixed plus non-monetary incentives, or individual-based incentives. Fixed-pay or individual-based incentives often interact with work team empowerment to produce a negative effect on manufacturing cost, manufacturing lead time, or non-value-added-activities.

In the sixth article, Leslie Kren proposes a more complete model of the process by which budget slack is created in the organization. The research model proposed suggests that there is an *ex-ante* as well as an *ex-post* process by which budget slack is created. In the *ex-ante* process, environmental uncertainty and budget participation are linked to managers' *propensity* to create slack through job-relevant information. In the *ex-post* process, the control system determines the slack in the final budget by providing information to superiors about a manager's performance capability. Thus, the *propensity* to create slack determines *actual* slack to the extent that the organization's control system fails to provide an effective assessment of the manager's performance capability.

Next, Mohamed E. Bayou and Alan Reinstein present a management accounting taxonomy for the mass customization approach. The traditional product-costing continuum is too limited to account for the new mass customization approach currently used by many corporations in many industries. Mass customization has changed the nature of many transactions, activities and, indeed, the very essence of many manufacturing companies, who have become more of assemblers than manufacturers. These new developments necessitate establishing new way of accounting for proper planning and control. After tracing the development of the mass customization approach from modular manufacturing into common platforms applied in one firm, and then shared by a group of firms, the article explains the benefits of these approaches to both manufacturers and their suppliers. It begins with the traditional product-process matrix in operations management literature and adds to it two elements: firm size and the modular manufacturing method. The rationale for this addition is that modular manufacturing is the best mass customization method; firm size and mass customization are inherently related as indicated by the typical evolutionary pattern of production processes.

The eighth article, by Alan S. Dunk and Alan Kilgore, reports on a study of top management involvement in R&D budget setting. Organizations are increasingly reliant on their top management to provide R&D units with a strategic focus reflecting changes in their competitive environments. However, little research has specifically explored implications arising from top management involvement in R&D budget setting. This empirical study examines the extent to which such involvement is associated with first, an emphasis on financial factors in setting R&D budgets, and second, with the importance of budget targets for R&D managers. Third, the study evaluates the impact of that involvement on R&D performance evaluation. The results of the research provide evidence of the relation R&D budget setting has to these three factors.

The article by Paul D. Harrison and Kamal Haddad reports on a cross-national test of the role of self-interest on project continuation decisions. Prior escalation research has supported the prediction that when a project manager has private information and an incentive to shirk (i.e. to protect his/her reputation) he/she will have a greater tendency to continue an unprofitable project than a manager who faces only one or neither of these conditions. This article extends the cross-national direction of this line of research by: (1) determining if Mexican nationals who have private information and an incentive to shirk have this same general propensity to continue an unprofitable project when compared to Mexican nationals who experience neither condition, and (2) comparing this general tendency with a sample of U.S. subjects. The results of this study indicate that the Mexican subjects in the private information, incentive to shirk group also had a tendency to continue unprofitable projects at a rate similar to their U.S. counterparts. The implications of these results are discussed.

In the tenth article, Mohamad Goedono and Heibatollah Sami use a laboratory experiment to investigate agency theory determinants of managers' adverse selection in resource allocation and an approach to solve agency problems. The results suggest that agents who experience an incentive to shirk, have private information, and/or face less risky sunk costs exhibit a greater tendency to either choose less profitable projects or continue losing projects. Consistent with agency theory predictions, the authors also found that the tendency to choose less profitable projects and continue losing projects declined when agents were compensated based on a variable (outcome-based) compensation scheme.

Next, Seleshi Sisaye presents a study on process innovation and adaptive institutional change strategies in management control systems. The author uses a 2 by 2 contingency table that relies on environmental conditions and organizational change/learning strategies, to build a process innovation framework. A combination of these two factors yields four process innovation strategies: mechanistic, organic, organizational development and organizational transformation.

The four process innovation typologies are applied to characterize innovations in accounting. The article concludes that if ABC is integrated into an organizational development or intervention strategy, the technical and administrative innovation aspects of ABC can be utilized to manage the organization's operating activities.

In the final article, TerryAnn Glandon investigates the critical factors that influence decisions involving a change in management accounting controls after implementation of electronic data interchange. Relying on a field study of 235 small businesses, the author asserts that attitude and stakeholder perceptions influenced decisions, although management had no immediate plans to modify controls. Firm size and accounting system complexity also affected decisions. Surprisingly, limited financial and human resources were not influential. Small business executives may be unwilling to modify controls because they may not fully understand the risks when accounting systems and/or business practices are changed. This situation may have a serious impact on businesses and their trading partners. It is cause for concern because of the predicted growth of electronic commerce. By demonstrating the link between emerging control issues and system design, owners and managers may be more likely to respond to third party concerns.

We believe the twelve articles represent relevant, theoretically sound, and practical studies the discipline can greatly benefit from. These manifest our commitment to providing a high level of contributions to management accounting research and practice.

Marc J. Epstein
John Y. Lee
Editors

SHIFTING PERSPECTIVES: ACCOUNTING, VISIBILITY, AND MANAGEMENT ACTION

C. J. McNair, Lidija Polutnik, Holly H. Johnston, Jason Augustyn and Charles R. Thomas

ABSTRACT

The objective of the research, and paper, is to determine first whether or not the accounting abstraction appears to dominate the manager's perceptions of the physical reality of the firm's utilization of its physical assets, and second, whether changes in the accounting abstraction (e.g. the addition of Capacity cost management *reports and measurements) lead to changes in how managers perceive, and use, their physical assets. Using a cognitive decision-making structure developed by Wagenaar et al. (1995), this study explores the interplay between the structure and nature of capacity reporting (the surface structure of the decision) and the subsequent analysis and choice of managers within the firm (the deep structure of the decision). A five-site field research methodology was used to gather data from companies across a multitude of industry contexts and situations. Results suggest that the nature of capacity measurement and reporting does shape manager's perceptions of current and potential future performance (the cognitive surface structure), with major implications for the nature and type of decisions and trade-offs made (the deep structure). Specifically, managers appear to make decisions that are illogical when considered in light of the physical reality of their operations based on the representations of this reality (e.g. the capacity measures*

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and reports). Analysis and interpretation of these results suggest that what accounting makes visible appears to drive decision-making and performance in organization.

INTRODUCTION

> Accountability, *n*. The mother of caution
> Ambrose Bierce
> *The Devil's Dictionary*, 1958, p. 9.

> Facts do not cease to exist because they are ignored
> Aldous Huxley
> *Proper Studies*

Accounting is an abstraction. Bound by rules and tradition, it presents a view of reality that is at once both a biased, and yet unbiased, interpretation of organizational performance. Both shaping, and being shaped by, the organizations it serves (Burchell et al., 1980; Hopwood, 1983), accounting's abstractions can at the same time facilitate and inhibit management action. Separating these influences requires the study of accounting within its context.

Long understood in concept, the empirical investigation of accounting within its organizational context remains as critical today as when it was first explored nearly 25 years ago – perhaps even more so. For in the past 15 years there has been a plethora of "new" accounting techniques developed and implemented by organizations. Responding to the charges first voiced in *Relevance Lost* (Johnson & Kaplan, 1987), and spurred on by the demands of consultants and practitioners, management accountants have added techniques and tools to their arsenal, often with little reflection on their organizational or societal implications.

In the midst of this maelstrom of apparent change, accounting has remained steadfastly focused on measuring the productive. Side-stepping the systemic perspective so critical to many of the new management methods, such as Total Quality Management (TQM; Deming, 1986; Imai, 1986; Juran, 1989) and process management (Born, 1995; Davenport, 1993; Rummler & Brache, 1995), accounting data has continued to emphasize the discrete, and concrete, dimensions of organizational performance. And so the crisis of confidence in accounting information, especially management accounting information, grows.

While caught up in a crisis of confidence, accounting information remains central to the management control process that defines objectives, measures progress, and rewards (or punishes) performance in organizations. If what is measured and rewarded truly drives behavior in organizations (Kerr, 1975; Merchant, 1985), then the unresponsive of accounting information may negatively impact performance. In failing to truly embrace change, accounting may effectively prevent the organization from changing. It is a constitutive role that would appear to have few redeeming qualities.

The question that remains unanswered, therefore, is to what extent accounting can and does limit management's perceptions, actions and reactions to organizational events. Does it truly blind its users to the physical realities of the organization, or does it merely inform and reinforce management's own beliefs and experiences? Is what accounting makes visible the critical force in explaining patterns of management action, or is accounting information interpreted in a more limited way? To answer these and related questions, this study used a cognitive decision-making model that seeks to separate the way information is presented (the *surface structure* of a decision) from the decision-maker's responses to this information (the *deep structure of cognitive decision analysis*; Wagenaar et al., 1995).

There are many settings in which the themes of accounting visibility and management cognition could be explored. Within this paper one specific aspect of the organization – the utilization of a firm's machine capacity – is used as the basis for understanding the relationship between the management of the physical versus the management of an abstraction of the physical (e.g. accounting-based performance measures). The objective of the research, and paper, is to determine first whether or not the accounting abstraction appears to dominate the manager's perceptions of the physical reality of the firm's utilization of its physical assets, and second, whether changes in the accounting abstraction (e.g. the addition of *capacity cost management* reports and measurements) lead to changes in how managers perceive, and use, their physical assets.

Using a five-site field research methodology, the study explores the impact of various forms of capacity cost and utilization reporting on management's attitudes and actions. Longitudinal in nature, the research tracks changes in management perspectives as the organizations shift from traditional accounting-based capacity measurements and analyses to capacity reporting systems that measure and report the distribution and financial impact of productive, nonproductive and idle resources.

The contribution of this research is that it provides a focused, empirical investigation of the role of accounting visibility – what and how accounting measures – in understanding and predicting management's actions. Specifically, it seeks to understand if the modification of management accounting information to include both the productive and unproductive elements of a system's capacity changes management's actions. The paper begins with a review of the relevant literature in both management accounting, and more specifically, capacity reporting. The methodology is then presented, along with a description of the five research sites and their primary characteristics. Attention then shifts toward understanding the phenomenon in question – the change in capacity reporting practices and its impact on management perceptions and actions. The paper concludes with a discussion of the findings and recommendations for future research.

THE DIALOG

The quest for an improved understanding of the role of accounting visibility in shaping management action has a rich history. It has been a recurring theme in the research published in behavioral accounting journals, beginning with the path-breaking works both authored and supported by Hopwood since the late 1970s. It is beyond the scope of this paper to review this literature in depth. It is important, though, to recognize that this research is anchored within the Hopwoodian dialog and its concern with the relationship between accounting and the organizations it serves.

Research into accounting within its organizational context emphasizes the interplay between accounting information and the beliefs and actions of managers. Themes that have been examined include the exploration of the ways by which accounting has become what it is (Burchell et al., 1980; Hopwood, 1983; Johnson, 1983; Libby & Waterhouse, 1996; Loft, 1988; Miller, 1994; Tiessen & Waterhouse, 1983), how accounting is implicated in the ongoing processes of organizational functioning (Albright & Lee, 1995; Birnberg et al., 1983; Ferris & Haskins, 1988; Flamholtz, 1983; Hayes, 1983; Mia & Chenhall, 1994; Tinker, 1991), and accounting as a changing phenomenon (Burchell et al., 1980; Hedberg & Jonsson, 1978; Hopwood, 1987).

One of the more notable periods for this burgeoning stream of research was 1980–1983, when *Accounting, Organizations and Society* (AOS) published a series of papers that pulled together many of the threads of the then nascent field. In the opening commentary to Volume 5, Burchell et al., discuss the accounting visibility phenomenon:[1]

> . . . New systems certainly can arise out of particular interests and concerns. They can be designed to make particular phenomenon visible, to inculcate a particular mission or form of organizational consciousness and to help establish a particular chain of command . . . once in operation, accounting systems are organizational phenomenon. Indeed having their own modus operandi they themselves can impose constraints on organizational functioning . . . they become mechanisms around which interests are negotiated, counter claims articulated and political processes explicated. They may influence the language, categories, form and even timing of debate, but they can rarely exclusively influence its outcomes.

It would seem that these authors are arguing that while accounting makes events visible, constrains organizational action, and mediates political negotiations, it is not the sole shaper of organizational fate. Yet, is it not likely that potential outcomes are dependent on the perceptions of participants – their worldview? If accounting systems do shape these perceptions, is it not possible that they may effectively block from view alternatives that remain unmeasured? In this case, it could be argued that accounting, in what it chooses to measure and how these measurements are presented, may shroud other realities, other potential outcomes, placing them behind the curtain of awareness.

What if the reality that is shielded from view by the accounting is the physical world, one that managers can actually see, one where "reality" is more than an abstraction – one that has a visible presence with definable shape, size and characteristics? It would seem implausible to suggest that in this case the accounting abstraction would be the primary shaper of action and management decision-making. Other measurements, non-financial in nature, would seem preferable in such settings. A rational manager would not likely ignore such a physical reality, unless, of course, their performance evaluation was keyed to the financial abstraction. In this case, rational behavior could lead a manager to manage from the abstraction of the physical to the physical, rather than the converse (Wagenaar et al., 1995).

In discussing several of the papers in the landmark edition of AOS in 1983, Hopwood notes that just this problem was being documented within organizations:[2]

> Meyer . . . emphasizes how the abstract fictions that permeate the accounting craft can nevertheless have a very real impact on organizational decision making and action. Not only does the symbolic define the real, but the reality so created can be and often is changed in the name of the symbolic . . . Cooper . . . too is aware that the technical and the rational can come to be seen as natural; that in other words, a new view of a seemingly natural order can be created in the name of the technical.

It was just such an occurrence that Johnson and Broms, in their recent book *Profit Beyond Measure*, describe this situation in the American automobile industry:[3]

> At first the abstract information . . . merely supplemented the perspectives of managers who were already familiar with the concrete details of the operations they managed, no matter how complicated and confused those operations became . . . . Increasingly after 1970, however, managers lacking in shop floor experience or in engineering training, often trained in graduate business schools, came to dominate American and European manufacturing establishments. In their hands the "map was the territory." In other words, they considered reality to be the abstract quantitative modes, the management accounting reports, ...

In other words, it can be argued that the *context* in which accounting operated after 1970 made it ever more possible that a rational individual would manage the abstraction *sans* consideration or recognition of the underlying physical reality.

The Cognitive Perspective

To better understand the implications of how the accounting abstraction influences management decision-making and action, one must shift focus from the organizational to the individual – to the field of cognitive psychology. Most modern theories of cognitive decision-making represent decision problems as a choice among alternative bets that have different risks and payoffs. In order to make a decision, an individual reduces the problem to the set of bets and corresponding risk/payoff schemes.

This form of a decision problem has been referred to as *deep structure*, and is an abstraction from the *surface structure* that may contain information that is irrelevant to the choice-among-bets representation (Slovic et al., 1982; Tversky & Kahneman, 1981; Wagenaar et al., 1995). The results of recent cognitive research have suggested that a critical feature of decision-making is the translation of a problem from surface structure to deep structure. Specifically, the information that comprises surface structure can change deep structure, and in turn the nature of the resulting decision (Wagenaar et al., 1995).

Based on evidence from the cognitive arena, one of the critical variables in this translation of the surface to the deep cognitive structure is the kind of information the individual is given (Hogarth & Kunreuther, 1995). Second, these decisions are affected by how the information is presented (Wagenaar et al., 1995). In other words, results from the field of cognitive psychology suggest *what* reality that is presented through the accounting abstraction (e.g. its measurement bias), as well as *how* this reality is presented (the form of the accounting measures), will ultimately define the list of potential alternatives to a problem that a manager will consider (Hogarth & Kunreuther, 1995).

If we combine the arguments made by the Hopwoodian School with recent findings in cognitive research, we can begin to see the underlying dynamics of the accounting phenomenon. Accounting information serves as a primary definer, or translater, of the surface structure of the organization to the decision-maker. While other forms of information clearly exist, the extent to which accounting both dominates the definition of the surface structure and also fails to provide a robust description of this structure, it may have a far-reaching impact on the formation of deep structures within the managerial psyche.

Bias and the Calculative Nature of Accounting

Accounting emphasizes a specific view of reality, one that is technical and mechanistic in nature (Johnson & Broms, 2001) and intensely focused on the utilization of labor (e.g. standard costing). Even in the face of the insistent, and consistent, dialog about the need to change this emphasis generated by recent work in activity-based accounting (Brimson, 1991; Cooper & Kaplan, 1992; Kaplan & Cooper, 1998), the evidence suggests that the calculative nature of accounting remains focused on measuring performance within a very narrow band of operation (Henning & Lindahl, 1995; McGowan, 2001).

What are the main features of traditional management accounting measurements and their managerial implications? They include (Cooper & Kaplan, 1992, 1987):

- reliance on engineered, static standards;
- focus on the efficiency of labor as a primary definer of productivity and capacity utilization;
- emphasis on inventory valuation to the exclusion of management decision needs;
- tied to monthly financial cycle, creating questions of relevance and timeliness of standard cost-based information;
- variances from standard used as single information point, then added to inventory and cost of goods to return accounts to result in average actual cost values;
- minimal linkage to other forms of internal performance measurement;
- inadequate treatment of indirect, or overhead costs, with respect to variation-causing differences in products or services; and
- emphasis on the productive, or outcome-producing, time and effort of the organization.

These characteristics create a unique bias, or surface structure, for managerial accounting information that, by definition, hides key features of the organization from view, including trends in performance (variances are not trended, but rather discarded after each use), process/system capability and performance (labor remains the primary choice of cost drivers), and the cost and performance implications of an increase in system utilization (standard, or average, costs are presented rather than incremental or marginal costs).

Significant discussion has taken place in the literature about the failures of traditional systems in dealing with product variation (Borden, 1990; Cooper, 1990; Cooper & Kaplan, 1992, 1987). More generalized critiques of management accounting information have highlighted concerns with the informativeness and focus of traditional management accounting data for management decision-making (Brimson, 1991; Johnson & Kaplan, 1987). The work completed to date, though, has spent little time exploring the bias toward the productive inherent in even the more modern, activity-based approaches to management accounting. This bias is implicit in the choice of a driver frequency for the cost equation. Specifically, when activity drivers are defined based on the amount of work that is currently planned for a process or department, or that has been completed in the area over the recent past, the emphasis is placed on what has been accomplished, not what was left undone.

The concept of the non-productive is a systemic construct that recognizes that the total potential of a system is seldom consumed by the work it completes. In management accounting terms, the non-productive has been proxied through opportunity and sunk costs. In the case of the former, a cost or resource that could have been put to a different use is emphasized, while in the case of the latter, or sunk cost treatment, the non-productive is depicted as irrelevant because it cannot be avoided. Both treatments of nonproductive cost bring with them specific assumptions, once again, of the primacy of the productive. Both provide a description of the surface structure that directs management's attention away from the potential of the nonproductive.

In a world focused on assigning all of the costs of resources consumed to actual output, the bias toward measuring the productive is logical. But, as initiatives such as *kaizen* costing (Imai, 1986) have suggested, improving system performance requires a more dynamic, and comprehensive, measurement of the potential of a system. It requires the addition of data about the actual utilization of this potential to create marketable products and services. Specifically, the *kaizen* or continuous improvement models emphasize improved utilization of the nonproductive or idle resources within an organization – its *waste* (McNair, 1995).

If the linkage between the visibility, or surface structure representation, contained in the accounting abstraction and management decision-making is accepted, then it is clearly important to include measures of the non-productive in any setting where managers are seeking to improve their utilization, or leverage, of existing asset or resource capability. This leads to the first research proposition explored in this paper, specifically:

> **Proposition 1.** If the management accounting system only measures the productive utilization of firm resources, management will tend to overlook the potential of its nonproductive and idle resources.

In other words, it is argued that the bias toward the productive will effectively blind the manager to the untapped potential to create value that lies in the currently accepted levels of resource waste (i.e. nonproductive and idle resources; McNair, 1995).

Capacity Reporting: An Alternative Perspective

Capacity cost management (CCM) is clearly an "old wine in new bottles." Focused on measuring both the productive and nonproductive time and cost of machine-based systems, CCM traces its historical roots to the early years of the 20th century (McNair & Vangermeersch, 1998). In 1901, Alexander Hamilton Church published the first of many articles and books on the topic. Church promoted measuring capacity at its "ideal" or maximum level to understand the value-creating element of a system or machine. In Church's model, the nonproductive costs were treated as a second charge, or supplemental burden rate. The goal of this two-tiered costing method was to draw attention to the level of wasted capacity and the impact of this waste on the firm's profitability.

By 1915, Henry Gantt had developed "idleness" charts that detailed the cause of downtime on specific machines and the cost of that downtime. Also wedded to the concept of measuring capacity in its totality (both the productive and nonproductive), Gantt parted ways with Church regarding the treatment of the cost of wasted, or nonproductive, resources. Gantt felt these costs should be placed "below the line" (e.g. gross margin), representing a cost that was caused by management's actions (or inaction), not by the productive process. Gantt succeeded in convincing a majority of the leading accounting practitioners and experts of the time that a "below the line" treatment was logical, and preferable. Engaged in a heated exchange with Church in 1915, Gantt noted:[4]

> It has been common practice to make the product of a factory running at a portion of its capacity bear the whole expense of the factory. This has been long recognized by many to be illogical . . . The expense of maintaining the idle portion of the plant ready to run . . . is really a deduction from profits, and shows that we may have a serious loss on account of having too much plant, as well as on account of not operating our plant successfully.

Gantt appears to be effectively arguing that both the first and second points identified in cognitive psychology – that both what is measured (the information given; Hogarth & Kunreuther, 1995) and how this information is presented (Wagenaar et al., 1995) affect management's treatment of its nonproductive costs.

In 1919, shortly before his death, Gantt published a final article that states why a manager should be concerned with nonproductive capacity and its accounting treatment:[5]

> . . . studies . . . made in numerous plants . . . have convinced us that a study of idleness is much more effective in increasing the output of a plant than a study of efficiency as it has been studied . . . It is on this account that I say that a recognition of the cost of idleness and the allocation of this expense to those who are responsible for it, is the most important economic fact that has been brought to the attention of the business world for many years.

In presenting this argument, based on experience, Gantt underscored the key role played by the measurement of the nonproductive in management decision-making.

For over 100 years, then, it appears to have been recognized that the manner in which nonproductive costs are measured impact management's understanding and utilization of key physical assets. Specifically, the early literature and debates between Gantt and Church suggest that the measures used to define capacity and its use, or the *abstraction* of physical reality of the machine, would have significant impact on how this potential to create value was perceived (the surface structure). Only if these measures make nonproductive and idle capacity *visible,* does it appear that they generate increased levels of awareness and utilization (e.g. incorporation in the individual's deep structure). In other words, it *would appear that these authors felt that the abstraction of reality, or the capacity measurements, would take precedence over the physical reality of the machines in shaping management decisions and actions*.

Were it not for the Great Depression of 1929, and the stream of legislation subsequently passed by Roosevelt as part of his New Deal program (Johnson & Kaplan, 1987; McNair & Vangermeersch, 1998, 1997), it is likely that accounting would have avoided, or at least reduced, the *bias of the productive* in its operational reporting methods. But, these events did occur, and accounting practices did change.[6] Placing primary emphasis on the actual cost of good units produced, whether this estimate was based on simple average costs or the standard cost model, resulted in a management accounting system that effectively makes the nonproductive *invisible*, and arguably, unactionable – unable to be incorporated in the deep structure of organizational reasoning and decision-making.

Since the mid-1990s, there appears to have been renewed interest in various forms of capacity cost management. The Institute of Management Accountants (IMA), the Society of Management Accountants of Canada (SMAC), and the Consortium for Advanced Manufacturing – International (CAM-I) have each sponsored and published books and best practice guidelines for CCM (IMA, 2000; Klammer, 1996; McNair & Vangermeersch, 1998; SMAC, 1996). A consistent theme in these publications is the tendency of managers to ignore nonproductive and idle capacity when they are not measured and reported on a regular basis.

If the combined arguments made above have merit, one would expect that the addition of information about the level and cost of nonproductive and idle capacity would change management's perceptions and actions surrounding the firm's fixed asset base. This logic suggests the second proposition explored in this study, specifically:

> **Proposition 2.** If capacity measures are added to the management accounting reporting system, managers will modify their perspectives on, and use of, its nonproductive and idle machine-based resources.

The two research propositions combine to suggest that making the nonproductive visible will change management action. A second and equally important implication of these propositions is that measuring the total potential states of machine utilization will shrink the gap between the underlying physical realities of the machine and the accounting abstraction through which it is represented. The narrowing of this gap would, arguably, reduce the potential for error in decision-making within the organization by adding richness to the accounting abstraction of the surface reality – allowing it to enter the deep structure of organizational cognition.

A five-site longitudinal field research study was conducted to explore the issues raised by the research propositions. Attention now turns to the methodology, and subsequent outcome, of this empirical work.

EVIDENCE FROM THE FIELD: METHODS AND DATA

A qualitative, field research methodology (Glaser & Strauss, 1967; Strauss & Corbin, 1990; Yin, 1984) was used to gather empirical data for this study. Specifically, a five-site longitudinal analysis of the impact of adding capacity reporting to the firms' existing accounting reports was conducted to determine if the new information would change managerial perceptions and actions. Multiple site visits, covering the period spanning 1995–2002, were used to gather information and observations.

The details of each site, the study time period and number of site visits, and the mode of researcher involvement are presented in Table 1. Emphasis in data collection was placed on the pre- and post-period surrounding the implementation of a capacity cost management system, focusing on the comments and observed actions of managers at the sites. As such, the data collection and analysis that serves as the basis for this paper was conducted as an interpretative, grounded theory initiative.

The interpretative paradigm places more weight on the statements made by the subjects of the research than on the observations of the researcher alone. Subject statements become, in essence, part of the empirical evidence that is both interpreted by the researcher, and, provided to the reader to provide a basis for assessment of the research findings or development of alternative interpretations (see note 1). Attention now turns to the discussion of the details in Table 1and an exploration of the specific features of each of the research sites.

Summary of Site and Study Characteristics

The defining feature of the sites that were included in this research is that their primary process, or work, is either machine-paced or machine-constrained. The

Table 1. Description of Site Characteristics.

Issue	Great Beer	Sutland Pet Foods	Standard Soap	Windows, Inc.	Easy Air
Period of study	1994–1995	1995	1990–1997	1998–2000	2000–2002
Number of researchers on site	1	1	2	3	3
Total visits to site	15	3	50	30	18
Nature of Involvement	Research	Research	Research	Research and Implementation Support	Research
Primary business	Brew/Package beer	Specialty pet foods	Private label bar soap production	Residential windows and doors	Passenger air travel
Estimated annual revenues	$2 billion	$750 million	$1.5 million	$1.5 billion	$450 million
Number of employees	3,800	800	250	4,500	22,000
Extent of CCM implementation	Pilot	Advanced	Pilot	Early	Pilot

firms in the study were drawn from a broad range of industries, spanning passenger air travel to a brewery. The size of the organizations studied also varied greatly, ranging from Standard Soap, a medium size manufacturer of private label bar soaps to a large, multi-site beer manufacturer posting over $2.0 billion in sales in 1998.

Managers at each of the sites were actively concerned with managing the physical capacity of their fixed assets prior to the beginning of the study. In each case, fixed assets comprised a majority of the firm's total asset structure. In the four manufacturing sites, a broad range of technologies and methods were deployed. Great Beer, Standard Soap, and Sutland Pet Foods[7] relied on predominantly process forms of manufacturing, while Windows, Inc. utilized repetitive, large batch and assembly line techniques. Easy Air was the most challenging of the sites. Its primary productive process is, unquestionably, machine-constrained, but traditional industry-based measures of its productive capacity (e.g. available seat miles, revenue passenger miles, airborne hours per day per aircraft, days in service per month, and passenger load factors) were under question for their informativeness.

As the table details, the site work was conducted over a period of seven years. Sites were studied one at a time due to the significant time required to complete capacity data collection and analysis at each firm. The primary researcher was present throughout the entire seven-year period, while supporting researchers participated in one or more sites during a more limited time period. Finally, at one site, Sutland Pet Foods, the researchers conducted a more limited 3-day field study. Managers provided insights into the implementation phenomenon, including a candid discussion of the decision failure that had led to the decision to improve their capacity reporting methods. While different in depth and focus, the insights gained from this site are crucial to the arguments of the paper.

Having established the basic features of the sites, attention now turns to specifics. Each firm will first be discussed in isolation, in chronological order. After the unique features and observations from each site have been developed, attention will turn to a comparison of the empirical evidence obtained from the sites.

Great Beer

The initial contact at Great Beer, a large North American producer of premium beers, was through the auspices of a balanced scorecard project (Kaplan & Norton, 1998; Lynch & Cross, 1990) undertaken by the CFO of the corporation. In 1995, the balanced scorecard initiative was in its infancy, and the firm was more concerned with gathering insights and approaches to performance measurement than to finding a "solution" to this issue. From the onset, then, the focus of the interaction was research and exploration of new ways to measure.

The first half of the study consisted of interviews across the various functional groups of the company, emphasizing its primary areas of marketing, production, distribution and finance. Four of the five main breweries were visited at least once, for between two and six days total, with plant managers and controllers providing detailed information about current measurements, operational concerns, and decision requirements. During one of the brewery visits, a plant manager made the following observation:

> What I would really like to know is when I am reaching the limits – when I'm going to kick a step in my costs. While a lot of the rest of this stuff is interesting, and maybe someone will use it, but what I want to know is when my costs are going to go to hell in a hand basket . . . can your balanced scorecard tell me this?

In other words, for this operational manager, in close proximity to, and responsible for, the physical, the underlying capability of key resources – their capacity – was of central concern. When queried about the measurements used for physical capacity, the response of the manager suggested that the current surface construction of physical capacity was serving his purposes:

> We have a good handle on our capacity . . . in fact, we're running at over 100% utilization of our packaging machines. We don't really need any more measurements there . . . the brew houses are a bit different, though. We're not as comfortable there, but I think our brew master has found a way to optimize even this capability by managing our brewing schedules to match projected demand.

Over the next several months, similar information was gathered at other breweries. Whenever the question of capacity reporting came up, operating managers noted that the existing measures were adequate for their needs, providing all the information needed to make effective use of the firm's beer-producing assets.

Two events followed upon these initial field discussions. First, the measurements project was used as a basis to explore exactly what the current capacity reporting system was measuring. As Fig. 1 suggests, the plant had significant idle and non-productive capacity, amounting to over 73% of at least one key asset's full potential (its high speed bottling line) measured at its ideal (24 hour a day operation, running at manufacturer's rating of top speed). Actual utilization was only 5,396,160 bottles of output per week against an "ideal" of 20,160,000 bottles per week.

In the minds of the plant manager and his support staff, though, a very different situation was taking place, as suggested in Table 2 .

While the plant manager knew that there were some problems with the bottling line, and was putting process improvements in place to address these issues, in his mind he simply was trying to close the gap between 5,396,160 bottles per week of output and the budgeted rate of 6,500,000 bottles per week – the accounting abstraction, or definition, of his system's potential.

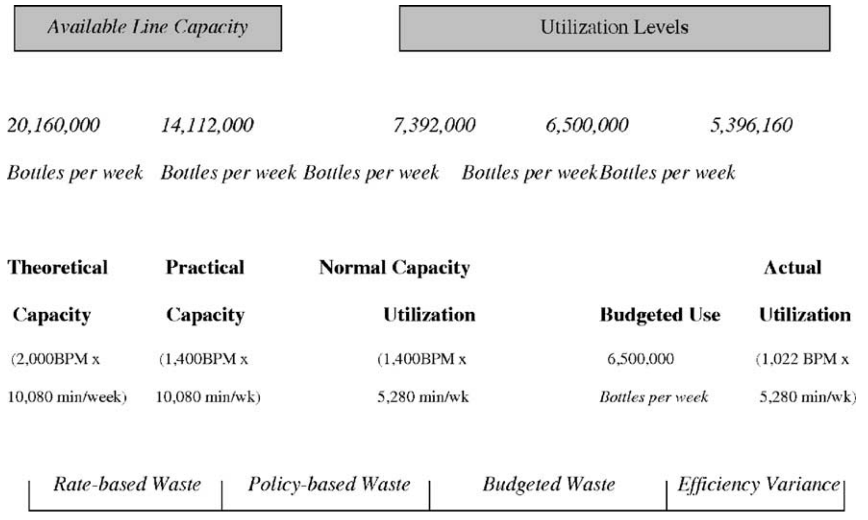


Fig. 1. Capacity Variance Analysis.

The response to the above graphic was at once negative. Managers felt the "ideal" was unattainable, and hence uninformative. They were held responsible for reaching their budget goals – information outside of that area would not aid them in meeting their performance goals. In other words, even in the face of a recasting of the measurements to make the non-productive visible, managers had inadequate incentive to change their capacity reporting system. The organizational incentive system reduced the perceived value of an alternative measurement of the physical capacity of the plant, suggesting that the cost/benefit tradeoff identified as pivotal to an individual's decision-making identified in cognitive psychology research by Wagenaar et al. (1995) was explicitly observable in this organization.

A second event, subsequent to the first discussions of the potential for an alternative form of capacity measurement, drives home a second critical observation gained at this first of the five field sites. During the latter stages of the project, management decided to close down one of its breweries based on the recommendations

Table 2. Capacity Utilization Measures.

Actual Utilization	*5,396,160 bottles per week*	26.8% utilization
Theoretical Capacity	20,160,000 bottles per week	
Actual Utilization	*5,396,160 bottles per week*	83.0% utilization
Budgeted Capacity	6,500,000 bottles per week	

of the outside consulting firm. The brewery went "off line" in March of 1995. The assets were disposed of, and production shifted to the remaining regional breweries.

All was well, with anticipated reductions in total brewery costs attained, when an unforeseen problem arose. Specifically, the company *ran out of beer* during the busiest week of the summer in the province where the brewery closure had occurred. They could not produce enough beer to meet peak demand with the reduced assets now in place. The problem did not lie in bottling capacity, though, but in the brew house. Within the company, output was measured in hectalitres of beer produced, but at the end of the day the bottles produced and sold were the focus of the capacity measurement system. There was an implicit belief that the capacity of the brew house was matched to the capacity of the bottling line, and so if enough bottles could be made in one plant to meet peak demand, the firm had adequate capacity.

The operating managers at the plant level had voiced concerns about this decision prior to the "great beer incident." But, once again, the culture did not really encourage the discussion of these issues. Top management, which was distanced from the physical reality of the breweries and encouraged by consultants who did not possess even the knowledge of top management regarding the physical realities of the firm, made a faulty decision based on *how the capacity information was presented*. The failure to separate the two primary subsystems of production, brewing and bottling, in the capacity measurements used by the firm led to a decision that harmed both the short- and long-term performance of the firm. Some of the beer drinkers who were forced to switch brands during the period of shortage did not return to Great Beer's products after the supply problem was addressed.

Thus, it appeared from this early analysis that simply presenting the physical reality – the surface construction of the capacity decision – in a different way was not enough to change the way that managers made their decisions (their deep structure). The risk of change, of running counter to the accepted organizational paradigms regarding measuring and using capacity, appeared to be greater than the perceived risk created by managing from the current accounting-based, and limited, abstraction of capacity. Second, the farther away a manager was from the physical, the more likely he or she was to rely on the abstraction, even to the point of a failure to deal with what was common knowledge within the firm – the distinct differences between the firm's total capacity, and methods of managing this capacity, in the brew houses versus the bottling lines. In other words, the accounting abstraction appeared to generate faulty decisions because it provided an incomplete, and biased, representation of the physical nature of the firm's production processes.

Sutland Pet Food

The fieldwork at Sutland Pet Food occurred after the firm had experienced its own version of the "great beer incident." Specifically, managers from the firm invited the researcher to conduct a field visit and case documentation of their experiences after attending an educational session on capacity measurement. As suggested by Semin and Gergen (1990), these ex post interpretations by the site managers form an acceptable level of data for use in an interpretative framework.

The site visit was conducted over a 3-day period, during which a major addition to the existing plant was toured. Interviews took place with managers at all levels of the plant, from the plant manager through the controller's staff, and across all key functional groups. As the visit unfolded, the potential impact of using the accounting abstraction of capacity surfaced as the major issue. During the tour of the new plant addition, the plant controller began to tell a simple story:

> What would you say if I told you that everything you're seeing, this huge addition, all of this new capacity, was a complete waste of resources?
>
> But how did we get here, what was the reason for building this plant? We weren't crazy, although in retrospect that may be hard to believe. No . . . we were responding to what our measurements were telling us. You see . . . we had always measured our capacity utilization based on the budgeted demand. And, we defined this capacity in terms of the earned labor hours recorded in the plant. Well, when we put those numbers together, we were running at 111% of our capacity . . . we needed to expand if we were to continue growing!
>
> Or did we . . . you see, when we sat back and analyzed our current capacity utilization against the ideal, we discovered that we were only using 28% of the *existing* plant. We didn't need this addition . . . and from what our marketing folks tell us, probably never will. But we have it . . . it's going to sit like a weight around our necks far into the future . . .
>
> We've since implemented a capacity reporting system that tracks the full capacity of the plant, but it's really too late. All we can do now is try to find new uses for a huge amount of idle resources, maybe close the old plant down, and a few other things. But, if we're not careful we'll hurt our market position – we can't just drop new products into the line without running the risk of eroding our differentiation strategy. I'm sure we'll find an answer, but it won't be easy . . .

The capacity measurement that had been used by the plant, its accounting-based earned hours against budget, had resulted in managers "blocking" a physical fact from view – that the plant was currently only running two shifts of production. Also, machines were shut down during the shifts for breaks, lunches and line meetings, and between shifts for crew changes. And, as had been seen at Great Beer, the firm was relying upon a standard definition of the potential run rate of its machines that was only 70% of the manufacturer's stated speed.[8] The combination of these effects reduced the utilized line time downward from the 16 hours two shifts physically populated to an effective time of production of approximately 9.5 hours.[9] Even more troubling, out of a possible 24 hours and seven days of production in a week (168 total hours) the firm was effectively using only nine hours for five days (47.5 hours), or only 28.3% of its available time.

It would seem that the very worries voiced by Gantt in 1919, that the good production would ultimately be charged with the cost of the bad, had been taking place at this firm. But, the company's differentiation strategy had placed it in the premium pet food market – it could recoup these excess costs, though not without a negative impact on the firm's profit potential. In other words, prior to the decision to add new plant, the accounting abstraction simply served to push the firm into a niche strategy that would allow it to sustain the high level of waste it had built into its cost structure. With the addition of the new plant, and its costs, it became much more difficult for the firm to achieve a break-even level of production – not because it couldn't produce more, but because its differentiation strategy effectively limited the total market demand for its products.

What is most interesting about this site is the very visible change the addition of a new accounting abstraction, or definition, of capacity had on the surface structure used by management to assess and deploy its physical asset base. A decision made on one form of abstraction – earned hours against budget – became illogical when a more comprehensive abstraction was provided. The revised capacity measures made visible, and hence problematic, idle and nonproductive assets and their related costs. If this information had been available before, rather than after, the decision, it is likely a costly and unneeded addition of physical plant could have been avoided.

Standard Soap

The research at Standard Soap took place over an extended period of time. Being a small, family-owned business, Standard Soap's management had a great familiarity with, and understanding of, its machine-based capacity. In fact, at the outset of the project, the entire costing system was defined around the pounds of soap produced by the plant. The founder, who was actively involved in the production process, knew how fast the various soap lines could make a bar of soap. This knowledge was at once complex, and yet simple – rules of thumb that dealt with differences in the water content, additives, size, color, packaging, and related features of the finished product were used to adjust the machine's expected run rate downward. At Standard Soap, the expected rate was set at the manufacturer's suggested run rate, rather than the 70% of this rate observed in earlier sites. Also, the plant was run for three full shifts, with a weekend shift being added whenever warranted. The owner-manager appeared to have a conception of his firm's capacity that Gantt would have supported.

During a particularly busy period, the plant manager described the owner's views and how that affected the running of the plant:

> I'll have to tell you, we don't always rely on those "standards" the manufacturer gives us. We work with the machines, try to find out how fast we can really run them . . . we can always squeeze another 10% or 20% of output out of the machine, above and beyond what the manufacturer suggests. Sometimes we run into problems, but there is so much time lost in set-ups around here that there are always opportunities for the mechanics to tinker with the presses and get them back in good running order . . . so we push them . . . as Allan (the owner) says, we don't make any money when the machines are sitting idle. That means every order is a good order . . . we just need to figure out how to make money on it.

The proximity of the owner to the business made it unnecessary to maintain a complex management accounting system. The physical system was the focus of capacity measurement and management, not an accounting abstraction of that system.

The initial projects completed at the firm involved the development of an activity-based cost (ABC) accounting system using student field projects to complete much of the data collection and analysis. Sponsored by the firm as part of the transition of the management of the business from the original owner to his son, the research and subsequent implementation of a more complex form of accounting was to have unanticipated results. Specifically, the owner's son, who had completed as masters degree in business administration at one of the nation's top schools, wanted to move the firm out of the dark ages and put some "real" measurements and modern management techniques in place.

What was not as apparent during the early stages of this extended field work was the fact that in defining activity pools, multiple levels and forms of capacity were being implicitly defined for the organization. Specifically, for every driver that was used in the resulting ABC system, a capacity, or abstraction of the capacity of the resources in each of the activity pools, had to be developed. As is commonly done, the current utilization, or driver frequency, became the proxy of capacity for these pools. And, as is also commonly done, an activity-based rate was developed for each of the major activities of the firm.

As was to be expected in a smaller firm, most of these activities were directly or indirectly linked to actual soap production. This fact led to the need to "negotiate" the meaning of the various activity pools and drivers with the entire management team. Allan, the original owner, voiced doubt from the onset about the project during private conversations, but did not oppose his son's initiatives:

> I don't really see why he wants this stuff . . . it's not that complicated. We make bars of soap, that's all . . . so, as long as we can cover the costs of materials and a little bit more in our bid price, we make money. But . . . John has a different perspective on the issue. We've talked about it, and all . . . he thinks we're just behind the times and he's going to change all that. I don't know . . . you've got to trust your kids, let go at some point, so whatever John wants is fine . . . .

The V. P. of Operations was not quite as easy to win over. Every time an activity cost pool and rate was discussed, he'd intone a simple phrase, "*But, a bar isn't a bar isn't a bar*." The product diversity that was explicitly built into the plant's operating metrics was not being captured in the ABC estimates. Through persistence, the V. P. was able to win his point, resulting in the use of "intensity factors" to create a weighted average cost of an activity. A bar that was hard to make, with a high level of content, a dark color, unusual shape, and/or extremely high quality acceptance threshold, would be charged five to ten times the amount of activity cost a simple white bar for use by hotels would bear. With these changes, the ABC system was put into place and began to be used to set prices for the bidding system the company used to obtain its orders (a job order system). No changes were made to the run rate measures (e.g. capacity) used for the soap lines. And time passed.

Two years after the initial implementation, the researcher returned to the site for a series of follow-up visits. From the onset, it was clear that there were problems at the firm. Where once there had been a need to run its machines beyond their rated speeds, sometimes up to 168 hours a week, machines now sat idle. Where orders had sat backlogged, with staged materials blocking aisles and filling corners, was empty space. What had happened? It was in answering this question that the unintended consequences of an accounting abstraction that *did not directly deal with the physical capacity* of the plant became clear.

The new ABC bidding system had resulted in exactly the type of production decisions that have been noted to be the strengths of that approach by its proponents (Cooper & Kaplan, 1987; Kaplan & Cooper, 1998). Specifically, the "complex" products that consumed more of the firm's support activities were charged more than the simple bars. Theoretically, this should have also resulted in a reduction of the price for simple bars due to a reduction in costs. Theoretically, while the complex jobs did get charged more, and customers continued to buy these bars from Standard Soap, it was the simple bars that were being lost to the firm. The question that immediately arose was simple . . . why?

The answer was surprising. The drivers that had been chosen for the indirect activities, while causally linked to the consumption of activity resources, did not measure the capacity of these resources at their limits – their ideal. Instead, they were average costs that reflected average usage of the resource pool. Even though the ABC rates had been adjusted to "penalize" the complex bars for their added costs, the fact remained that the simpler bars were also asked to bear some level of these support costs. While it is true that these customers created a demand for an activity, their needs were quite simple and inexpensive to meet. *The processes that had been put in place, though, had to support both the simple and the complex*. As long as the activity costing charge was stated as an average of current costs, weighted or not, it would place a burden on the low end products that they could not competitively bear.

Unintentionally, the ABC system had actually shifted the mix of customers from unsophisticated, simple but highly repetitive hotel bar soap customers to sophisticated, complex, and one-time customers who began to use Standard Soap as an extension of their research laboratories. Once Standard Soap had helped the firm identify the optimal production methods for a complex bar, these customers would begin the high volume production of the item *in their own plant*. Implicit in the implementation of the new costing system had been a strategic shift away from a cost-based strategy to one more reflective of a product differentiation.

During conversations in this second of three sets of field visits, top management (the son and his new team) was asked about the radical drop off in plant utilization:

> I always told Dad that those hotel bars were simply not worth our while . . . we hit them with a relatively minor cost increase, just making them pay for the costs they were causing, and they left us. I don't think we'll miss them, constantly pushing us to bring our costs down . . .
>
> The new customers we've gained are so much more profitable for us. They will pay the new charges, and they really appreciate us for what makes us special – our ability to run any type of soap efficiently. We're not worried – in fact, we're going to expand our capabilities, add a state-of-the-art warehousing system, and take the company to the next level. We're a little slow now, granted, but it won't last.

Troubled, the researchers once again exited the firm. Eighteen months passed and a third, and final, round of site visits were conducted. Over this time period, the firm had installed the new warehouse, added several new soap lines, and implemented a small business version of a popular enterprise resource planning (ERP) system. At first glance, these were all positive indications of the firm's apparent success under its new management and measurement systems.

Upon entering the plant in the middle of the first day on site, the researcher was struck by an almost eerie quiet. Of a total of 12 soap lines in the plant, only two were running. These were making small trial bars of a new product for a major corporation that was using them to complete its market research before launching the item. When asked about the turn of events, the new V. P. of Operations noted:

> Yeah, things have been a bit slow, and we've had to let a lot of our workforce go, but these things happen in business. You can't do that much about them on our end, but we really have been pressuring our marketing group to get busy. John's even taken to going out in the field with some of our older salesmen, seeing if he can get them back on track. The orders are out there . . . marketing just isn't doing its job.

This is one interpretation of the events that had come to pass, but there were others. During the first day on site, one of the few remaining managers from the first visits suggested that the research team meet him at a local bar after the day of interviews was over. At this off-site, and somewhat clandestine meeting, insights began to be offered into the problems at Standard Soap:

> When all of this stuff started, it seemed like a good idea. Allan was never really convinced, but he stepped away and left John in charge . . . and, it just wasn't a good idea to say "no" after that. So, we all did whatever was asked, even when it didn't quite make sense . . . long hours, too . . . my wife almost left me a couple of times.
>
> But, bit by bit, the orders started to dry up. At first it didn't seem like any big deal. We didn't make much money on the hotel bars, never had. They kept us busy, but that was about it. The new customers, they offered us a lot of money for our time. So, it was logical to try to please them . . . .
>
> After a while, though, some less logical things started to happen. I mean, we used to produce an entire product line for a major corporation . . . we'd been making the product for them forever, it seems. One day they simply cancelled their orders. Said we had gotten too expensive . . . losing that order hurt, but not as much as the loss of Company Y . . . . I mean, they seemed to be ours forever. We made their soap using old-fashioned methods, up in the old part of the plant, using piano wire to cut the bars, the whole thing. Allan put that operation together on a shoe string, never spent a lot of money on it. But, the bars we made for them were pretty complicated as far as soap goes. Anyway, to make a long story short, they didn't leave us for someone else . . . they actually went out of business themselves. I have my hunches that the price increases we hit them with – and that they agreed to pay – hurt them.
>
> Today, it's like a ghost town. I don't know how long we can keep going like this. Maybe Allan was right all along . . . every customer is a good customer, every bar a good bar . . . .

In thinking through the events at this site, and the comments both off- and on-line that were collected, it could be argued that the cost system was not the sole driver of this downward spiral in the firm's performance. On the other hand, it is equally possible that changes to the accounting model, specifically the addition of ABC-based charges for indirect manufacturing activities, had led to an overall increase in bid prices that had slowly eroded the firm's business structure. The ABC costs, which were stated at average or "normal" levels of capacity utilization, appeared to have created the very effects in the firm that the systems had been designed to prevent – the *death spiral*. The subjugation of the physical to the accounting abstraction (the surface structure), even if done for just the indirect (ABC) costs, had apparently created radical changes in the deep structure of the firm's decision-making. What was not clear was whether these changes would have been moderated if a more comprehensive measurement of activity- and machine capacity had been included as part of the revised system.

Windows, Inc.

With the above observations fresh in the minds of the research team, there was a heightened interest in understanding the relationship between accounting measurements of capacity and managerial decision-making. The last two research sites in this study, therefore, were chosen to help shed light on the observations that had been gained from the first phase of the research. Specifically, the researchers determined that it was important to link the accounting systems in a more direct way to the market and customer preferences, using this data to inform the development of the new forms of accounting.

Windows, Inc. represented an opportunity to study the development of a new product line. The firm was engaged in extensive market research that would provide information to feed target costing and value engineering initiatives. The goal of the capacity reporting project was to find a way to capture the impact of the new line on the firm's existing facilities. While the final assembly of the product was targeted for a new facility, the new product would place significant demand on the sub-assembly and component manufacturing departments in the existing plant, as well as many of the related support activities.

The management team at Windows was a combination of "old" line managers who had worked their way up from the plant floor, and "new" managers who had been hired from the outside. For the project team, this created a unique challenge. Given what had been observed at Standard Soap, it was clear that the new system was more important for the "new" managers than for those who had lengthy, and direct, production experience. Older managers simply noted that "*we've been taught to just do the right thing for our customers – the customer's always right*." For the new managers, this apparent truism wasn't as broadly accepted. In fact, those with little experience on the plant floor appeared to place more reliance on the accounting system reports and measurements than managers who had more "hand-on" understanding of operations.

Having completed the pre-implementation interviews, plant tours, and fact gathering, the research team began to work with the Controller of the Business Development team to determine how to measure the impact of the new product on the existing plant. In early discussions, she had noted:

> I know we can't use the existing standard costs . . . they don't even begin to deal with the impact the new volume will have on the plant. On one hand, the new volume will help us obtain some economies of scale, but on the other, I know we're going to kick some stepped costs in the process. Since the standard costs don't give us any information about either of these situations, they're not of much use.
>
> Of course, don't tell my boss I said that . . . as far as the finance folks are concerned, the new product should be charged at standard cost for every part it uses. That's been good enough for everything they've done in the past (at least in their minds), and it's good enough now. I don't agree, but I've got to go carefully here. I don't think we'll get a lot of buy-in for changing the system unless we have a lot of proof.

The decision was made to turn over the "study" of the existing plant's operational costing system to the research team. Traditionally, the firm had been much more receptive to this approach than to the actions and suggestions of internal managers who tried to champion new ideas. In fact, there were several internal managers who had extensive knowledge about target costing, capacity cost management, and activity-based costing as well as the issues that these techniques brought to light. They had attempted to bring this knowledge to the product design group, but had been rebuffed. The firm, and its management culture, was traditional, and highly resistant to changes in the surface structure of its decision support systems, especially when these changes were internally generated.

As the data collection began, some significant issues arose. While the management of the firm felt that they had a good understanding of their capacity, with little or no need for more information, the search for this information within the formal reporting systems led to the conclusion that very little formal information existed about the utilization of the firm's physical assets. Instead, the entire plant reporting system was built around a complex system of labor standards and rates that were used to set performance goals, and ultimately, to define an individual's profit sharing payout percentage.

At Windows, Inc., profit sharing comprised up to 50% of an individual's annual salary. Within this type of incentive structure, then, it appears that the concept of capacity was serving a unique evaluative role far removed from its traditional conceptualizations. There was effectively no information in the management accounting system about machine or asset utilization, and very little data about the quantity of output produced by any of the component or sub-component manufacturing cost centers. Individuals, including cost center managers, were driven by a single measure – the budgeted efficiency standards. Labor efficiency had become, in the context of the firm, the basis for evaluating and managing its mechanistic, or physical assets.

To complete the capacity study objectives, raw data had to be developed and estimated from a wide-ranging set of reports, databases, and personal files. Line and machine hours had to be estimated from cost center labor reports. Units produced had to be developed for all but final assembly using labor tickets and an extrapolation from unit sales figures backwards through the bill of materials. These bills were stated at standard, so there was no way to identify how much work was actually completed by a cost center, or to finely split the estimated output among product lines that shared common parts. Quality reports, which were maintained by a small team of business development managers, were used to estimate lost time due to quality problems. And so on. In other words, in this well-established, highly measurements-oriented, bureaucratic firm, one specific accounting abstraction, earned labor hours, appeared to be the sole definer of capacity utilization.

It took over one year for a team of three of the project researchers to complete the collection and estimation of the basic information required to generate a capacity-based analysis of Windows, Inc.'s operations. An example of this report for one of the 47 cost centers included in the study is provided in Fig. 2. Using the basic capacity reporting categories recommended by the CAM-I study (Klammer et al., 1996), estimates were made of the levels of productive, nonproductive and idle capacity for the two-year period 1998–1999. The report was split into four primary components, or summary tables, all designed to fit on one sheet of paper for each cost center: capacity utilization defined in time, defined in cost terms, stated as a breakdown of committed (e.g. physical asset) and managed (e.g. labor and related operating expenses) costs per hour, and finally, a per unit estimate of the productive, nonproductive and idleness capacity costs.

As the analysis unfolded, it became clear that the majority of the cost centers were heavily weighted toward managed, rather than committed, capacity costs. A second observation was that while the time-based potential capacity firm's physical assets was not well utilized (25–35% of theoretical capacity), the costs of these inefficiencies was not as significant. Specifically, between 40 and 60% of the total operating costs of the cost centers was traceable to good units produced.

There was significant homogenization in the capacity results, with the exception of two areas of the plant: a free-standing plastics extrusion facility and the door sub-plant. The plastics extrusion sub-plant was dedicated to the development and application of a new polymer to a broad range of Windows' current and planned products. The manager of this area had developed, over the course of setting up the measurements for his facility, a capacity-based reporting system that captured all of the key variables of these systems. The system that he developed was run outside of the corporate reporting system. In responding to questions about these reports, the cost center manager noted:

> We really don't know a lot about this process, so I decided I would do some reading and find out what other companies were doing to understand how well their extruders were performing. It all kept coming back to capacity, understanding how much throughput the extruder lines were producing. Since they stuck us out here in the countryside, I really didn't have to worry about the corporate system . . . no one seemed to really care how we managed ourselves. So, we took a bit of license. It was easy for me to report the information corporate wanted using my capacity system, and I was able to see the impact of the tweaks we made to the machines using my data. So, on their metrics I got better, but I got there using mine.

The impact of the "tweaks" was apparent in looking at the two-year analysis of the cost center's performance. Marked improvements in utilization, with concurrent reductions in nonproductive time, had led to a 40% drop in the conversion cost of a pound of extruded material. It appeared that the capacity reporting approach could potentially have a positive impact on decision-making in the firm given the results in this specific cost center.

Cost Center 485 Speaker Component Assembly

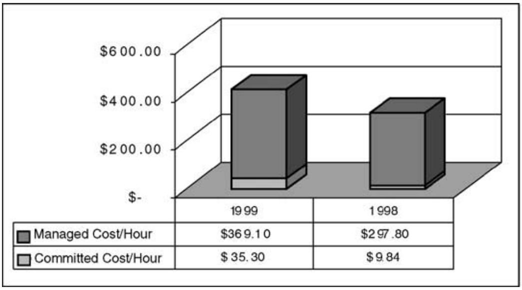
1998 Vs. 1999 -- Comparison of Hours of Capacity by Category

	Category	Hours -- 1999	% of total hrs	Hours -- 1998	% of total hrs
Idle Capacity	Management Policy (Holidays)	408.0	4.7%	408.0	4.7%
	Idle but Usable	2,072.0	23.7%	2,556.0	29.2%
Total Idle Capacity		**2,480.0**	**28.3%**	**2,964.0**	**33.8%**
Non-Productive Capacity	Manned Idle (Unaccounted)	30.4	0.3%	103.1	1.2%
	Internal Failure - Cost of Quality	100.4	1.1%	1,197.9	13.7%
	Material Problems	521.9	6.0%	195.1	2.2%
	Machine Breakdowns	761.1	8.7%	323.1	3.7%
	Scheduled	103.4	1.2%	124.3	1.4%
	Change-overs	380.3	4.3%	161.0	1.8%
	Clean-up	58.3	0.7%	33.6	0.4%
	Mgt. Policy (Lunch, Allowance)	411.5	4.7%	342.9	3.9%
	Rate Variance	406.0	4.6%	133.3	1.5%
	Mgt. Downtime (Misc)	89.5	1.0%	48.4	0.6%
	Non Itemized Downtime	35.0	0.4%	5.0	0.1%
Total Non-Productive		**2,897.8**	**33.1%**	**2,667.7**	**30.5%**
Productive Capacity	Manufacturing	3,113.8	35.5%	2,800.8	32.0%
	Developmental	268.4	3.1%	327.5	3.7%
Total Productive		**3,382.2**	**38.6%**	**3,128.3**	**35.7%**
		-	0.0%	-	0.0%
Total Capacity Hours		**8,760.0**	**100.0%**	**8,760.0**	**100.0%**

1998 Vs. 1999 -- Comparison of Dollars of Capacity by Category

	Category	Dollars 1999	% of total $'s	Dollars 1998	% of total $'s
Idle Capacity	Management Policy (Holidays)	$ 14,402	0.6%	$ 4,015	0.2%
	Idle but Usable	$ 73,142	3.2%	$ 25,151	1.4%
Total Idle Capacity		**$ 87,544**	**3.8%**	**$ 29,166**	**1.7%**
Non-Productive Capacity	Manned Idle (Unaccounted)	$ 11,221	0.5%	$ 30,703	1.7%
	Internal Failure - Cost of Quality	$ 37,058	1.6%	$ 356,735	20.3%
	Material Problems	$ 192,633	8.4%	$ 58,101	3.3%
	Machine Breakdowns	$ 280,922	12.2%	$ 96,219	5.5%
	Scheduled	$ 38,165	1.7%	$ 37,017	2.1%
	Change-overs	$ 140,369	6.1%	$ 47,946	2.7%
	Clean-up	$ 21,519	0.9%	$ 10,006	0.6%
	Mgt. Policy (Lunch, Allowance)	$ 151,885	6.6%	$ 102,116	5.8%
	Rate Variance	$ 149,855	6.5%	$ 39,697	2.3%
	Mgt. Downtime (Misc)	$ 33,034	1.4%	$ 14,414	0.8%
	Non Itemized Downtime	$ 12,919	0.6%	$ 1,489	0.1%
Total Non-Productive		**$ 1,069,578**	**46.4%**	**$ 794,441**	45.3%
Productive Capacity	Manufacturing	$ 1,149,291	49.8%	$ 834,091	47.5%
	Developmental	$ 99,066	4.3%	$ 97,530	5.6%
Total Productive		**$ 1,149,291**	**49.8%**	**$ 931,621**	53.1%
		$ -	0.0%	$ -	0.0%
Total Capacity Hours + Costs		**$ 2,306,413**	**100.0%**	**$ 1,755,228**	100.0%

Fig. 2.



		1999		1998
Good Units		302,129		279,455
Cost Per Unit Estimates:				
Competitive	$	3.804	$	3.334
NonProd.	$	3.540	$	2.843
Idle Capacity	$	0.290	$	0.104
Total	$	7.634	$	6.281

Fig. 2. (*Continued*)

The second area that deviated from the norm once the capacity data analysis was completed was the door sub-plant. During plant tours of this area, it appeared that the area had recently purchased a significant number of new production lines. Labor was much less visible in the sub-plant, reinforcing the perception that this area was not being managed in the same manner as the other five sub-plants (or 40 cost centers). The sub-plant was even at a slight distance from the main plant, making it necessary to walk through several parking lots to reach the facility.

Given these observations, it was expected that the results of the capacity analysis would be significantly different in this area. These expectations were borne out. Specifically, this was the only part of the company where both the committed and managed costs per hour had increased over the two-year study period, while its labor costs had dropped markedly. The sub-plant manager had learned how to game the existing incentive system. The capacity reporting system had brought attention to this phenomenon, which would have remained hidden from view under the traditional costing model. By bringing little or no visibility to bear on the impact of the asset purchase on the total costs of producing a door, the traditional accounting system had failed to detect that promised cost and performance improvements used to justify the asset purchase had not been attained.

In reviewing the results of the capacity analysis, the V. P. of Operations very rapidly pinpointed the two situations described above. As he described his reactions, he noted:

> I knew, somehow, that things just weren't going as planned in the door subgroup. But I couldn't put my finger on what it was . . . I mean, the numbers in our reports were all in line, yet I couldn't see how all of those expensive machines were in the end buying us very much. Volumes hadn't changed, so it only made sense that the cost of a door must have gone up, but every time I looked at the accounting reports, it just wasn't there. So . . . I figured I was missing something. Guess now I'd have to say I wasn't.
>
> I like this, by the way . . . I can finally compare these cost centers in some meaningful way. The apples-to-apples stuff . . . that helps me counter a cost center manager's claim that his or

> her group can't be compared to another . . . I can finally hold them all to the same set of criteria, and track whether they're getting better. But, I don't know how they'll feel about it . . . that will be an interesting discussion.

One year after the study was complete, the accounting group at Windows was asked to extend the capacity analysis for fiscal year 2000. The re-casting of plant operations using a different model, or accounting abstraction, appeared to have provided new information to corporate management, helping them gain a different perspective on the utilization of the firm's physical assets – to modify the deep structure of top management's decision-making.

Easy Air

The final research site in this study was chosen for the unique challenges it offered to understand the role of capacity-based information in organizations. Being highly regulated, the airline industry provided a unique opportunity to explore capacity measurements because this form of measurement was both well defined and utilized by internal and external industry decision-makers (e.g. managers and regulators). The standard capacity definitions used by the industry, *available seat miles* and *revenue passenger miles*, reflected the unique nature of a company whose assets' capacity physically moved through space and time.

The management of Easy Air was concerned that their existing capacity reporting system was not capturing the underlying economics of their business. In fact, it was felt that it had led to an increasing tendency to offer a broad range of fare options to attempt to fill the existing seats. The profitability of these various fare options was often difficult to identify because, in the end, the majority of the resources required to move a passenger from point A to point B was the same, regardless of when a ticket was purchased. Without a clear linkage between capacity utilization measurements and profitability, Easy Air's management felt that they could not ensure that they were optimizing the return on their primary asset – the fleet of airplanes.

In describing the situation, one of the top financial managers of the company made the following observations:

> We've been working on this capacity thing for a while now, but we haven't really had a lot of success . . . we even brought a consulting group last year to help us out, but at the end of the day we just couldn't figure out a different way to measure capacity and its costs. We know it matters, but we just can't seem to get our arms around the problem.

This was an interesting twist to the research project. Specifically, a firm that actually had ongoing reports of capacity utilization had been identified, only to find that while the measurements existed, they were not perceived by the management team to be a sound representation, or abstraction, of the firm's physical reality.

One of the most difficult parts of the study, then, became the development of a capacity measurement system that would more completely capture the unique features of airline operations. What became clear was that the traditional methods of measuring airline capacity did not measure these assets *at their limits*. *Available seat miles, passenger revenue miles*, and *airborne hours per day per aircraft* all appeared to be closely related to the type of capacity measurement that had been used at Great Beer and Sutland Pet Foods – they emphasized current utilization compared to expected or "normal" utilization – not the ideal capacity of the airplane, or its capability to create value.

To overcome this problem, a new form of capacity reporting was suggested that would focus on the documenting the utilization of a single plane over 24 hours of potential flying time. Distance no longer was emphasized – time was. Time-based plane capacity created an upper limit, or boundary, on the potential use of the asset, a feature that was missing in the distance-based capacity measurements. With this potential in mind, managers at Easy Air began to cull their databases to see if they could re-create 24 hours in the life of an airplane (or "tail" in site jargon). While the information system did not provide this data directly, over the course of an eighteen-month period the site implementation team was able to reconstruct the relevant data for the entire fleet of planes for a 66-month period ending in June of 2002. An early version of the capacity report that was developed from this work is presented in Fig. 3, and a more recent version of the summary report is presented in Fig. 4.

Unique features of the airline industry drove the development of multiple productive and nonproductive capacity categories not normally found in manufacturing reports. For instance, the "revenue passenger on-time" category in Fig. 4 reflected the fact that on-time performance was a critical dimension of performance. A complementary category, "nonproductive airborne," captured the impact of empty seats on total capacity utilization within a scheduled flight. "Scheduled idle," another key category, was developed to capture management's decisions about the length and intensity of its operating day. "Taxi time" was used to replace traditional set-up time, and so on.

As Easy Air's managers examined the first fully developed capacity reports, which used a format similar to that presented in Fig. 3 (with supporting detail back-up sheets), they made the following points:

- Additional capacity utilization categories and better ways to measure time in some of the existing categories existed.
- Changes in the format of the report and data would help their internal managers begin to understand, and use, the reports. Specific attention was drawn to the

Capacity Report
Year Ending: 12/31/2000
(in millions of dollars)

Industry Specific	*Category*	*Hours*	*% of total hrs*	*Cost Code*	*Cost Rate*	*Total Dollars*	*% of total $'s*
Off Limits	Airport/Flying Restrictions						
Marketable	Unscheduled--Idle in Hangar						
Total Idle Capacity							
Standby	Repositioning Aircraft						
	Idle--Scheduling Gap						
Service Quality Issues--Delays	Crew Shortages--Scheduling Problems						
	Repositioning aircraft--schedule prob.						
	Baggage handling delays						
	Wait for connecting flights						
Maintenance	Unplanned Maintenance						
	Scheduled Maintenance						
Set-ups	Allowable gate/turn time						
	Excess gate/turn time						
	Airplane servicing						
Load Factor Loss (Yield)	Airborne Time						
	Taxi/Take-Off						
	Landing/Taxi In						
Uncontrollable Delays	Weather delays/rerouting						
	Air traffic delays--in flight						
	Passenger emergencies						
	Airport delays--on ground						
Non-Work Related	Personnel training						
	Developmental projects						
Total Non-Productive							
Airborne Time							
Taxi/Take Off							
Landing/Taxi-in							
Total Productive							
Total Capacity Hours + Costs							

Fig. 3.

need to help managers shift their perspective on the firm's overall capacity utilization levels and the impact of various forms of ground-based and airborne nonproductive time.

- The need to highlight the extent to which necessary but nonproductive uses of the aircraft, such as required maintenance, would reduce productive time if conducted during the normal operating day when this time was largely marketable.
- A desire to track performance on key categories (productive, nonproductive and idle) over time to allow managers to assess the impact of continuous improvement efforts.

To reflect these new issues, a major revision to the capacity database and related reports was undertaken. Figure 4 details the basic nature of the revised capacity summary report developed for Easy Air.

In working through the issues in the project, the Easy Air team came to realize that the capacity of its fleet of airplanes was affected in a significant way by the effectiveness of its management of its more traditional fixed asset base – its gates at various airports, its baggage handling system, and its ticket and gate

Capacity Cost Management Report--for June 2001 All Tails Combined						
		Hours	% of Total Time	Rate	Total Costs	% of Total Costs
Idle Capacity	Nonmarketable Time	83,000	20.6%	$ 614.78	$ 51,026,357	12.3%
	Scheduled Idle	39,319	9.8%	$ 614.78	$ 24,172,240	5.8%
	Total Idle	122,318	30.3%	$ 614.78	75,198,597	18.2%
Nonproductive Capacity	Standby/Repositioning Total	7,685	1.9%	$ 1,256.96	$ 9,659,256	2.3%
	Service Quality Delay Total	3,450	0.9%	$ 1,256.96	$ 4,336,207	1.0%
	Aircraft Maintenance Total	43,060	10.7%	$ 1,256.96	$ 54,124,967	13.1%
	Taxi Set-up Total	88,135	21.9%	$ 1,256.96	$ 110,782,092	26.8%
	Nonproductive Airborne	50,350	12.5%	$ 1,256.96	$ 63,287,952	15.3%
	Revenue Passenger Service Late	14,213	3.5%	$ 1,256.96	$ 17,865,383	4.3%
	ATC Ground Holds	1,673	0.4%	$ 1,256.96	$ 2,103,488	0.5%
	Total Nonproductive	**208,567**	**51.7%**	**$ 1,256.96**	**$ 262,159,347**	**63.4%**
Productive Capacity	Revenue Passenger Service On-time	72,131	17.9%	$ 1,333.85	$ 75,883,559	18.4%
	Other Passenger Service Productive Uses	205	0.1%	$ 1,333.85	$ 215,818	0.1%
	Other Productive Uses	30	0.0%	$ 1,333.85	$ 31,234	0.0%
	Total Productive	72,366	17.9%	$ 1,333.85	$ 76,130,612	18.4%
	Total Capacity	**403,251**	**100.0%**		**$ 413,488,556**	**100.0%**

Fig. 4.

counter operations. While an airplane was in flight, these interdependencies were perceived to have minimal effect on overall performance. But, when the plane touched down, the control of its potential capacity shifted away from the plane itself to the ground-based assets. In other words, the "bottleneck" or pacing characteristic during on-the-ground time was not the plane or any inherent feature of the airplane. These interdependencies had long been recognized by the firm's top management, but had never been captured in the firm's measurement system.

To meet this new challenge, the project was expanded to include the cost and performance of the major ground operations activities. Activity-based costs were developed to provide a basis for assessing the economic costs and benefits of increased airplane capacity utilization through speedier "turns," modifications to baggage and passenger-based activities and processes, and related factors. In discussing the progress of the project, the leader of the site implementation team noted:

> We don't really understand all of the information yet, but we're already seeing some interesting trends that we thought were happening, but we just couldn't pin down. What we really want to do now, though, is to take this information and start looking for patterns across the system . . . do some routes perform better than others? Do some stations create more problems and delays than others? How does delay in one area impact another? And, as our loads increase or decrease, what happens to our utilizations? It looks like a good start, but we'll need to work with the data to make sure that what we're capturing is a good proxy for what's really going on out there.

Factoring in these non-plane based delay factors led to the expansion of the non-productive capacity categories to include ground-based delays and service quality delays. In addition, bills of activities are being developed to link the cost and impact of ground-based activities to the firm's ability to utilize its available plane capacity.

The changes that were made to the capacity reporting model at Easy Air appear to reflect a search for ways to make the capacity measures more useful to managers by creating a surface structure that more adequately reflects how they envision the operating nature of the business. Ensuing conversations underscored this belief, as well as drawing attention to the impact the report structure would have on the manager's willingness to incorporate the new form of information into their deep structures of cognition and decision-making. In some cases, the Easy Air support team pushed for reducing the amount of "good" time (e.g. removing flight delay time from productive airborne time) and changing concepts of "uncontrollable" delays to simply note what aspect of the chain of activities and parties had created the delay. Their logic for making these changes is telling:

> We don't want anyone to think that waste or delays are simply something we have to accept. Everything we do can be done better . . . we know that. And the last thing we want to do is create a report or a system that hides information or provides justification for accepting waste. We have to push the limits . . . find better ways to utilize our assets. In fact, we owe it to our managers to make sure they have all the facts, not just those we find convenient or comfortable to report.

These comments and changes represent another example of how Easy Air's capacity project team is attempting to create a measurement and reporting system that will accurately reflect the surface structure of the capacity management problem to ensure that their manager's deep structures of cognition and decision-making will be objectively and fully developed.

ANALYSIS AND CONCLUDING COMMENTS

The objective of this paper was to explore the impact of capacity cost information, as a form of management information, on the deep and surface cognitive structures of management decision-making. Exploratory and longitudinal in nature, the study of the five sites yielded insights on the research propositions presented early in the discussion. The first proposition suggested that to the extent that the accounting abstraction of the firm's physical asset capacity failed to reveal the waste created by nonproductive and idle resources, this untapped potential would fail to be recognized by management – that they would form their decisions within the parameters of the bias of the existing capacity measurements (surface structures). Across four of the five sites this proposition appears to be confirmed. At Easy Air, the proposition was not supported. In this case, management appeared to view the standard capacity measurements with distrust, reverting to their observation of physical reality in their decision-making. Easy Air was, interestingly, the most commercially successful of the firms comprising this study.

The second major proposition of the study was that the presence of capacity-based information would lead to a change in management's perceptions regarding the level of asset utilization, and subsequently to changes in the deep structure of its decision-making. The results relating to this proposition are once again mixed. Across the sites, the addition of capacity information defined at the physical limits, or theoretical capacity, of the system or asset did appear to change management's perceptions, but there was not an easily observable shift in the way decisions were made. In some of the sights, such as Sutland Pet Food, there were clear changes in management decision-making when the nonproductive elements of capacity were revealed. In others, the changes were limited in nature or not discernable. There appeared to be no consistent relationship between the nature of the capacity information (or surface structure) and the related deep structure of operational decision-making.

Having noted these results, there are some interesting observations that can be made from the analyses of the results from the five sites:

- The more distanced a manager was from the actual physical assets that the accounting abstraction measures, the more likely he or she was to manage from the abstractions – to use the surface structure presented by the accountings to form the deep structures of their decision analysis.

- The accounting presentation of capacity did appear to have both a constitutive and reflective role in the organizations, serving to make visible patterns and performance outcomes that may or may not reflect the underlying physical reality.
- The accounting bias toward measurement of the productive, or failure to embrace Gantt's logic of the ideal, did appear to lead to a tendency to increase the number and type of assets owned by the firm, and hence its average costs.
- What was measured by the accounting system did appear to define the firm's capacity at both the surface and deep structure levels of decision-making. If the accounting system focused on labor, it appears that the capacity of the machine-based or physical assets were not fully considered in the decision process.

While these observations are interesting, they do not serve to prove or disprove the ultimate value, or impact, of the accounting bias toward the productive aspects of capacity for management decision-making. As such, there is ample room for further research in a more controlled setting to study, for instance, how different representations of capacity affect the manager's ability to effectively manage the physical using the accounting abstraction of that physical capability. As with all exploratory field studies, there have been more questions raised by this research effort than have been answered.

There are also limitations within this research that must be acknowledged and used to judge the implications of the observed phenomenon. First, the study took place across a significant period of time and in very different organizations. While this added breadth to the study, it did limit its generalizability as well as the depth of analysis that could be completed. Second, the use of interpretative data collection methods, by definition, inserts the bias of the researcher into the discussion of the results. To the extent that the researchers' personal limitations prevented them from perceiving and recording key issues or facts at the five sites, the study remains incomplete and open to interpretation and evaluation by the reader.

Finally, while high in external validity, the study described here has a very low level of internal validity. Few, if any, controls could be used to shape the study, the development of the capacity information, or the use of any data that was developed during the course of the study. Individual manager's biases and personal motives and limitations cannot be separated from their comments or the reseacher's observations. As such, then, this research makes no claim to have "proved" or "disproved" any specific outcome, but rather to have explored a unique dimension of the impact of accounting on the organizations in which it operates. It is the mere start of a journey, not its conclusion.

NOTES

1. S. Burchell, C. Chubb, A. Hopwood, J. Hughes and J. Nahapiet, The roles of accounting in organizations and society. *Accounting, Organizations and Society*, *15*(1), 1980, 17.
2. A. Hopwood, On trying to study accounting in the contexts in which it operates. *Accounting, Organizations and Society*, *18*(2–3), 1983, 295.
3. H. T. Johnson and A. Broms, *Profit beyond measure*. New York: The Free Press, 2001, p. 25.
4. H. L. Gantt, The relation between production and costs. *Proceedings*. American Society of Mechanical Engineers, 1915, pp. 109–128.
5. H. L. Gantt, Influence of the executive. *Annals of the American Academy of Political and Social Sciences* (September), 1919, pp. 260, 262–263.
6. For a more elaborate discussion of this period and the issues that it raises, see McNair and Vangermeersch (1997, 1998). Specifically, these authors argue that the National Industrial Recovery Act, with its emphasis on establishing industry cost and pricing practices that reflected the “costs of the least efficient producer” (Johnson, 1935), led to the abandonment of any interest or attempts to measure the cost and performance impact of nonproductive or idle resources. In 1997, the major accounting professional organizations had once again come to the conclusion that at least idleness costs should be excluded from cost of goods sold (as they are the cost of not producing). To date the debate continues on the proper accounting treatment of the various forms of capacity costs.
7. Each of the names presented here is a pseudonym. Each site participating in this study required the signing and enforcement of non-disclosure agreements that would ensure that while the nature of the phenomenon could be discussed, the actual identity of the firms would not be revealed.
8. The use of a standard run rate that is 70% of the manufacturer’s stated run speed is common practice in most firms and for most engineers. The rate reduction is made based on the belief that the machine cannot sustain a higher run rate on a consistent basis, although there would be little or no incentive for a manufacturer to overstate this capability since it would open the manufacturer to an increased liability for product failure.
9. This reduction, or stated utilization, was based on information provided by the site managers and was not validated by the researcher because of site-based access constraints.

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COST SYSTEM RESEARCH PERSPECTIVES

John Y. Lee

ABSTRACT

This study examines the nature of the researchers' perspectives used in analytical and empirical cost system research published in the 1990s in an attempt to better understand current cost system research. The conceptual framework used for the evaluation is based on the research perspectives that have influenced the selection of different approaches in cost system research in the last three decades and reflects assumptions made in the research models and useful empirical implications.

The taxonomy used in the paper deepens our understanding of current cost accounting research and is argued as relevant on the premise that researchers would certainly care about finding a "better" cost system. A "better" system is defined in this study as the system that would lead to changes in decisions resulting in payoffs that are greater than the costs of implementing the new system.

1. INTRODUCTION

This study examines the nature of the researchers' perspectives used in analytical and empirical cost system research published in the 1990s in an attempt to better understand current cost system research. The conceptual framework used for the evaluation is based on the research perspectives that have influenced the selection

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The taxonomy used in the paper deepens our understanding of current cost accounting research and is argued as relevant on the premise that researchers would certainly care about finding a "better" cost system. A "better" system is defined in this study as the system that would lead to changes in decisions resulting in payoffs that are greater than the costs of implementing the new system.

This paper is organized around the conceptual framework found in the research perspectives that have influenced the selection of different approaches in cost system research in the last three decades and reflects assumptions made in the research models and useful empirical implications. In Section 2, I discuss the evolution in cost system research and take a look at research paradigms and their implications in shaping cost system research perspectives. Section 3 is used to examine in detail the different states of cost system research perspectives. In Section 4, I provide a summary, conclusions, and the direction of future research.

2. THE EVOLUTION IN COST SYSTEM RESEARCH PERSPECTIVES

Cost system research perspectives have undergone substantial changes as new paradigms appeared in the cost system practice or research in the last few decades. The evolution in cost system research to its present stages involves the application of different approaches and framework. Starting with the application of operations research and management science approaches to cost accounting problems in the 1960s, they also involve the use of a conceptual framework offered by information economics in assessing the value of new information provided by a new cost system and the agency (analytical) research approach employed in actual evaluations of the relative desirability of different cost systems. Despite some inherent limitations in their application to finding answers to cost-related problems (Dopuch, 1993), these approaches represent the dominant research methods that have been used in the last few decades.

The 1990s saw an evolution in the perspectives used in cost system research. From the early divorce of the various approaches from one another in the process of finding a "better" cost system, cost system researchers have advanced to the stage in which formal analysis-friendly methods were applied to the issues raised on new and popular cost system practice, for example. Up until the dawn of the 1990s, cost system research endured the depletion of normal paradigm and a period of little discovery that Kuhn (1962) stated. Although activity-based costing (ABC) advocates have claimed that their new view of cost-activity relationships has allowed their field to experience a period of creativity and of progress (Kaplan, 1998), the ABC approach has not adopted a fundamentally different conception of the new cost accounting paradigm.

2.1. Cost System Research Paradigms and Perspectives

The research in cost systems in the 1990s was performed in the atmosphere that a new paradigm was needed in cost accounting. The term "paradigm" that first appeared in cost accounting for the prediction of managerial accounting changes for the 1990s (Lee, 1987) has since become popular in referring to the dominant research culture. Citing the explanation of the role of paradigm in advancing knowledge by Kuhn (1962), Lee asserted the need for "a new paradigm within which to map the proper courses of action" in cost accounting research. This referred to the influence a major paradigm shift can have on research because, if the scholars can adopt a fundamentally different conception of their paradigm, then their field may experience a period of creativity and of progress.

A paradigm shift takes place when the normal paradigm cannot explain new events, and in cost accounting the changes in research perspectives reflected the fundamental changes in the cost accounting environment. The changes in the cost accounting environment as observed in the 1990s represent the introduction of new management and manufacturing technologies and the shift in the cost structure of firms (Johnson & Kaplan, 1987). The historical perspectives used in the evaluation of management accounting practices in Johnson and Kaplan have influenced subsequent development of cost accounting perspectives used in most of the published research dealing with a new paradigm in cost accounting.

2.2. Why Should Researchers Care About a "Better" Cost System?

In the early 1990s cost system researchers found themselves either: (1) favoring the derivation of normative implications from a new approach that was extremely popular among practitioners but not yet proven through sufficient empirical validations, or (2) looking for an analysis-friendly abstract method that would provide a clean, formal evaluation of the relative desirability of alternative cost accounting systems. The first category of research involves ABC and the second one represents analytical research.

Why should researchers care about a "better" cost system? From the perspectives of Dopuch (1993), different accounting numbers that are generated from an alleged "better" cost system should lead to changes in decisions that result in payoffs that

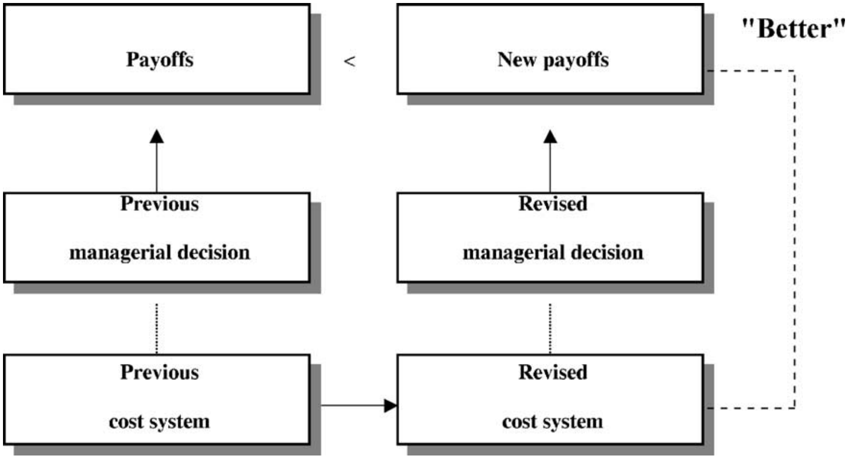

Fig. 1. What is a "Better" Cost System?

are greater than the costs of implementing the new system. Then, the question that must be asked is this: how do we determine the relative net economic benefits? (See Fig. 1.) Information economics, despite its practical dilemma that the paradigm can rarely be applied in actual tasks, provides a conceptual framework for evaluating the relative desirability of different accounting systems.

As James March commented in the address to the 1987 annual meeting of the American Accounting Association, however, useful information about the way managers use information and make decisions is scarce. There are remarkably few analyses of what managers actually do with their time, or what information they use or might use. Despite some progress made in this respect (Bruns & McKinnon, 1993), there still is considerable debate on how managers use accounting numbers, which makes it difficult to determine whether new accounting numbers generated by a new cost system improve managerial decisions.

Although it is well-nigh impossible to accomplish in a single research study, the 1990s saw serious efforts made by cost system researchers in their attempts to explicitly determine how newly generated cost numbers can actually affect managers' decisions. As Kuhn (1962) stated, over time, every normal paradigm gets depleted, and a period of relatively little discovery follows. The previously stated practical dilemma involving information economics led cost accounting researchers to abandon a normative approach and favor agency theory. The difficulty of implementing agency research prescriptions in practice, nevertheless, has contributed to the relatively little discovery of useful findings that led to the derivation of empirical implications, either normative or positive (Dopuch, 1993).

Dopuch attributes this limitation of agency research to the highly abstract formal analyses agency researchers use either because they deliberately divorce their work from the real world or some underlying form of incompatibility.

2.3. ABC's Effect on Cost System Research

ABC is not a paradigm. The emergence of ABC, however, coincided with the major change in the culture of cost system research that was caused by the changes in the environment. Accordingly, the emergence of ABC seems to have had the effect of the "paradigm shift." ABC advocates have been criticized by many cost system researchers for "moving too far in the direction of deriving normative implications from their research" which is motivated simply to provide "better" accounting numbers to managers, on the premise that "a selection of additional cost drivers and cost pools will move researchers closer to the 'true' cost numbers" (Dopuch, 1993).

Although ABC advocates have not adopted a fundamentally different conception of the new cost accounting paradigm, their new view of cost-activity relationships has allowed their field to experience a period of high productivity. This is evidenced by the growth in cost system research in the 1990s with respect to cost drivers, cost allocations, and alternative cost systems. Even agency theory research has benefited from the ABC emergence as discussed in subsequent sections. If viewed as an important part of the primary culture that represents a normal paradigm, ABC has helped cost system researchers define, at least, the areas of research in the 1990s. ABC has not, however, contributed noticeably to finding new methods of inquiry or new standards of what constitutes the research progress, that Kuhn described as the role of a new paradigm (1962).

3. FOUR STATES OF RESEARCH PERSPECTIVES

For the purpose of examining the nature of the perspectives used in analytical and empirical cost system research published in the 1990s, articles dealing with cost systems published in *Journal of Accounting and Economics (JAE), Journal of Accounting Research (JAR), The Accounting Review (AR), Journal of Management Accounting Research (JMAR), Management Accounting Research (MAR-U.K.)*, and *Advances in Management Accounting (AIMA)* for the period of ten years (1990–1999) are evaluated.[1] The assessment of the perspectives reveals that the changes in the environment have had the impact on cost accounting systems although the pace of change has been slow. The assessment yields four

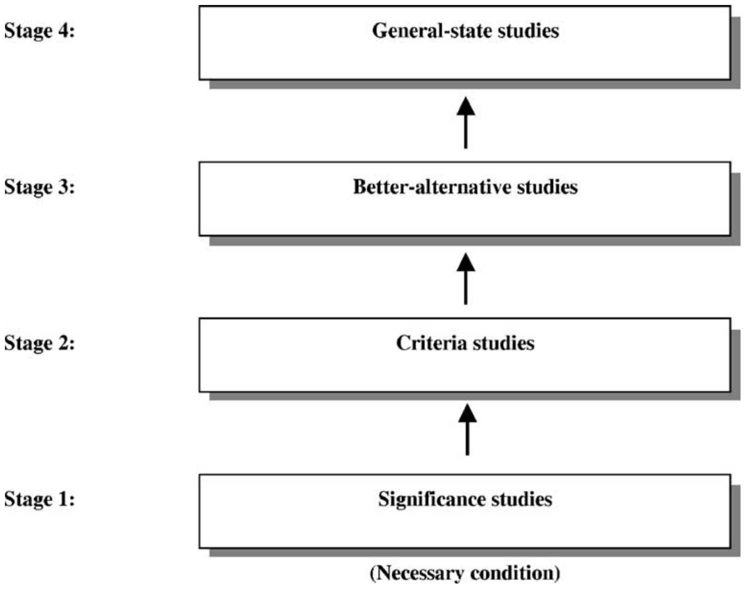

Fig. 2. Four Stages of the Perspectives Used in Cost Accounting Studies.

distinct states of cost accounting studies: *significance studies*, *criteria studies*, *better-alternative studies*, *general-state studies* (Fig. 2).

3.1. Significance Studies

Demonstrating the significance of the new accounting numbers generated from the newly designed research relative to the traditional or existing one, *significance studies* address issues involving costs, cost structure, cost-activity relationships, the role and nature of cost systems, and the effect of new technology on cost systems, among others. A precursor to any serious cost accounting study, significance represents a necessary condition for the new cost numbers to make potential improvements in managerial decisions.[2]

The 1990s saw the efforts of cost accounting researchers in examining the relationships between costs and activities. Albright and Reeve (1992) used a case study to understand the sources and costs of process variation at a manufacturing facility. Operation variables that managers thought were cost drivers were empirically evaluated and found to be significant sources of variation in product quality. Banker and Johnston (1993) draw upon previous work in cost accounting and economics to develop analogs in the airline industry for product diversity, production run volumes, and process complexity and find both volume- and operations-based cost drivers to be statistically significant. Banker et al. (1995) further expanded on the above finding and demonstrated that most of the variation in overhead costs is explained by measures of manufacturing transactions, not volume, using manufacturing data from the electronics, machinery, and automobile components industries.

Efforts to better relate costs to activities are also observed in Anderson (1995a), Ittner et al. (1997), and Srinidhi (1992). Anderson (1995a) examined the impact of product mix heterogeneity on manufacturing overhead costs in three manufacturing plants using a regression analysis and found that differences in processing efficiency and in customer-specified quality requirements were costly. The new measures of heterogeneity were found to perform better in estimating overhead costs than the traditional measure, the production volume. Anderson also found that experience producing a heterogeneous mix of products mitigates costs of heterogeneity.

Using time series (monthly) data from a manufacturer, Ittner et al. (1997) also confirmed that the manufacturing measures generally correspond to the ABC cost hierarchy classifications. They further found that operational measures corresponding to this hierarchy explain both costs and revenues. Srinidhi (1992) proposed a refinement of the ABC framework in tracing some overhead costs such as the cost of delay in common processing centers and the holding cost of work-in-process inventory and used results from queuing theory to show how.

Studies examining cost-activity relationships were not confined to manufacturing. MacArthur and Stranahan (1998) investigated the significance of volume and complexity variables in determining hospital overhead costs. Treating complexity as an endogenous variable, they used two-stage least squares regression and found that volume and complexity variables were all statistically significant drivers of hospital overhead costs.

While the previously mentioned studies deal with cost-activity relationships, the following two studies looked directly at costs as a cost structure-related issue. Boer and Jeter (1993) examined the claim that labor was no longer a significant cost and that overhead was the most significant cost in manufacturing operations. Using the results of an examination of material cost and labor cost data from a variety of manufacturing industries for the years 1899 through 1987, they found that, labor as a percentage of sales indeed declined since 1950 and became relatively insignificant for some industries. They claimed, however, that labor cost represented a significant portion of total manufacturing cost for other industries as late as 1987, and the trend indicated that for some industries overhead costs were rising while for others they remained relatively constant. Foster and Gupta (1994) examined marketing costs, a large component of the cost structure in many industries, with respect to measures that can be used to evaluate both the efficiency and cost effectiveness of marketing functions. Based on field interviews with and a questionnaire survey of marketing executives, they found gaps between the usefulness of information available from existing accounting systems and the potential value of accounting information in marketing decisions.

Some significance studies deal with the normality assumption in labor variance, a new joint cost allocation approach, levels of cost aggregation, and overhead allocations in hospitals. Gribbin and Lau (1991) tested whether the direct labor efficiency variances are normally distributed, using the data from 14 production departments of a manufacturing plant. Their study concluded that one should not simply assume normally distributed variances indiscriminately. Cheng and Manes (1992) proposed an easy-to-apply marginal approach for allocating joint costs in the context of a practical budget planning process.

Gupta (1993) examined distortions in product cost measures caused in part by methods of aggregation in the accumulation and allocation of costs. Based on empirical analyses of field data, he found positive correlations between the degree of heterogeneity and the level of differences in costs allocated to products at different levels of aggregation. Eldenburg and Kallapur (1997) empirically proved that hospitals change their patient mix and cost allocations to maximize hospital cash flows in light of the Medicare policies.

Cost systems and their link with the level of competition, the nature of change in cost systems, and their effect on performance drew cost accounting researchers' attention. Libby and Waterhouse (1996) provided evidence contradictory to the charge that management accounting systems are generally resistant to change. Based on tests of economic and organizational factors associated with changes in systems, they found 31% of the systems in the sample organizations changed. The system components that support decision making and control changed more frequently than components that support planning, directing, or product costing.

Hansen (1998) used a theoretical model to examine the link between the level of competition and the investment in more extensive management accounting systems. Contrary to the common view, his analysis showed that increasing the number of competitors leads to a decreased investment in cost reduction subsystems. Sim and Killough (1998) investigated whether manufacturing practices, such as total quality management (TQM) or just-in-time (JIT), and management accounting systems interactively affect performance and proved they did. Balakrishnan et al. (1996) examined whether there was any effect JIT adoption had on the return on assets of adopting firms and found no significant effect.

Some significance studies dealt with managers' and employees' satisfaction with ABC implementation. Swenson (1995) measured financial and operating managers' satisfaction with ABC at a variety of manufacturing firms and found significant improvements in their cost management systems following the ABC implementation. McGowan and Klammer (1997) examined employees' satisfaction with ABC implementation and determined that employees' perceptions concerning the ABC success were, on average, favorable. Top management support, the adequacy of training, and the linkage of ABC to performance evaluation systems were found to be instrumental in explaining the perceptions.

Cost accounting researchers were also interested in the economic role for indirect cost allocations and the role of contracting costs in specifying the value of more accurate product costing. Rajan (1992) investigated a role for indirect cost allocations to various decentralized profit centers, and concluded that simple compensation contracts did not provide adequate incentives to guarantee the owner's desired outcome. Such allocations had been criticized in the agency literature as being irrelevant for motivating managers in the presence of compensation contracts. Past agency studies did not address cost allocations across multiple divisions since they did not model multiple productive divisions among which common costs were to be allocated. Further, because they modeled single-agent settings, the second-best incentive schemes they derived were enough to motivate managers efficiently. Luft (1997) examined the use of a broader representation of preferences in explaining a wider range of accounting-related behavior and concluded that alternative-preference-related contracting costs should be considered for a complete specification of the value of more accurate product costing.

3.2. Criteria Studies

Some cost accounting studies go one step beyond the previously mentioned significance studies and attempt to articulate how cost numbers are actually used in managerial decisions. The *criteria studies* show the cost accounting researchers' efforts to identify actual decision criteria used by managers that affect *ex ante* optimal decisions. Some criteria studies reach the level of specifying how new (and different) cost numbers are used in particular decision contexts by individual managers and others deal with more general situations. Due to the need to address decision criteria in formal analyses, these criteria studies employ analytical frameworks or clear association between choice of systems and use of practices.

One of the few studies in accounting on how managers actually use accounting information, Bruns and McKinnon (1993) used a field study to learn more about it. Based on interviews, they revealed that information-hungry managers preferred informal sources of information to other sources for day-to-day needs, and used unit data for short-term management and financial information for longer-term management. Many managers were found to develop their own personal systems for getting the information they wanted. The most effective management accounting systems would support these systems rather than attempt to displace them.

Two studies looked at cost bias or cost changes related to system changes. Babad and Balachandran (1993) relied on a modified information economics framework in their evaluation of different accounting (cost allocation) systems. Using an optimization model for balancing savings in information processing costs with loss of accuracy, they demonstrated how to determine the number of drivers and identify the representative drivers. Hwang et al. (1993) designed a model to explain the determinants of the product cost bias resulting from a conventional two-stage overhead cost allocation system. More specifically, they derived an expression for the firm's economic loss from product cost distortion as a function of each product's squared bias and the extent of product market competition. The squared bias was determined (using simulation) to be a function of the heterogeneity of the production technology, unit input costs, and the product mix. Prior to this study, the extent of product cost bias had been hypothesized to be a function of production technology heterogeneity, unit input costs, and product mix.

Changes in production processes were known to have effect on both direct and indirect manufacturing costs. Research focused primarily on how changes in production processes influenced the level of manufacturing overhead costs while assuming such changes did not affect direct unit-level costs until the field study of Dopuch and Gupta (1994). Their study showed that production changes reduce direct labor productivity and material yields raising costs beyond the labor and material costs incurred in setups associated with these changes. Results suggested there could be significant benefits from re-examining existing manufacturing and marketing policies that increase the frequency of changes in production processes.

Several criteria studies involved various aspects of the ABC implementation. Anderson (1995b) developed, using a field-based account of ABC adoption by General Motors, a framework for and hypotheses about evaluating ABC implementation. The information technology and organizational change literatures, as well as anecdotal evidence were found to guide the search for factors that influence ABC implementation success. Anderson theorized ABC implementation as an evolutionary sequence of implementation stages that are influenced by socio-technical variables. A mail survey-based study by Shields (1995) elaborated on implementation variables that are associated with ABC success. Behavioral and organizational variables that were found to be important to explaining ABC success were: top management support, link to competitive strategies, link to performance evaluation and compensation, training, ownership by non-accountants, and adequate resources. ABC success was not found to be significantly associated with the use of technical implementation variables such as software. Using survey results involving contextual and organizational variables found to be associated with ABC success in prior studies, Krumwiede (1998) tested how these variables affected the stages of the ABC implementation process. Different factors were found to become important as implementation reached higher stages. The direction and level of importance for many factors were also found to vary by stage.

Two criteria studies addressed the issues of setting standards in relative performance evaluation and benchmarking and effects of feedback on decision performance. Banker et al. (1998) presented a new method for estimating standards. Dealing with the need for flexibility in setting standards to allow managerial trade-offs between efficiency and attainability, they used stochastic data envelopment analysis of hospital nursing cost data to introduce flexibility in setting standards and deriving mix and yield variances. Briers et al. (1999) tested the effects of benchmark and process properties feedback on product related decision performance in the presence of imperfect product cost data. They found that, while subjects receiving only conventional financial performance reports showed some improvement, those receiving additional feedback information had superior performance. There were no differences between those receiving benchmark or process properties feedback with respect to decision performance.

3.3. Better-Alternative Studies

The criteria studies do not advance to the level at which cost accounting research can be focused on whether a new system is a "better" one. Better-alternative studies have a clearly stated objective of finding a better cost accounting system. Depending on how "better" is defined, however, there have been three contrasting types of better-alternative studies representing different research perspectives.

Since the definition of the most desirable type of cost accounting system has yet to be established, the first type of better-alternative studies relies on statistical criteria that has been well established in other disciplines with respect to its validity. A study by Datar et al. (1993) attempted to demonstrate that, in the presence of simultaneous relations between activities and their costs, better estimates of the individual activity costs were performed by using two-stage regression estimation procedures rather than ordinary least squares. Their definition of "better" was relative to statistical criteria; the estimates of coefficients computed from the two-stage regression were less biased and were consistent (converge to a mean value) in their setting. There was, however, no proof that their approach would always lead to improved managerial decisions because the net economic benefits of the method could not be assessed. As Dopuch (1993) criticized, they implicitly assume that users of the cost accounting numbers will prefer information systems

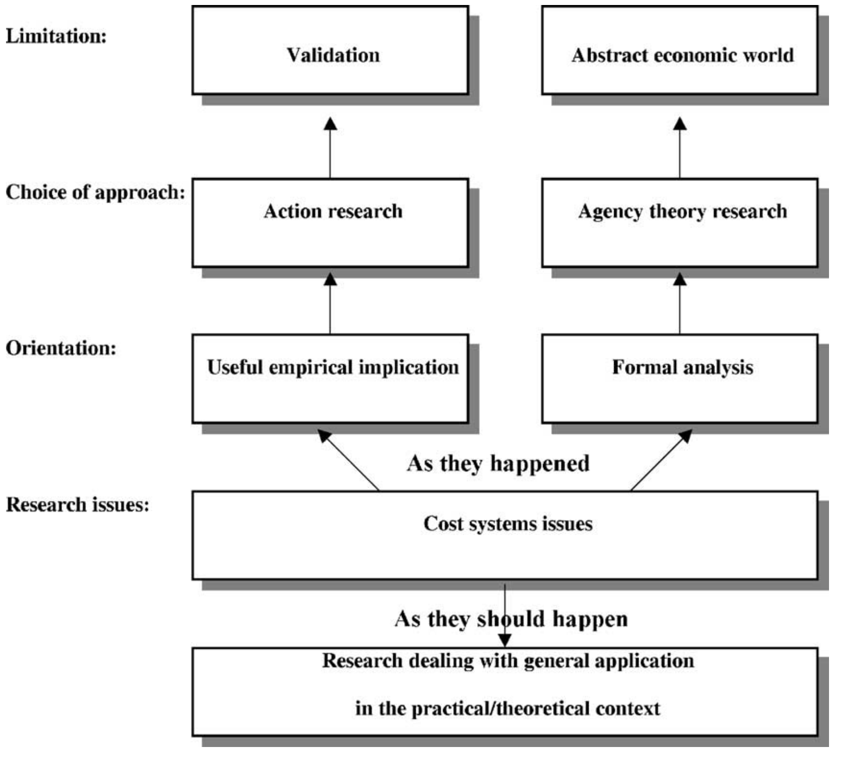

Fig. 3. Analytical Research versus Action Research: Two Perspectives Contrasted.

that generate numbers more closely adhering to some general criteria over systems producing numbers further removed from the assumed criteria.

The remaining two types of better-alternative studies represented the perspectives of analytical research and action research. As shown in Fig. 3, the two types used contrasting perspectives in their approaches. In their research orientation, one advocated promoting more useful cost accounting system while the other valued the employment of a formal analysis. In their limitations, one suffered the lack of an empirical proof that their approach was better than all other approaches that existed, while the other dealt with conditions from an abstract economic world.

Banker and Potter (1993) represented an example of analytical research. They put the claims about the benefits of ABC systems under the scrutiny of analytical models incorporating rational behavior by users of product costing systems. They demonstrated that a monopolist or firms competing in an oligopoly were almost always strictly better off using multiple cost drivers of an ABC system even when the system made measurement errors in assigning overhead costs to activities. The firms were found to be strictly better off with a direct labor based single cost driver system, nevertheless, if the demand for the overcosted labor intensive product was expected to grow sufficiently relative to the demand for the undercosted setup intensive product. They reasoned that, facing imperfect competition, it was sometimes optimal for firms to prefer a single cost driver system to an ABC system. They also identified conditions under which the use of traditional systems leads to higher expected profits than an ABC system even when the costs of implementing an ABC system were negligible.

Eldenburg (1994) examined the effects of providing cost reports, as a new information set, in the complex hospital environment characterized by implicit contracts. An economic analysis explored the conditions necessary to align hospital and physician goals around cost management, and found that an appropriate set of accounting information might help detect overtreatment of patients. Banker and Hughes (1994) looked at the economic sufficiency of the activity-based unit cost in pricing decisions. Regarding the issue of how costs of resources committed to support activities should enter into pricing decisions, they found in their particular setting that only normal cost entered into pricing rules established at the time initial capacities are set. Hemmer (1996) provided an agency parallel to Banker and Hughes (1994) and found similar results on the optimal capacity cost allocation.

There were two studies that dealt with the choice of information systems and the economic performance of the chosen systems. Ittner and Larcker (1995) examined the association between the use of advanced manufacturing practices (TQM) and the choice of information and reward systems, and looked at the impact of these choices on organizational performance. Their study explored the issue of whether the poor performance of TQM adopting firms was due in part to continued reliance on traditional management accounting systems. They found that basic production-oriented TQM practices are related to information and reward systems that place greater emphasis on team and nonfinancial performance. Their results did not support the claim that the highest performance levels should be achieved by organizations making the greatest use of both TQM and nontraditional information and reward systems. O'Brien and Sivaramakrishnan (1996) analyzed the economic performance of two different accounting information systems, traditional accounting and cycle time accounting, in an order initiated production environment. They modeled a stochastic order initiated environment in which work-in-process and finished goods and cycle times were determined by the order acceptance decision. Their simulation results indicated that a simple cycle-time cutoff based order acceptance rule outperformed all accounting information based decision rules because it provided better control over opportunity costs.

Despite the desirability of a formal analysis, the analytical research result is difficult to be made operational in practice because of the numerous assumptions made in the study. Useful empirical implication, in contrast to this limitation, was what action research advocates regarded as of paramount importance in the research for a better cost accounting system. Defending a series of research that he and his co-authors had conducted over several years and was well received in practice, Kaplan (1998) called their research action research.

Quoting Argyris (1997), Kaplan stated that researchers who believed that existing practices could be improved might develop and implement entirely new approaches.[3] Action research that engages the researcher to develop new solutions that alter existing practice, according to Kaplan, emerges if some scholars believe that the existing practices occurring in companies are not desirable or optimal. Kaplan acknowledged that field research helps test theories about stability, equilibrium and optimality in the existing practice, but the test of the feasibility and properties of the innovation, he claimed, was performed through active intervention in companies (laboratories). Attempting to formalize a theory of this mode of knowledge creation, Kaplan stated that laboratories could not simulate the complex settings, relationships and structures where new management ideas must be implemented.

As Kaplan acknowledged, a critical ingredient in the development of a new theory has yet to materialize in his construction of validity in action research.[4] Just how to evaluate the efficacy of theories that emerge from a program of action research has been unclear.

3.4. General-State Studies

There should be the type of studies that address important cost accounting system-related issues in analytical and empirical studies without being constrained by the known limitations of information economics, agency theory, or action research. Called *general-state studies*, these cost accounting studies would directly deal with "better" system issues in a general context. Although they were not performed in the most desirable setting, there have been a small number of cost accounting studies that employed economically relevant measurements and costs in evaluations of alternative cost accounting systems.

The two studies that would shed some light on what would constitute a more general state of studies were not free from the inherent constraints, but the direction of the studies was relevant and promising. Datar and Gupta (1994) attempted a systematic analysis of the intuitive argument that multiple cost pools and multiple activity drivers better reflected the cause and effect relation between overhead resource consumption and products. Their analysis revealed the existence of trade-offs attributable to specification error, aggregation error, errors in measurement of overhead costs and errors in measurement of product-specific units of allocation bases. They found that partially improving specification of cost allocation bases and increasing the number of cost pools in a costing system could actually increase specification and aggregation errors. They also demonstrated that reductions in specification and aggregation errors from more disaggregated and better specified costing systems might increase measurement errors and errors in product costs. It is interesting to observe a study that addressed an implicit assumption that refinements in the cost system would always lead to improved accuracy of product cost numbers and proved that such incremental refinements in the cost system might actually cause product cost errors to increase.

Drake et al. (1999) addressed the issue on the costs and benefits of ABC relative to more traditional volume-based costing systems. They looked at ABC focusing on activities and resources that were under the control of multiple workers. Noting that a coordinated effort is needed to reduce the consumption of those resources, they studied incentives that motivate workers to cooperate as a prerequisite to successful use of ABC. Using workers as subjects in their experiments, they examined how cost accounting system and incentive structure choices interacted. They found that profits were highest when ABC was linked with group-based incentives, which provided motivation to cooperate. The lowest profits resulted when ABC was coupled with tournament-based incentives. Volume-based costing, a cost system that provided a lower level of cost driver information, was found to moderate the incentive effect.

The issues addressed in the two studies involve the measurement errors and changes in a new costing system, the effectiveness of a new costing system relative to the existing system, and a success ingredient in the evaluation of alternative costing systems. These studies contribute to the efforts of cost accounting researchers to identify meaningful issues of a comprehensive nature regardless of whether an analytical or empirical approach is used.

4. SUMMARY AND CONCLUSIONS

The assessment of the nature of perspectives used in analytical and empirical approaches used in cost accounting research in the 1990s reveals four distinct stages of cost accounting studies. *Significance studies* address the issues on understanding costs, cost structure, cost-activity relationships, the economic role of and the nature of changes in cost systems, and the effect of the introduction of new technology on cost systems. They focus on the significance of the new accounting numbers generated from the research design with respect to the particular issue or system relative to the traditional or existing one. *Criteria studies* attempt to articulate how cost numbers are actually used in managerial decisions and show the efforts to identify actual decision criteria used by managers that affect *ex ante* optimal decisions. *Better-alternative studies* deal directly with the critical issue of what really represents a "better" cost accounting system. Limited with respect to their scope or validation process due to inherent constraints, these studies attempt to judge if one cost system is better than the other. *General-state studies* address issues dealing with a general application potential and investigate them in both practical and theoretical contexts.

The research in cost accounting in the 1990s was performed in the atmosphere that a new paradigm was needed in cost accounting. ABC is not a paradigm. The emergence of ABC, however, coincided with the major change in the culture of cost accounting research. Although ABC advocates have not adopted a fundamentally different conception of the new cost accounting paradigm, their new view of cost-activity relationships has allowed their field to experience a period of creativity and of progress. This is evidenced by the growth in cost accounting research in the 1990s with respect to cost drivers, cost allocations, and alternative cost systems. Even agency theory research has benefited from the ABC emergence as discussed in this paper.

The most desirable type of future research would be one that addresses important cost accounting system-related issues in analytical and empirical studies without being constrained by the known limitations of information economics, agency theory, or action research. There have been a small number of cost accounting studies that employed economically relevant measurements and costs in evaluations of alternative cost accounting systems. These studies were not free from the inherent constraints, but the direction of the studies was relevant and promising.

NOTES

1. *Accounting, Organizations and Society* published very few cost system research articles and was not included in the list.
2. This significance is mentioned in Dopuch (1993) as the condition for the new system generating accounting numbers that are *materially different* from those obtained from the existing system. See West (1999) regarding the test of conflicts.
3. Kaplan quoted Argyris (1997) as follows: "If social scientists truly wish to understand certain phenomena, they should try to change them. Creating, not predicting, is the most robust test of validity-actionability." – Kurt Lewin, as quoted in Argyris (1997) from the Kurt Lewin Award Lecture.

4. The validity in this case refers to both internal validity and external validity as discussed in Campbell and Stanley (1963) and evaluated in Birnberg et al. (1990). With respect to internal validity, changes in the dependent variable would refer to improvement in a cost accounting system as explanatory variables (additions of more cost drivers, for example) change. Improvements in managerial decisions would be a dependent variable when cost systems serve as explanatory variables. External validity would refer to the issue of whether generalizations could be made from a causality found between a cost accounting system change (or choice) and improvements in managerial decisions.

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OPERATIONAL PLANNING AND CONTROL WITH AN ACTIVITY-BASED COSTING SYSTEM

Robert C. Kee

ABSTRACT

Theeuwes and Adriaansen (1994), among others, have asserted that activity-based costing (ABC) is inappropriate for operational decision-making. In this article, ABC is modified to reflect separate flexible and committed cost driver rates for an activity. This enables the model to reflect the difference in the behavior of an activity's flexible and committed costs needed for operational planning decisions. The modified ABC facilitates determining the resources required to produce the product mix developed from the firm's strategic plan and the excess capacity that will result. The modifications made to ABC aid in determining an optimal product mix when the firm has excess capacity, while the traditional ABC may not. Equally important, it facilitates measuring the financial implications of the resource allocation decisions that comprise the firm's operational plan. As the operational plan is implemented, operational control is used to ensure that it is performed in an efficient and effective manner. The modified ABC enables the firm's managers to compute the different types of deviations that arise from using flexible and committed resources at the unit, batch, and product levels of the firm's operations. This aids in understanding problematic aspects of the firm's operations and identifying where management resources are needed to improve operational efficiency.

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INTRODUCTION

Operational planning and control are crucial for managing a firm's resources to achieve its financial objectives. Operational planning translates the policies, strategies, and objectives developed from the firm's strategic plan into quantifiable goals and objectives to be achieved during the current period. During each period, operational control is used to assess how well the operational plan was implemented. Analysis of planned and actual results provides feedback information to determine operating efficiency and effectiveness. Differences between planned and actual results are used to identify inefficient business processes and to stimulate efforts to improve their performance. Additionally, information developed from operational control is used as an input into formulating future period's operational plans. This enables the firm to advance its strategic plan, given the problems and adjustments experienced during the prior period's operations. Operational planning and control are integral and complementary aspects of managing a firm's business processes and activities. Operational planning is used to implement strategic planning over successive fiscal periods, while operational control is used to ensure that the firm is proceeding towards its strategic goals in an efficient and effective manner.

Operational planning and control, like any managerial systems, are dependent upon an accounting system for information to evaluate, develop, and implement resource allocation decisions. Traditional cost accounting has a well developed set of techniques, such as variable costing, annual budgeting, standard costing, variance analysis, and flexible budgeting, to implement operational planning and control. However, traditional cost accounting allocates overhead to cost objects based on volume-based metrics, such as direct labor hours. Consequently, traditional cost accounting can lead to significant distortions in the measurements of cost objects, such as products and customers (Cooper & Kaplan, 1988). Activity-based costing (ABC) was developed to overcome the limitations of traditional cost accounting. Surveys of firms using ABC indicate that it is used for product mix, pricing, and product and process improvement decisions (Swenson, 1995) and objectives, such as product costing and better cost information (Shields, 1995). However, these surveys did not indicate that ABC is used for operational planning and control.[1] This may reflect the lack of development and/or modification of traditional cost accounting techniques to the structure of ABC. Theeuwes and Adriaansen (1994) and Bakke and Hellberg (1991), among others, have suggested that ABC is inappropriate for short-run decisions. Therefore, ABC, in its present form, may not be appropriate for operational planning and control decisions.

The purpose of this article is to discuss and illustrate how a modified ABC model may be used to implement operational planning and control. The paper demonstrates that ABC may be modified to support operational planning and estimate its financial implications. Equally important, the article illustrates how the modified ABC model may be used to compare actual and planned results to measure deviations or variances needed to implement operational control.

The remainder of the paper is organized as follows. The next section discusses operational planning and control. The following section discusses ABC and its deficiencies for operational decisions. A modification of ABC is then proposed for supporting operational planning and control. This is followed by a numerical example that illustrates the application of the modified ABC to operational planning and control decisions. The final section presents the summary and conclusions of the article.

OPERATIONAL PLANNING AND CONTROL

Production-related decisions in the current period are determined, in part, from the policies, strategies, and objectives of the firm's strategic plan.[2] Implementation of these decisions, however, is influenced by the nature of the firm's resources. In the current period, the costs of an activity's resources can be classified as flexible and committed. Flexible resources are those acquired as needed, such as supplies, power, and temporary workers. Conversely, committed resources are those contracted for in advance of their usage, such as a lease on a building and a labor agreement for unionized employees. The cost of committed resources will be incurred whether they are used or not. Consequently, committed resources provide capacity to perform the firm's production-related activities. Operational planning involves translating the goals and objectives of the firm's strategic plan into the production-related decisions of the current period, given the capacity provided by the firm's committed resources.

Since a product mix is determined from the firm's strategic plan as well as commitments made to the firm's customers, operational planning begins by determining the quantity of each activity's service or cost driver required to manufacture the firm's planned product mix. This requires reversing the flow of a cost system. That is, the quantity of each product is used to compute the quantity of service or cost drivers required of each support and production activity. The quantity of each activity's service can be further decomposed into the number of full-time employees, office space, supplies, and other specific types of resources necessary to provide an activity's service.[3] From this analysis, the financial consequences of the firm's planned product mix can be estimated. The flexible and committed costs of each activity's services are subtracted from the product mix's revenue to determine the income based on the cost of the resources used in its production. Finally, the cost of unused capacity is deducted to determine the product mix's expected net income. If the estimated income is sufficient to meet the firm's financial objectives, then the firm can begin preparing to implement its operational plan.[4]

Operational control is used throughout the implementation of an operational plan. It consists of daily, weekly, and monthly non-financial measures of performance, such as measuring and evaluating the number of defective units, rework, scrap, and yield rates that are useful to the firm's line employees. Monthly, quarterly, and annual comparisons between actual and budgeted revenue and cost are used to measure deviations from planned performance. This analysis can be extended by calculating the variances or deviations for individual products and each production and support activity. This enables the firm's management to identify problematic aspects of its operations with greater specificity and to direct management attention to address these problems. Analysis of problematic activities enables the firm's management to correct inefficiencies in the firm's production and support processes and thereby maximize efforts to achieve its operational goals. In cases, where an activity's variances are not subject to management control, then the quantity and cost of resources used to produce an activity's service are used to update its cost driver rate, as well as the cost of the products and customers that consume its services.

ACTIVITY-BASED COSTING

ABC is a model of an organization's cost structure. It traces the cost of flexible and committed resources to the support and production activities where they are consumed. An activity's committed cost is divided by a measure of the capacity its resources provide.[5] The resulting cost per unit of an activity's service is combined with the flexible cost per unit of its service to determine an activity's cost driver rate. An activity's cost driver rate is used to trace the cost of an activity's flexible and committed resources to the products that consumed its services during their production. While committed costs are fixed in the short run due to the contractual obligations of the firm, ABC treats the cost of committed resources as if they were flexible, or variable, in nature. As noted by Kaplan and Cooper (1998), the cost of committed resources becomes variable over longer time periods by the change in demand for an activity's capacity and management's subsequent adjustment of the quantity of the committed resources supplied to an activity.

ABC measures the cost of the resources used to manufacture the firm's goods and services (Cooper & Kaplan, 1992). It enables managers to understand the economics of their manufacturing processes and the products they are used to produce. Equally important, ABC provides information for adjusting the capacity of the firm's support and production activities. When the demand for an activity exceeds its capacity, it creates a bottleneck that restricts production and provides a signal to add capacity. Conversely, an activity with unused capacity signals the need for redeploying unused resources to other areas of the firm's operations or reducing the quantity of committed resources. The adjustment of capacity and the subsequent change in spending for committed resources are the mechanisms that enable committed resources to become flexible. The modification of capacity is also the means whereby the profit estimated for a product or customer with ABC may be realized by the firm. The economic measurement of resource allocation decisions made with ABC is interrelated with the management of the firm's production capacity. As noted by Kaplan and Cooper (1998) there is a subtle interplay between resource allocations made with ABC and capacity management decisions.

Critics of ABC suggest that it is inappropriate for short-run resource allocation decisions. For example, Theeuwes and Adriaansen (1994) assert that ABC is primarily focused on the long term and assumes a proportional relationship between the demand for an activity's services and change in an activity's cost. In the near term, management has limited ability to adjust the supply of committed resources to the production needs of the firm. However, ABC incorporates committed cost in the computation of an activity's cost driver rate as if it were a flexible cost. In the short run, committed costs are essentially fixed in nature and are irrelevant for decision-making. Therefore, treating a committed cost as if it were flexible can lead ABC to overestimate the costs that are relevant for short-run, production-related decisions. Theeuwes and Adriaansen (1994) further indicate that ABC fails to distinguish between constrained and non-constrained activities in developing production-related decisions. In the long run, the capacity of constrained activities can be adjusted to meet the firm's production needs.[6] However, in the near term, it may be more difficult to add capacity to activities that restrict the firm's production opportunities. For example, capacity for some activities comes in large, discreet quantities and/or requires commitments months, and sometimes years, in advance of their acquisition, making it difficult to balance the demand and supply for committed resources. Constrained activities create an opportunity cost for every product that uses a bottleneck activity's services and alters the economics of their production. The deficiencies of ABC postulated by Theeuwes and Adriaansen (1994) led them to assert that ABC is unsuitable for operational decision-making. Similarly, Bakke and Hellberg (1991), MacArthur (1993), and Huang (1999) have also hypothesized that ABC is inappropriate for short-run, production-related decisions. Finally, Kaplan and Cooper (1998) suggest the relevant costs for short-term production decisions are short-term variable costs and that ABC provides little insights into these costs.

ABC and Variance Analysis

Several studies have examined how variance analysis might be implemented within an activity-based cost system. Malcom (1991) illustrated variance analysis based on an activity's variable cost by determining a flexible budget variance. Mak and Roush (1994, 1996) extended Malcom's (1991) analysis by disaggregating an activity's resources into variable and fixed costs. A price and efficiency variance was computed for an activity's variable cost, while a budget and capacity variance was computed for its fixed cost. Like Mak and Roush (1994), Kaplan (1994) disaggregated an activity's resources into its flexible and committed costs. However, unlike Mak and Roush (1994), Kaplan (1994) calculated a combined flexible and committed set of variances, rather than separate variances for each type of resource. Finally, Kaplan and Atkinson (1998) illustrated variance analysis by comparing actual revenue and expenses with a flexible budget. The variances in the Kaplan and Atkinson (1998) example for unit- and batch-level activities were disaggregated into price and quantity effects.

Malcom (1991) treated an activity's cost as variable or flexible in the short run. However, in the short run, many of the resources used by the firm's production and support activities are a committed cost. Malcom (1991), Mak and Roush (1994, 1996), Kaplan (1994), and Kaplan and Atkinson (1998) largely adopt the methodology of traditional cost systems to develop variance analysis for an ABC system. For operational control, differences between planned and actual resource usage and cost should incorporate the difference in the behavior of an activity's flexible and committed costs. Variances for an activity's flexible and committed costs have different interpretations and implications for management. Equally important, variances should be based on the hierarchical level at which these resources and costs are incurred. Different types of variances are created when an activity's resources are used at the unit, batch, and product levels of a firm's operations.

Proposed Modification of ABC

For ABC to support operational planning and control, it must be based on the costs that are relevant for these decisions. Consequently, to be useful for short-run decisions, it is proposed that ABC should distinguish between an activity's flexible and committed costs. In effect, a separate cost driver rate would be computed for an activity's flexible and committed resources. The flexible cost driver rate approximates the incremental cost of producing a product over a period of time in which committed costs are largely fixed in nature. Separating an activity's cost into its flexible and committed components also aids in measuring the cost of resources that will be incurred in producing a product mix, as well as the income from its production. Finally, disaggregating an activity's cost into flexible and committed components enables ABC to calculate variances based on the underlying nature of an activity's resources in the near term.

A NUMERICAL EXAMPLE

To illustrate how operational planning and control may be implemented with the modified ABC model, consider the example provided in Table 1. XYZ, Inc.

Table 1. XYZ, Inc. Revenue, Cost, and Operating Structure.

	X1	X2	X3	Committed Cost	Flexible Cost	Total Cost
Panel I: Unit-Level Activities						
Assembly-Machine Hours (MH)	0.5	1	2			
Assembly Overhead						
Expected Cost				$2,760,000		
Practical Capacity-MH				230,000		
Cost Per MH				$12	$6	$18
Panel II: Batch-Level Activities						
Set-Up						
Batch Size	1000	500	500			
Hours/Batch	1	2	2			
Expected Cost				$351,000		
Practical Capacity-Hours				780		
Cost Per Set-Up Hour				$450	$50	$500
Purchasing						
Batch Size	1000	500	500			
Orders/Batch	2	6	10			
Expected Cost				$162,000		
Practical Capacity-Orders				2,700		
Cost Per Purchase Order				$60	$40	$100
Panel III: Product-Level Cost						
Engineering						
Drawings/Product	100	150	200			
Expected Cost				$300,000		
Practical Capacity-Drawings				500		
Cost Per Drawing				$600	$150	$750

Table 1. (*Continued*)

	Product X1		Product X2		Product X3	
	Total Cost	Flexible Cost	Total Cost	Flexible Cost	Total Cost	Flexible Cost
Panel IV: Activity-Based Cost						
Unit Cost						
Direct Material Cost ($10/Lb)	$15.00	$15.00	$15.00	$15.00	$15.00	$15.00
Labor Cost ($8/DLH)[a]	$8.00	$0.00	$8.00	$0.00	$8.00	$0.00
Unit-Level Cost						
Assembly	$9.00	$3.00	$18.00	$6.00	$36.00	$12.00
Batch-Level Cost						
Set-Up	$0.50	$0.05	$2.00	$0.20	$2.00	$0.20
Purchasing	$0.20	$0.08	$1.20	$0.48	$2.00	$0.80
Product-Level Cost						
Engineering	$0.94	$0.19	$1.13	$0.23	$3.75	$0.75
ABC Cost	$33.64	$18.32	$45.33	$21.91	$66.75	$28.75
Price	$52.00	$52.00	$84.00	$84.00	$148.00	$148.00
Profit	$18.36	$33.68	$38.67	$62.09	81.25	$119.25
Planned Sales	80,000	80,000	100,000	100,000	40,000	40,000
Potential Demand	110,000	110,000	120,000	120,000	50,000	50,000

[a] 250,000 Labor Hours Available.

is a medium-sized firm with three support activities – set-up, purchasing, and engineering – and one production activity – assembly. To facilitate discussion, the number of production and support activities and has been limited. However, the principles and concepts discussed in the article are applicable to firms with a larger number of production and support activities. In producing XYZ, Inc.'s products, assembly costs are incurred at the unit level: set-up and purchasing costs are incurred at the batch level: and engineering cost is incurred at the product level. In Panels I, II, and III of Table 1, a cost driver rate for the assembly, set-up, purchasing, and engineering activities is computed and then traced to the products available for sale in Panel IV.

In Panel I, the assembly activity's costs were disaggregated into their flexible and committed components. The assembly activity's committed costs of $2,760,000 were divided by their practical capacity of 230,000 machine hours to determine a committed cost driver rate of $12 per machine hour. The flexible cost of resources used to produce a machine hour of service in assembly is $6. Therefore, the total cost driver rate for assembly is $18 per machine hour. A unit of Product X1, X2, and X3 requires 0.5, 1.0, and 2.0 machine hours, respectively. Using the assembly cost driver rates computed in Panel I, the total assembly costs traced to Products X1, X2, and X3 in Panel IV are $9, $18, and $36, respectively, while the short-run flexible costs of the assembly activity traced to each product are $3, $6, and $12, respectively.

In Panel II, the cost driver rates for XYZ, Inc.'s batch-level activities are given. For the first batch-level activity, set-up, its committed cost was divided by its practical capacity of 780 hours to determine a committed cost driver rate of $450 per set-up hour. The cost of flexible resources for the set-up activity was $50 per set-up hour. Therefore, the total cost driver rate for the set-up activity is $500 per hour. The total and flexible cost driver rates were multiplied by the number of set-up hours needed to produce a batch of each product and divided by the number of units in the batch to determine the set-up cost per unit. Therefore, as indicated in Panel IV, the total and flexible set-up costs per unit of Product X1 are $0.50 and $0.05, respectively. The total and flexible set-up costs for the remaining products in Panel IV were computed in a similar manner. Flexible and total cost driver rates for the purchasing activity and their conversion to a unit cost for each product were determined like those of the set-up activity.

In Panel III, a cost driver rate for XYZ, Inc.'s product-level activity, engineering, is given. Engineering's committed costs were divided by its practical capacity of 500 drawings to derive a committed cost driver rate of $600 per drawing. The cost of flexible resources used in engineering was $150 per drawing. Therefore, the total cost driver rate is $750 per drawing. The total and flexible cost driver rates were multiplied by the drawings required to design each product and divided by a product's planned sales. Therefore, the total and flexible engineering costs for Product X1 are $0.94 and $0.19 per unit, respectively.

In the last panel of Table 1, Panel IV, the per unit activity-based cost, price, profit, planned sales and potential demand for each of XYZ, Inc.'s products are given. The costs of direct material and labor were traced directly to each product, while the costs of assembly, set-up, purchasing, and engineering were traced through the cost driver rates computed in Panels I, II, and III. In Panel IV, the total and flexible costs of each of XYZ, Inc.'s three products are given. The total cost represents a product's traditional activity-based cost. For example, the total cost of Product X1, $33.64, represents the costs of the flexible and committed resources that are expected to be used in its production. Conversely, the flexible cost for Product X1 of $18.32 represents the incremental cost of producing the product in the short run.[7] Each product's total and flexible costs were subtracted from its current sales price to measure its long- and short-term profitability.[8] For example, in Panel IV, the profits of Product X1, based on its total and flexible cost and price, are $18.36 and $33.68, respectively.

Product-Mix

The products and sales quantities developed from XYZ's Inc.'s strategic plan for the current period are listed in the row labeled "Planned Sales" in Panel IV of Table 1. The maximum demand for each product is listed in the row labeled "Potential Demand." In Panel I of Table 2, the available capacity of each activity and the capacity required to produce the firm's planned sales mix are listed. For example, to produce the planned sales of 80,000 units of Product X1 80,000 labor hours (1 DLH/unit × 80,000 units), 40,000 MH (0.5 MH/unit × 80,000 units), 80 set-up hours (1 set-up hour/batch × (80,000 units ÷ 1,000 units/batch)), 160 purchase orders (2 orders/batch × (80,000 units ÷ 1,000 units/batch)), and 100 engineering drawings are required. The capacity required for the planned sales of Products X2 and X3 were computed in a similar manner. The sum of the capacity required to manufacture each product is listed in the row labeled "Capacity Usage" in Panel I. The capacity usage for producing the firm's planned sales mix was subtracted from available capacity to compute the firm's excess capacity.

One of the questions confronting the management of XYZ, Inc. is how should the excess capacity remaining after its planned sales mix is produced be used? As indicated in Panel IV of Table 1, the firm can sell additional units of each of its products over the quantities specified in its planned sales mix. Since the strategic plan and customer commitments will determine future periods' planned sales, selecting a product mix to use excess capacity is a near-term decision. While the firm may be faced with similar decisions in the future, the planned sales mix and available capacity of each activity in future periods will be different. A critical aspect of selecting a short-run product mix is to identify if the firm has a bottleneck activity, and if so, which activity is the bottleneck? In Panel II of Table 2, the maximum quantity of each product that can be produced with each activity's excess capacity is computed. For Product X1, the maximum number of units that can be manufactured is 30,000 units, 20,000 units, 140,000 units, and 270,000 units with the excess labor, assembly machine hours, set-up hours, and purchase orders, respectively. The maximum quantity of Product X1 that can be produced is determined by the activity that restricts its production the most. As indicated, the maximum quantity of Product X1 that can be produced is 20,000 units, and the most constrained activity in its production is the assembly activity. Analysis of Products X2 and X3 indicates that the maximum quantity that can be manufactured with the excess capacity of each activity is 10,000 and 5,000

Table 2. XYZ, Inc. Unused Capacity and Product Mix Selection with Unused Capacity.

	Quantity	Labor	Assembly	Set-Up	Purchasing	Engineering
Available Capacity		250,000 (Hours)	230,000 (MH)	780 (Hours)	2,700 (Orders)	500 (Drawings)
Panel I: Capacity Availability and Usage						
Capacity Demand						
Product X1	80,000	80,000	40,000	80	160	100
Product X2	100,000	100,000	100,000	400	1,200	150
Product X3	40,000	*40,000*	*80,000*	*160*	*800*	*200*
Capacity Usage		*220,000*	*220,000*	*640*	*2,160*	*450*
Excess Capacity		30,000	10,000	140	540	50
Panel II: Production with Excess Capacity						
Product X1		30,000	20,000	140,000	270,000	N/A
Product X2		30,000	10,000	35,000	45,000	N/A
Product X3		30,000	5,000	35,000	27,000	N/A
Most Constrained Activity		NO	Yes	NO	NO	
Panel III: Product Mix Selection for Excess Capacity						
Traditional ABC	X1	X2	X3			
Profit Per Unit-ABC[a]	$19.30	$39.80	$85.00			
Bottleneck Usage	0.5/MH	1/MH	2/MH			
Profit Per Assembly MH	$38.60	$39.80	$42.50			
Profitability Ranking	**3**	**2**	**1**			
Product Mix Decision	0	0	5,000			

Table 2. *(Continued)*

	Quantity	Labor	Assembly	Set-Up	Purchasing	Engineering
Available Capacity		250,000 (Hours)	230,000 (MH)	780 (Hours)	2,700 (Orders)	500 (Drawings)
Panel IV: Product Mix Selection for Excess Capacity						
Modified ABC	X1	X2	X3			
Profit Per Unit-Modified ABC[a]	\$33.87	\$62.32	\$120.00			
Bottleneck Usage	0.5/MH	1/MH	2/MH			
Profit Per Unit of Bottleneck Usage	\$67.74	\$62.32	\$60.00			
Profitability Ranking	**1**	**2**	**3**			
Product Mix Decision	20,000	0	0			
Panel V: Product Mix and Capacity Utilization						
Capacity Demand						
Product X1	100,000	100,000	50,000	100	200	100
Product X2	100,000	100,000	100,000	400	1,200	150
Product X3	40,000	*40,000*	*80,000*	*160*	*800*	*200*
Capacity Usage		*240,000*	*230,000*	*660*	*2,200*	*450*
Excess Capacity		10,000	0	120	500	50
Redeployment of Excess Capacity[b]		*5,000*	*0*	*20*	*200*	*0*
Expected Unused Capacity		5,000	0	100	300	50

N/A = not applicable since engineering costs have already been incurred.
[a] Engineering costs are excluded from computing unit-level profit.
[b] Redeployed in the second half of XYZ Inc.'s fiscal year.

units, respectively. The activity that limited the production of X2 and X3 is also the assembly activity. Therefore, the assembly activity is the most constrained activity with respect to manufacturing products with the excess capacity listed in Panel I.[9]

In Panel III, a product mix is selected based on a traditional ABC model. The profit of each product is its price less its unit- and batch-level costs. Product-level cost will have already been incurred to produce each of the three products for the firm's planned sales mix and will not be incurred again if additional units of any of the three products are produced. To incorporate the opportunity cost of using the resources of a constrained activity, the unit profit of each product was divided by the quantity of the assembly activity's service required to produce a unit of the product. As indicated, Product X3 has the highest profit per unit of the assembly activity service, followed by Products X2 and X1, respectively. Using the traditional ABC model, managers would produce 5,000 units of Product X3 with the firm's excess capacity.

In Panel IV, the modified ABC was used to select a product mix for the firm's excess capacity. The profit of each product is its price less its flexible unit- and batch-level activity's costs used to manufacture the product. Product-level costs were excluded since they will have already been incurred to produce each of the three products in the firm's planned sales mix. To incorporate opportunity cost, the profit of each product was divided by its use of the bottleneck activity's service. As indicated, Product X1 has the highest profit per unit of the bottleneck activity's service, followed by Products X2 and X3, respectively. Using the modified ABC model, the firm would produce 20,000 units of Product X1 with the excess capacity listed in Panel I.

The analysis of the products in Panels III and IV of Table 2, with the traditional and modified ABC models, respectively, illustrate the frequent conflict between products that are the most attractive to produce over time horizons in which management has different degrees of control over committed resources. The traditional ABC model treats the cost of all resources as a flexible cost. Over a period of time, a firm's management has discretionary power over its committed resources and can adjust the supply of these resources to that needed to produce the firm's planned product mix. In effect, the cost of products estimated with ABC reflects the cost the firm can expect to incur as it adjusts the capacity of committed resources to that required to manufacture its products. However, in the near term, the firm has less discretionary power over committed resources, and its cost is essentially fixed in nature. The modified ABC model treats committed resources that management cannot influence as a sunk cost that is irrelevant for decision-making. The basic difference between the traditional and modified ABC reflects different assumptions about management ability to influence committed resources. Since the product mix decision being evaluated in Panels III and IV is for the current period, the modified ABC model was used to select the product mix to produce with the firm's excess capacity.

Resource Requirements and Projected Income

The 20,000 units of Product X1 selected with the modified ABC model was added to XYZ, Inc.'s planned sales mix and is listed in Panel V of Table 2. The capacity required of each activity to produce each product of the revised sales mix is listed in each product's row. The capacity required to manufacture the sales mix was subtracted from the available capacity of each activity to determine its remaining excess capacity. As expected, all of the activities, except for the assembly activity, have excess capacity. At this point, the firm has excess capacity that cannot be used to increase production. Therefore, the firm's management should redeploy excess capacity to other productive uses within the firm or eliminate it if possible. The capacity of resources that can be redeployed and/or eliminated is listed in the row labeled "Redeployment of Excess Capacity." As indicated, the redeployed excess capacity will occur in the second half of the firm's fiscal period. The quantity of capacity redeployed was subtracted from excess capacity to derive the firm's expected unused capacity for the next period.

The budgeted income for the product mix, cost driver usage, and unused capacity listed in Panel V of Table 2 is given in Panel I of Table 3. The revenue of each product was computed from its sales quantity and price. Similarly, each product's direct material and labor costs were computed by multiplying its sales quantity and unit cost of material and labor given in Panel IV of Table 1, respectively. The costs of the assembly, set-up, purchasing, and engineering activities was computed for each product by multiplying the quantity of their cost drivers required to produce each product listed in Panel V of Table 2 times their total cost driver rates listed in Table 1. The revenue and cost of resources used to produce each product were summed to determine the firm's revenue and cost. The cost of resources was subtracted from the revenue of each product to determine its income based on the resources used in its production. The expected unused capacity for each activity in Panel V of Table 2 was multiplied by its committed cost driver rates to determine unused capacity cost. The cost of unused capacity is attributable to production but not to individual products. Therefore, it was deducted from the firm's income. As indicated in Panel I of Table 3, the estimated income of the revised product mix is \$8,839,500.[10] Based on the analysis in Tables 1 through 3, XYZ, Inc.'s management chose to implement the revised sales mix listed in Panel V of Table 2 with expectations of earning the income forecasted in Panel I of Table 3.

Table 3. XYZ, Inc. Budgeted Revenue and Expenses and Actual Operating Results.

	X1	X2	X3	Firm
Panel I: Budgeted Revenue and Expenses				
Sales	$5,200,000	$8,400,000	$5,920,000	$19,520,000
Resources Used				
Direct Material (Lbs)	$1,500,000	$1,500,000	$600,000	$3,600,000
Direct Labor Hours (DLH)	$800,000	$800,000	$320,000	$1,920,000
Assembly (MH)	$900,000	$1,800,000	$1,440,000	$4,140,000
Set-Up (Hours)	$50,000	$200,000	$80,000	$330,000
Purchasing (Orders)	$20,000	$120,000	$80,000	$220,000
Engineering (Drawings)	$75,000	$112,500	$150,000	$337,500
Total Cost of Resources Used	$3,345,000	$4,532,500	$2,670,000	$10,547,500
Income Based on Resources Used	$1,855,000	$3,867,500	$3,250,000	$8,972,500
Unused Capacity				
Direct Material (Lbs)				$0
Direct Labor Hours (DLH)				$40,000
Assembly (MH)				$0
Set-Up (Hours)				$45,000
Purchasing (Orders)				$18,000
Engineering (Drawings)				$30,000
Total Unused Capacity Cost				$133,000
Net Income				$8,839,500

Table 3. *(Continued)*

	X1	X2	X3	Total
Panel II: Quarter One				
Actual Operating Results				
Sales (Units)	24,000	25,000	10,000	59,000
Direct Material (Lbs)	37,000	37,500	15,500	90,000
Direct Labor (DLH)	25,000	25,800	11,400	62,200
Assembly (MH)	12,200	25,200	20,100	57,500
Set-Up (Hours)	28	106	48	182
Purchasing (Orders)	54	316	230	600
Engineering (Drawings)	105	154	210	469
Batches	26	51	22	99

	Total Flexible Cost	Cost Driver Usage	Cost Driver Rate	Total Committed Cost	Practical Capacity[a]	Cost Driver Rate
Panel III: Quarter One						
Actual Operating Cost						
Direct Material (Lbs)	$918,000	90,000	$10.20	$0		$0
Direct Labor (DLH)	$0	62,200	$0.00	$500,000	62,500	$8.00
Assembly (MH)	$365,125	57,500	$6.35	$713,000	57,500	$12.40
Set-Up (Hours)	$8,827	182	$48.50	$93,600	195	$480.00
Purchasing (Orders)	$25,200	600	$42.00	$42,930	675	$63.60
Engineering (Drawings)	$65,660	469	$140.00	$325,000	500	$650.00

[a] Adjusted to a quarterly basis except for engineering.

Operational Control

As the operational plan in Panel V of Table 2 was implemented, daily, weekly, and monthly measurements of defective units, rework, scrap, and yield rates were used by line personnel to evaluate and adjust the operating processes of the firm. At the end of the first quarter, budgeted and actual financial results were compared to obtain a comprehensive overview of the firm's operations. This enables the firm's management to review the actions of line personnel and evaluate how well they have maintained operational efficiency. Furthermore, an analysis of deviations between actual and budgeted costs over a period of months, and from a firm wide perspective, enables the firm's management to identify trends, repetitive problems, and separate causes of operating inefficiencies from their symptoms. This information is used to identify problematic aspects of the firm's operations and to direct management resources to eliminate these inefficiencies in the firm's production processes. In cases where the problematic aspects of the firm's operations cannot be eliminated due to overly optimistic estimates of the quantity and cost of resources used to perform an activity or manufacture a product, variance analysis enables the firm's management to adjust its operational plan with more accurate cost data to plan subsequent operations.

The operating data and costs for XYZ, Inc.'s first quarter's production are given in Panels II and III of Table 3, respectively. In Panel II, first quarter sales, the quantity of direct material, labor, and each activity's services, and the number of batches used to manufacture each product are given. XYZ, Inc.'s sales and production are incurred uniformly throughout the year. Engineering costs to design Products X1, X2, and X3 are incurred initially during the year. During the remainder of the year, engineering resources, other than those shown in Panel III of Table 3, are devoted to research and development efforts. The cost of engineering resources devoted to research and development is considered a facility level cost and is excluded from the analysis of the firm's current production. As indicated in Panel II, first quarter sales of Product X1 were 1,000 units below the operational plan while Products X2 and X3 sales were as budgeted. The flexible and committed costs incurred during the quarter are listed in Panel III. Flexible costs were divided by the quantity of their service used in production, while committed costs, except for engineering, were divided by their practical capacity, adjusted to a quarterly basis to compute their actual cost driver rates.

In Table 4, variances for direct material, labor, and each activity were determined by computing the deviation between their product and actual costs. Product cost is the standard quantity of input or service required for the quantity of each product manufactured times the standard cost or cost driver rate for an input or service. Actual flexible cost is the actual input or service used to produce the firm's products

Table 4. XYZ, Inc. Variance Analysis for Quarter 1.

Panel I: Material and Labor			
Direct Material (flexible cost)			
Product Cost	(88,500 lbs × $10/lb)		$885,000
Efficiency Var.	(90,000 − 88,500) lbs × $10/lb	−$15,000	
Price Var.	($10.00 − $10.20)/lb × 90,000 lbs	−$18,000	
Actual Cost	90,000 lbs × $10.20/lb		$918,000
Direct Labor (committed cost)			
Product Cost	59,000 DLH × $8/DLH		$472,000
Efficiency Var.	(62,200 − 59,000) DLH × $8/DLH	−$25,600	
Unused Capacity Var.	(62,500 − 62,200)DLH × $8/DLH	−$2,400	
Capacity Var.	(62,500 − 59,000) DLH × $8/DLH	−$28,000	
Budget Var.	($8.00 − $8.00)/DLH × 62,500 DLH	$0	
Actual Cost	$8/DLH × 62,500 DLH		$500,000
Panel II: Unit-Level Activities			
Assembly (flexible cost)			
Product Cost	57,000 MH × $6/MH		$342,000
Efficiency Var.	(57,500 − 57,000) MH × $6/MH	−$3,000	
Price Var.	($6.35 − 6.00)/MH × 57,500 MH	−$20,125	
Actual Cost	$6.35/MH × 57,500 MH		$365,125
Assembly (committed cost)			
Product Cost	57,000 MH × $12/MH		$684,000
Efficiency Var.	(57,500 − 57,000) MH × $12/MH	−$6,000	
Unused Capacity Var.	(57,500 − 57,500) MH × $12/MH	$0	
Capacity Var.	(57,500 − 57,000) MH × $12/MH	−$6,000	
Budget Var.	($12.40 − $12.00) × 57,500 MH	−$23,000	
Actual Cost	$12.40/MH × 57,500 MH		$713,000
Panel III: Batch-Level Activities			
Set-Up (flexible cost)			
Product Cost	164 hrs × $50/hr		$8,200
Batch Var.	(172 − 164) hrs × $50/hr	−$400	
Efficiency Var.	(182 − 172) hrs × $50/hr	−$500	
Price Var.	($48.50 − $50.00) hrs × 182 hrs	$273	
Actual Cost	182 hrs × $48.50/hr		$8,827
Set-Up (committed cost)			
Product Cost	164 hrs × $450/hr		$73,800
Batch Var.	(172 − 164) hrs × $450/hr	−$3,600	
Efficiency Var.	(182 − 172) hrs × $450/hr	−$4,500	
Unused Capacity Var.	(195 − 182) hrs × $450/hr	−$5,850	
Capacity Var.	(195 − 164) hrs × $450/hr	−$13,950	
Budget Var.	($480.00 − 450.00)/hr × 195 hrs	−$5,850	
Actual Cost	$480/hr × 195 hrs		$93,600

Table 4. (*Continued*)

Purchasing (flexible cost)			
Product Cost	548 orders × $40/orders		$21,920
Batch Var.	(578 − 548) orders × $40/order	−$1,200	
Efficiency Var.	(600 − 578) orders × $40/order	−$880	
Price Var.	($42 − $40)/orders × 600 orders	−$1,200	
Actual Cost	600 orders × $42/order		$25,200
Purchasing (committed cost)			
Product Cost	548 orders × $60/order		$32,880
Batch Var.	(578 − 548) orders × $60/order	−$1,800	
Efficiency Var.	(600 − 578) orders × $60/order	−$1,320	
Unused Capacity Var.	(675 − 600) orders × $60/order	−$4,500	
Capacity Var.	(675 − 548) orders × $60/order	−$7,620	
Budget Var.	($63.60 − $60.00) orders × 675 orders	−$2,430	
Actual Cost	675 orders × $63.60/orders		$42,930
Panel IV: Product-Level Activities			
Engineering (flexible cost)			
Product Cost	450 drawings × $150/drawing		$67,500
Product Var.	(469 − 450) drawings × $150/drawing	−$2,850	
Price Var.	($140 − $150) drawings × 469 drawings	$4,690	
Actual Cost	469 drawings × $140/drawing		$65,660
Engineering (committed cost)			
Product Cost	450 drawings × $600/drawing		$270,000
Product Var.	(469 − 450)drawings × $600/drawing	−$11,400	
Unused Capacity Var.	(500 − 469) drawings × 600/drawing	−$18,600	
Capacity Var.	(500 − 450) drawings × $600/drawing	−$30,000	
Budget Var.	($650 − $600)/drawing × 500/drawing	−$25,000	
Actual Cost	500 drawings × $650/drawing		$325,000
Panel V: Bottleneck Variance			
Capacity Variance in Assembly			
Income Reduction[a]	(500 MH/ (0.5 MH/unit)) × $33.87/unit		−$33,870
Unused Capacity Cost[b]			
Direct Labor	(1,000 DLH × $8/DLH)	−$8,000	
Set-Up	(1 hrs × $450/hr)	−$450	
Purchasing	(2 orders × $60/order)	−$120	−$8,570
Total Bottleneck Variance			−$42,440

[a] The reduction in Product X1's unit profit is its price less its flexible unit- and batch-level costs.
[b] Unused capacity costs resulting from a bottleneck variance are included in the capacity variance for each activity with committed cost.

times the actual cost or cost driver rate for an input or service. For activities with committed resources, practical capacity was used in place of actual input or service to compute actual committed cost.

Direct material is a flexible cost incurred at the unit level of the firm's operations. Therefore, in Panel I of Table 4, a product cost, efficiency and price variance, and actual cost for direct material were computed using the procedures of traditional cost accounting. Due to the firm's labor agreement, direct labor is a committed cost. Product cost for direct labor was computed by multiplying the standard 1 labor hour per unit times the 59,000 units of Products X1, X2, and X3 produced times the standard wage rate of $8 per hour. An efficiency variance was computed by subtracting the standard 59,000 labor hours from the actual 62,200 labor hours used in production and multiplying by the standard wage rate for an unfavorable variance of $25,600. In Quarter 1, labor provides a capacity of 62,500 hours. However, only 62,200 hours were used in production, leading to an unfavorable, unused capacity variance of $2,400. A capacity variance was computed by taking the difference between the capacity of labor and the standard labor hours that should have been used in production for an unfavorable capacity variance of $28,000. The capacity variance represents the quantity of unused capacity that would have resulted if the firm had used an activity's services efficiently. Alternatively, a capacity variance represents the sum of all variances related to capacity. The final variance for labor is how much the firm under, or over, spent its budget for its committed resources. A budget variance was computed by subtracting standard from actual labor costs per unit and multiplying by the capacity provided by labor resources. The sum of labor's product cost, capacity, and spending variances is equal to its actual labor cost. The assembly activity has flexible and committed costs that are used at the unit level like those of direct material and labor, respectively. Therefore, variances for assembly's flexible cost were computed like those of direct material and variances for its committed cost were computed similar to those of direct labor.

In Panel III of Table 4, variances for the firm's batch-level activities are given. For the first batch-level activity, set-up, the standard number of batches required to produce each product was determined by dividing each product's sales quantity by its standard batch size. Therefore, 24, 50, and 20 set-up batches should have been used to manufacture Products X1, X2, and X3, respectively. The set-up hours per batch times the number of batches that should have been used for each product results in a standard of 164 set-up hours. Product cost for the set-up activity's flexible cost was $8,200. In Panel II of Table 3, 26, 51, and 22 batches were actually used to produce the three products. For the actual batches used, the standard set-up hours should have been 172. The difference between the set-up hours for the actual and standard number of batches times the flexible cost driver rate results in an unfavorable batch variance of $400. The actual set-up hours used to perform the actual batches was 182. The 10 additional set-up hours lead to an unfavorable efficiency variance of $500. The batch variance represents the deviation from standard cost due to using either more or fewer batches than standard, while the efficiency variance measures the deviation of an activity's actual units of service differing from its standard units of service for the actual batches performed. The last variance for the set-up activity's flexible cost was a favorable price variance of $273.

Product cost for the set-up activity's committee cost was computed similarly to the set-up activity's flexible cost, except that its committed cost driver rate was used to determine allowable cost. A batch and efficiency variance was computed for the set-up activity's committed cost based on the difference between its actual and standard number of batches and the difference between its actual and standard set-up hours for the actual batches, respectively. The batch and efficiency variances for an activity's committed cost represent the capacity used in performing a nonstandard number of batches and the quantity of an activity services used in excess of the standard quantity for the actual batches performed, respectively. The difference between the set-up activity's capacity and the actual set-up hours used in production resulted in an unused capacity variance of $5,850. The set-up activity's capacity variance, the difference between its capacity of 195 hours and the standard 164 hours allowed for production times its committed cost driver rate, was $13,950 unfavorable. The set-up activity's actual cost driver was $30 per hour more than the standard, leading to an unfavorable budget variance of $5,850. Variances for the purchasing activity's flexible and committed costs were computed similar to those of the set-up activity.

In Panel IV of Table 4, variances for the firm's product-level activity, engineering, are computed. For engineering's flexible cost, a product variance was computed for the 19 additional drawings used to design Products X1, X2, and X3. As indicated, this caused an unfavorable product variance of $2,850. Engineering's flexible costs were $10 per drawing less than its standard cost, for a favorable price variance of $4,690. For engineering's committed cost, the 19 additional drawings used in excess of the planned number led to an unfavorable product variance of $11,400. Analysis of engineering's available and used capacity resulted in unfavorable unused capacity and capacity variances of $18,600 and $30,000, respectively. The cost of each engineering drawing exceeded its standard cost by $50, leading to an unfavorable budget variance of $25,000.[11]

The last variance computed in Panel V of Table 4 was a bottleneck variance. Discussions of cost control ignore the effect of a bottleneck activity. However, every unit of a bottleneck activity's capacity lost through waste, inefficiency, or other causes results in fewer units of the firm's product mix being produced. Equally important, a bottleneck variance causes the firm's non-bottleneck activities to have additional unused capacity. The bottleneck activity for XYZ, Inc. is its assembly activity. Therefore, the 500 machine hours of assembly's capacity used inefficiently led to producing 1,000 fewer units of Product X1. This leads to lost sales of $52,000 and reduced income of Product X1 by $33,870. The reduction in the unit profit of Product X1 is its price less its flexible unit- and batch-level costs. The 1,000 fewer units of Product X1 produced also lead to an additional 1,000 labor hours, 1 set-up hour, and 2 purchase orders of unused capacity and increased unused capacity cost by $8,750.

Variance Analysis and Interpretation

The variances for an activity's flexible cost represent the difference between actual and standard expenditures for resources used to produce the firm's products. Therefore, variances for an activity's flexible cost reflect deviations from planned performance that directly affect the firm's net income. Accordingly, the firm's management must determine which of these variances arose from random effects and which arose from underlying defects in the firm's production processes. Once variances that indicate a prospective problem in the firm's operations have been identified, the level at which a flexible variance occurred aids in its analysis. For example, an efficiency and price variance for a unit-level activity can be interpreted the same as variable cost variances in a traditional cost system. However, batch-level variances relate to providing a support service necessary to produce a predetermined quantity of a product. Consequently, analysis should focus on the actions and decisions made with respect to manufacturing a product in non-standard batch sizes, as well as how an activity's resources were used to perform batch-level activities. Conversely, product-level variances involve providing a service that is necessary to manufacture a product independent of the number of units or batches produced. Consequently, product-level variances should be analyzed with respect to the decisions and actions related to preparing the product for production.

With the exception of budget variances, an activity's committed cost variances relate to how the capacity of its committed resources was used in production. Under ABC, capacity-related costs are incorporated into the estimated and actual income either through product or unused capacity cost. Therefore, capacity-related variances have no effect on the amount of committed cost incurred nor on the firm's net income. However, analysis and elimination of the underlying cause(s) of these variances are still important. The efficiency, batch, and product variances for committed cost all represent capacity that was used in excess of the standard quantity. Therefore as the firm eliminates the causes(s) of these variances, they will become unused capacity the firm can either redeploy to alternative uses within the firm or eliminate. As the firm is able to reduce capacity-related variances and its unused capacity, it will be able to realize the income of products estimated with ABC.

An activity's budget variance represents the difference between the actual and budgeted costs of its committed resources. Consequently, these variances, like flexible cost variances, impact the firm's net income. Accordingly, they should be analyzed at the level at which an activity's capacity was used in production. The last variance in Table 4 is the bottleneck variance. Analysis of the bottleneck variance is particularly important since every unit of its capacity lost reduces the firm's production opportunities. Consequently, identification and correction of the underlying cause(s) of inefficiencies in using a bottleneck activity's capacity is needed to maximize the firm's production opportunities. Accordingly, a bottleneck activity should be monitored frequently to identify and correct inefficiencies that reduce production and increase the unused capacity of the firm's non-bottleneck activities.

SUMMARY AND CONCLUSIONS

Operational planning and control are critical aspects of managing a firm's operations to achieve its economic objectives. Operational planning is used to implement the policies, strategies, and objectives of the firm's strategic plan. Operational control is used to ensure that the firm is proceeding towards its strategic plan in an efficient and effective manner. Surveys of firms using ABC seldom report its application for operational planning and control (Shields, 1995, Swenson, 1995). This may suggest the lack of development and/or modification of operational planning and control techniques used by traditional cost accounting to the structure of ABC. Furthermore, Theeuwes and Adriaansen (1994) and MacArthur (1993) have suggested that ABC is inappropriate for short-run decisions. Therefore, ABC, in its present form, may not be appropriate for operational planning and control decisions.

In this article, ABC was modified to reflect an activity's flexible and committed costs. Separate flexible and committed cost driver rates for an activity enable the modified ABC to reflect the difference in the behavior of an activity's cost needed for operational planning and control decisions. When the firm has capacity in excess of that needed to produce the product mix developed from its strategic plan, the modified ABC model can select an optimal product mix, while the traditional ABC may not. Equally important, the modified ABC model facilitates determining the resources required to produce the firm's sales mix and estimate its financial implications. For operational control, the modified ABC model aids in computing deviations between a firm's actual and planned performance. Variances developed from the modified ABC model aids in understanding the difference in behavior of an activity's cost, as well as understanding the different types of variances that arise from using an activity's resources at the unit, batch, and product levels of a firm's operations.

The modified ABC model provides information useful for operational planning and control decisions. Consequently, the modification of ABC proposed in this article overcomes the criticism of ABC that it is inappropriate for short-run decisions. The modified and traditional ABC models provide a complementary perspectives of a firm's cost structure. The traditional ABC measures the cost of resources used to produce the firm's products and the adjustments to its committed resources necessary to achieve a product's estimated cost and related profitability. Conversely, the modified ABC measures the resource requirements and income of a product mix in the current period, reflecting management's limited ability to adjust the supply and demand for committed resources. Equally important, the modified ABC enables operational control decisions to ensure that the operational plan is implemented in an efficient and effective manner.

NOTES

1. In a survey of firms using activity-based cost management (ABCM), Foster and Swenson (1997) found that budget and planning with ABCM was ranked seventh out of fourteen decision areas. Respondents were asked to rate the current ABCM relative to the previous cost management system on a scale of 5 (excellent), 4 (good), 3 (average), 2 (fair), and 1 (poor). The use of ABCM relative to the respondents' prior cost management systems for budgeting and planning was ranked 2.86. In effect, budget and planning with ABCM was ranked slightly less than average relative to performing this function with the firm's prior cost management system. This may indicate the need to modify ABC to perform the budgeting and planning functions more effectively relative to traditional cost systems.
2. Although the paper focuses on the application of operational planning and control with ABC in a manufacturing environment, the principles and concepts are equally applicable to service firms.
3. See Brimson and Antos (1999) for an extended discussion of this and related issues.
4. If the projected income is insufficient to meet the firm's financial objectives, analysis of the firm's strategic goals, the price and cost of its products, and opportunities for product and process improvement may be used to determine alternative product mix and cost scenarios to enhance the firm's profitability. Several iterations of operational planning may be required to determine a plan with a projected income sufficient to meet the firm's financial objectives.
5. Several measures of capacity are available, such as theoretical, practical, normal, and expected capacity. Kaplan and Cooper (1998) prescribe the use of practical capacity to estimate an activity's cost driver rate. Practical capacity is defined as theoretical capacity adjusted for normal events such as repairs and maintenance, which reduce the quantity of

theoretical capacity available for production. In addition, the protective capacity needed for activities, subject to stochastic variation and/or surges in demand, may also be deducted from theoretical capacity to reflect the practical capacity of these activities (Kaplan & Cooper, 1998). Throughout the paper, practical capacity was used to determine cost driver rates consistent with prescriptions in the ABC literature (Cooper & Kaplan, 1992; Kaplan & Cooper, 1998). However, theoretical, normal, or expected capacity may be used and would lead to alternative measures of product cost, as well as different types and quantities of unused capacity.

6. Short and long run are relative terms. For purposes of this paper, short run is a period of time in which the majority of the firm's committed resources are not subject to management adjustments of their capacity. Conversely, the long run is a period of time in which the majority of the firm's committed resources are subject to management adjustments and are flexible with respect to decisions to maintain, expand, or eliminate the capacity they provide.

7. The modified ABC represents an alternative conceptualization of ABC in which flexible costs are discretionary with respect to the decision to produce a given quantity of a product and committed costs are discretionary with respect to the decision to provide production capacity.

8. If a product's current- and long-term prices are expected to differ, then its long-term price should be used to evaluate long-term, production-related decisions.

9. If the bottleneck shifts among activities with respect to the maximum quantity of each product that could be produced, then the firm is faced with the potential for interactive constraints. That is, the selection of an optimal product mix can be affected by two or more constraints simultaneously. Under these conditions, mathematical programming will be required to solve for the optimal product mix. See Kee (1995) and Malik and Sullivan (1995) for a discussion and examples of selecting an optimal product mix using mixed integer programming.

10. If the traditional ABC model had been used to select a product mix for the excess capacity in Panel I of Table 2, the firm would have produced 5,000 additional units of Product X3 and had an expected income of $8,762,100. The modified ABC resulted in an expected income of $8,839,500, or $77,400 more than that of the traditional ABC model.

11. The variances computed in Table 4 can be further decomposed into individual product variances.

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THE EFFECTS OF BENCHMARKING AND INCENTIVES ON ORGANIZATIONAL PERFORMANCE: A TEST OF TWO-WAY INTERACTION

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ABSTRACT

Using data collected in 1999 from manufacturing units, this paper reports the results of an investigation into the interactive effect of benchmarking and incentives on manufacturing unit performance. Based on a mail questionnaire sent to a sample of manufacturing units within U.S. electronic industry, the results of this paper provide evidence of significant interaction effect of benchmarking and incentives resulting in product cost improvement and product quality performance.

INTRODUCTION

In today's intensely competitive environments, firms must become experts at developing low-cost, high-quality products that have the functionality that customers demand. They must develop integrated quality, functionality, and cost management systems that ensure that products are successful when launched (Cooper & Slagmulder, 1999). These competitive pressures have led organizations to focus on the manufacturing function as being of strategic importance. For many business units, these competitive pressures have led to the implementation

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of advanced manufacturing practices such as benchmarking. Benchmarking is necessary both to identify the best practices of competitors and to provide measurements in the control system for assessing performance related to improved processes.

Many firms have proven that benchmarking provides added value (Chan, 1993; Elnathan et al., 1996; Hutton & Zairi, 1995; Voss & Ahlstrom, 1997). However, implementation by some organizations has proven problematic resulting in failure (DeToro, 1995). The act or process of benchmarking is embedded in a behavioral and organizational context that defines programs and innovations that are implemented. Thus, it is very important that benchmarking implementation strategy focus on these behavioral and organizational variables. Incentive systems represent an important organizational variable that influences the context within which manufacturing unit managers formulate and implement strategies (Fisher & Govindarajan, 1992). Several research surveys have shown, for example, that an important aspect of continuous improvement is an appropriate linkage to incentive structures (Banker et al., 1993; Johnson & Kaplan, 1987; Kaplan, 1990; Wruck & Jensen, 1994). Therefore, the purpose of this study is to investigate the interactive effect of benchmarking and incentives on manufacturing unit performance.

Since prior studies did not examine benchmarking in the context of incentive systems, the purpose of this paper is to investigate the complementarity effect of incentives and benchmarking on manufacturing unit performance. Research on complementarity within accounting is beginning to appear (Drake et al., 1999). In recent work, researchers have investigated complementarities among investment bundling decisions (Miller & O'Leary, 1997) and between and organizational structure choices (Ghosh, 1998). Sim and Killough (1998) examine complementarities between TQM, JIT and performance measures. Drake et al. (1999) examine cost system and incentive structure effects on innovation, efficiency and profitability in teams. Using 1999 survey data, this paper provides initial evidence that the complementarity between benchmarking and incentives leads to perceived improvements in both product quality and product cost in manufacturing units within the electronics industry. The unit of focus for this paper is the strategic business unit (SBU) because competitive advantage is ultimately won or lost primarily at the SBU level rather than the corporate level (Porter, 1980).

The paper is arranged into five sections. The second section provides a summary of prior literature relevant to this study and research hypotheses. The third section explains the research method and describes the variables used to explore the interaction effect between benchmarking and incentives to influence manufacturing unit performance. The fourth section reports the results of the analysis. The final section provides conclusion and discussion and makes suggestions for future research.

LITERATURE REVIEW AND RESEARCH HYPOTHESES

This section provides a summary of prior literature relevant to this study and discusses the variables which include benchmarking, incentives and organizational performance. The discussion provides rationale for the interaction between benchmarking and incentives and how this interaction effect impacts organizational performance of manufacturing units.

Benchmarking

Benchmarking consists of analyzing the best products and processes of leading competitors in the same industry, or leading organizations in other industries, using similar processes (Ahire et al., 1996). Social influence theory proposes that relative performance comparisons against salient others (such as best-practice organizations) leads to a heightened sense of competitiveness resulting in increased levels of effort (Briers et al., 1999; Ferris & Mitchell, 1987; Frederickson, 1992). When other agents performing the same task provide cues about the appropriate performance level, the focal agent is expected to engage in social learning, social comparisons, and modeling, resulting in greater cognitive activity and information processing and, hence, increased effort levels (Ferris & Mitchell, 1987). In the case of benchmark feedback, comparing against best practice can both increase one's awareness that there is room for improvement and suggest possible strategies to imitate. Thus, benchmark feedback plays a motivational role by challenging the decision maker to find ways to improve task performance (Briers et al., 1999).

The quality literature argues that benchmarking allows organizations to determine what level of performance is achievable, to set challenging goals, and to identify superior methods for designing products and processes (Ittner & Larcker, 1995). "Benchmarking" of products, processes, and services can also provide valuable information on superior methods for designing and improving those products and processes (Harrington, 1991). Providing process and problem-solving information to workers not only facilitates problem identification and correction, but also encourages closer communication and coordination between work groups, allowing more rapid cross-functional problem-solving and smoother production flows (Ittner & Larcker, 1995).

Cost advantage can result from adopting "best practices" that focus on firms' production process (Gupta & King, 1997; Hart, 1995; Stead & Stead, 1996). Such practices are intended to reduce cost of production by: (1) increasing the efficiency of production processes; (2) reducing input; (3) eliminating waste in processes to achieve greater efficiency and productivity (Bemowski, 1991; Hammer & Champy, 1993); and (4) reducing waste disposal costs (Hart, 1995; Newman & Breeden, 1992; Smart, 1992; Stead & Stead, 1996).

Briers et al. (1999) provide empirical evidence that corroborates the work of Gupta and King (1997) by testing the effects of several types of feedback on decision performance in the presence of imperfect product cost data. Outcome feedback in the form of financial performance reports, information about competitors' outcomes or benchmark feedback, and information relating to process being managed or process-properties feedback. Subjects in a product-pricing experiment were given (biased) product cost data in conjunction with various combinations of feedback. While subjects receiving only conventional financial performance reports showed some improvement, as predicted, those receiving additional feedback information had superior performance.

Incentives

There exist many possible characteristics of a well functioning incentive or compensation system. This study will focus on two key incentive approaches that have the potential to produce different motivations to employees. The issue is whether to use individual or group incentives to achieve motivation.

Proponents of incentive-pay systems argue that establishing performance-based pay systems in U.S. companies is imperative despite the complex relationship between performance and rewards (Muczyk, 1988). There must be congruence among the goals that organizations seek, the strategies that are most likely to attain these goals, the cultures that support these strategies, and the reward systems that elicit and maintain behaviors consonant with the appropriate strategy and its supporting culture (Shields, 1995).

Economists have often argued that group incentives are ineffective due to free-riding or the "1/n-problem." This argument holds that any group structure provides the potential for individual employees to secretly shirk, thus, free-riding on the performance of other group members. However, this argument neglects the possibility of synergies within the group and mutual monitoring among employees to enforce an optimal, cooperative response to a group incentive in an on-going or repeated game situation (Weitzman & Kruse, 1990). Group incentives are superior to discretionary bonuses or special recognition awards because they are more effective in influencing behavior (Wilson, 1990).

Individual incentives can tend to foster rivalry and competition between employees, and inhibit the cooperation and teamwork that are increasingly required under conditions of rapidly changing demand and technology (Best, 1990; Dertouzos et al., 1989). Hansen's (1997) findings indicate that the introduction of a group incentive plan caused performance to converge to a standard. However, the initially least productive workers improved greatly, whereas the performance of the initially most productive workers did not change. Nevertheless, this evidence suggests that the incentive plan was successful in increasing the level of productivity across the work group. Unlike individual incentives, group incentives do not place individuals in competition with each other in a seemingly zero-sum game. Thus, any potential gains from cooperation should be realized.

Weiss (1987) studied three plants within a large U.S. electronics manufacturer and estimated the change in individual output when the incentive schemes for workers changed. The study found that the group incentive failed to motivate the majority of the workers, and workers' performance converged to a standard. Brown (1990) summarized Weiss' work as "strong evidence that in large groups these incentive effects may be lost." Lawler et al. (1992) cite six separate studies of the relationship between pay and performance, and find that their evidence indicates that pay is not very closely related to performance in many organizations that claim to have merit increase salary systems. Thus, Lawler et al.'s work suggests that pay may not be related to performance whether based on individual or group incentive schemes.

Interactions

Manufacturing performance results from the interaction of manufacturing controls and human behavior (Young et al., 1988). Compensation systems represent an important mechanism that influences the context within which manufacturing unit managers formulate and implement strategies (Govindarajan & Fisher, 1990).

Contingency theory asserts that there is a relationship between organizational structure and situation, and that organizational effectiveness results from this relationship. Milgrom and Roberts (1990, 1995) provide a theoretical framework that attempts to address the issue of how relationships among parts of a manufacturing system affect performance. They suggest that organizations often experience a simultaneous shift in competitive strategy along with various elements of organizational design when they move from mass production to modern manufacturing such as lean production systems. In addition, synergies, or complementarities, often arise within clusters of these elements that improve overall performance. In essence, Milgrom and Roberts' (1995) framework suggests that the various characteristics and activities of modern manufacturing are mutually complementary and so tend to be adopted together, with each making the others more attractive.

Given the importance of workers' role in benchmarking practices, management control systems often are used as mechanisms to motivate and influence workers'

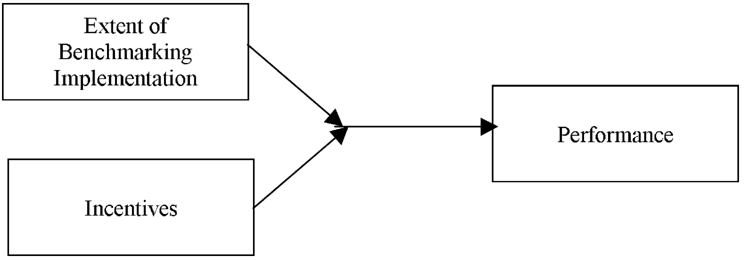

Fig. 1. Panel A: Theoretical Relationships between Independent and Dependent Variables.

behavior in ways that will maximize the welfare of both the organizations and workers. For example, reward systems tied to benchmarking performance could be used as a mechanism to motivate workers, which should lead to higher operational performance. MacDuffie (1995) argues that multiple skills and conceptual knowledge developed by the work force under flexible production are of little use unless workers are motivated to contribute mental as well as physical effort. That is workers will only contribute discretionary effort to problem-solving if they believe that their individual interests are aligned with those of the company, and that the company will make a reciprocal investment in their well being. In the absence of an equitable compensation system, workers' morale may be low, and performance may be compromised.

Figure 1 depicts the theoretical relationships between the dependent and independent variables. In considering the "fit" of incentive structures and benchmarking we follow the process identified by Milgrom and Roberts (1995). We suggest that the combination of incentives and benchmarking has a complementarity effect on performance for each hypothesis stated earlier.

Accordingly, in light of the above discussion, we expect that performance will be enhanced when there is an appropriate match between benchmarking and incentives. It is the synergy in the joint implementation of organizational and behavioral variables that has even greater impact on manufacturing performance. For example, if an organization desires to achieve high product quality and reduced costs while pursuing benchmarking, then its performance will be higher to the extent that benchmarking initiatives are used in concert with incentive compensation. Specifically, we argue that, although the use of benchmarking may be effective independently of incentives, it is the synergy between these two systems that produces higher performance. Therefore, the implementation of benchmarking, when combined with compensation incentive is likely to impact manufacturing unit performance. Thus, the following hypotheses are suggested:

H_1. There is significant two-way interaction between benchmarking and incentives positively affecting manufacturing product cost improvement.

H_2. There is significant two-way interaction between benchmarking and incentives positively affecting manufacturing product quality.

RESEARCH METHOD

Sample

To collect the research data, we used a survey questionnaire with a cover letter explaining the purpose of the study and assuring respondents of the confidentiality of the information provided. A self-addressed, postage paid envelope was attached for returning the completed questionnaire directly to the researcher. Respondents were business unit managers and directors of several levels of hierarchy. These managers and directors were approached to participate in the study as they are the most appropriate personnel, with experience, and are charged with responsibility for the performance of their units.

This method of data collection would model the whole-plant focus. The electronics industry (SIC code 36) was chosen as the primary industry for the study. Restricting a single industry reduces noise, thereby increasing statistical power, and consequently provides a higher likelihood of identifying valid relationships. Although it can be argued that the focus on a single industry tends to make results less generalizable than a study that crosses industries, the findings of this study have a wide appeal because the electronics industry has an impact on virtually every organization in every industry and governmental agency in the U.S. economy. The sample selection process for this study involved searching a variety of sources in order to identify adopters of benchmarking. The primary source includes the National Automated Accounting Research System (NAARS) database that was searched to identify any firms that mentioned benchmarking adoption in their annual report or form 10-K. Additional sources include The Wall Street Journal, and Industry Week series on manufacturing excellence, various industrial engineering journals, and periodical indices for articles in any journal that might produce a case report or other information to determine if benchmarking is related to production systems. We obtained randomly selected names and addresses of the managers and directors from those sources. A total of 345 questionnaires were mailed to managers in the electronics industry. Within five weeks, 69 of the managers responded. Eight weeks later after the initial mailing, we sent a reminder to all 345 managers to complete the questionnaires. A cautionary note stated that if the company had previously completed the survey, this mailing should be discarded. This second mailing resulted in 54 new responses. In total, respondents returned 123 questionnaires. However, 5 returned questionnaires from the first wave and 11 from the second wave were unusable. This elimination resulted in 107 usable responses or a 31% response rate.[1] Table 1, Panel A contains sample distributions by early and late respondents. Table 1, Panel B presents information on the respondents' job titles. This information indicated that almost all respondents were plant managers, manufacturing managers, operations managers, and directors of manufacturing.

We used a survey questionnaire to collect information to test the hypotheses and complement related empirical studies. However, a survey, like any research method, has its strengths and weaknesses and the results should be interpreted with them in mind (Binberg et al., 1990; Shields, 1995). Subjective performance measures, such as those collected here, are widely accepted in organizational research (Dess, 1987; Lawrence & Lorsch, 1967).

Table 1.

Response Wave	Returned Responses	Usable*		Cumulative Response
		Sample Size	Percent of Sample	
Panel A: Frequencies by Wave of Responses				
Responded within 5 weeks	69	64	18.55%	18.55%
Responded after 5 weeks	*54*	*43*	*12.46*	*31.01*
Total	123	107	31.01	

Job Title Used by Respondents	Number of Respondents	Percentage
Panel B: Job Title of Respondents		
Accounting Manager	5	4.7%
Plant Manager	41	38.3
Manufacturing Manager	22	20.6
Operations Manager	19	17.8
Director of Operations	3	2.8
Director of Manufacturing	14	13.1
Sourcing and Fabrication Manager	2	1.8
Product Integrity Manager	*1*	*0.9*
Total	107	100

Note: *Reduction due to Jacknife procedure of "8," which reduces the "Total Sample" to 99.

Measurement Instruments

Following the procedure used by other writers (e.g. Abernathy & Stoelwinder, 1991; Merchant, 1989), we asked respondents to indicate their perceptions of both the independent and dependent variables using a seven-point Likert-scale. Measurement instrument for the variables in the questionnaire were developed from existing studies. We assessed the reliability and validity of the scales for each variable with more than one item. Construct reliability, the extent of measurement error in a measure, was estimated through the Cronbach coefficient alphas. Coefficient for the constructs were greater than 0.70, above the minimum acceptable level suggested by Nunnally (1967). Construct validity was supported by the fact that each question loaded on its respective construct as expected (loading greater than 0.60). The subsequent subsections discuss the instruments and the Appendix presents the survey questionnaire.

Independent Variables

The use of benchmarking is significantly related to both operational and business performance (Voss & Ahlstrom, 1997). Therefore, to test whether there is a link between the interaction effect of benchmarking and incentive on performance, we constructed two indices of performance used as dependent variables: operational performance and business performance. Operational performance measures performance in product quality. Business performance measures performance in product cost. Independent variables were "benchmarking," "incentives." We also controlled for past performance, plant size and industry.

The first independent variable is "Degree of Benchmarking" (BENCH). Three items were used to measure benchmarking. The items were: (1) emphasis on benchmarking competitors' products and processes; (2) effectiveness of benchmarking on product quality improvement; and (3) effectiveness of benchmarking on product cost reduction. The measures were developed and then validated by Ahire et al. (1996), anchored by a seven-point Likert scale (1 = extremely low improvement; 7 = extremely high improvement). The Cronbach alpha was 0.92, indicating that the measures were reliable. A mean score across the items was computed as the measure of the degree of benchmarking resulting in a continuous variable.

The second independent variable is "Incentives" (INCENT). Borrowing from the literature (e.g. see Dye, 1984; FitzRoy & Kraft, 1995; Green & Stokey, 1983; Hansen, 1997; Nalebuff & Stiglitz, 1983) incentive type consists of two categories, i.e. "group incentives" or "individual incentives." Specifically, plants using "group incentives" were coded as "1," while the remaining plants were coded as "0," resulting in a dichotomous variable.

Dependent Variables

Two attributes taken from the literature were used as measures for the dependent variables, i.e. product costs improvement, and product quality performance.

The first dependent variable is "Product Costs Improvement" (PC_{1999}). Through benchmarking, non-value added activities can be reduced or even eliminated completely. According to Cooper and Kaplan (1992), an improved costing system is a means to an end. Focusing on cost, management is in a much better position to identify and eliminate costs that do not add value, thereby improving product costs (Lee, 1999). Product costs improvement for 1999 was a single item measure: "extent to which product costs have improved as a result to benchmarking initiatives and incentives." Respondents were asked to utilize a seven-point Likert scale (1 = extremely low improvement; 7 = extremely high improvement) in their reply.

The second dependent variable is "Product Quality Performance" (PQ_{1999}). Borrowing from Lynch and Cross (1991), product quality performance was used as the second performance measure. Five items were used to measure product quality performance for 1999: (1) units of defects as a percentage of units inspected (at final inspection); (2) cost of scrap as percentage of total manufacturing cost; (3) units reworked as a percentage of units inspected (at final inspection); (4) units returned as percentage of units sold; and (5) warranty costs as percentage of sales dollars. Respondents used a seven-point Likert scale (1 = extremely low improvement; 7 = extremely high improvement). The items were validated by Lynch and Cross (1991). The Cronbach alpha was 0.73 for 1999. Product quality performance was thus measured as an average over the five questions in the questionnaire.

Control Variables

The first control variable is "Past Performance." Following Ittner and Larcker (1995) and Sim and Killough (1998), we controlled for past performance. Including past performance assumes the: (1) organizational performance can be described as a first-order autoregressive process; (2) the autoregressive parameter is identical for each organization; and (3) past performance is not correlated with product cost improvement and quality improvement. If organizations choose their current benchmarking practices and incentives as a function of past performance, the inclusion of past performance will reduce the explanatory power associated with benchmarking and incentives constructs. However, the organizations typically remained in the same benchmarking and incentives categories in both 1999 and 1997. Consequently, it is unlikely that a model estimated in changes would have much explanatory power.

We used product costs improvement for 1997 (PC_{1997}) and product quality performance for 1997 (PQ_{1997}) as past performance measures. Product costs improvement for 1997 was a single item measure: "extent to which product costs have improved as a result to benchmarking initiatives and incentives." Responses were provided using a seven-point Likert scale (1 = extremely low improvement; 7 = extremely high improvement). Five items were used to measure product quality performance for 1997: (1) units of defects as a percentage of units inspected (at final inspection); (2) cost of scrap as percentage of total manufacturing cost; (3) units reworked as a percentage of units inspected (at final inspection); (4) units returned as percentage of units sold; and (5) warranty costs as percentage of sales dollars. Respondents used a seven-point Likert scale (1 = extremely low improvement; 7 = extremely high improvement). The Cronbach alpha was 0.78 for 1997. We used the average of these five variables as the measure for past performance related to quality.

The second control variable is "Industry Effect" (IND). Following Sim and Killough (1998), we also controlled for industry effects. Industry was controlled to a four-digit SIC-code level within the electronics industry, SIC-code 36. Manufacturing plants under SIC-code 3630 (household appliances) were coded 1, plants under SIC-code 3665 (radio, television, and communication equipment) were coded 2, and plants under SIC-code 3670 (electronic components and accessories) were coded 3.

The third control variable is "Plant Size" (SIZE). We also controlled for plant size, as measured by the number of production employees. Plant size is an important factor. Innes and Mitchell (1995) find larger firms are more likely to adopt ABC, although the reasons for the size impact are not clear. Hicks (1997) suggests that smaller companies often avoid implementing ABC not for a lack of resources but for a perceived lack of resources. Smaller plants have flatter organizational structures and more informal communication channels. Thus, because smaller plants are more manageable, benchmarking and ABCM organizational support and coherence may be more effectively applied in smaller plants. Researchers have also asserted that smaller organizations have more ability to encourage and implement innovation (Sironopolis, 1994). On the other hand, larger firms have more capital resources and professional managerial expertise (Finch, 1986) to innovate and establish more contemporary, sophisticated management systems.

A summary of all the variables employed in this study is shown in Table 2.

Table 2. Variable and Measurement Used in the Study.

Independent Variables
BENCH = Extent of benchmarking implementation
(1) Emphasis on benchmarking competitors' products and processes
(2) Effectiveness of benchmarking on product quality improvement
(3) Effectiveness of benchmarking on product
INC = incentives 1 = Group incentive scheme 0 = Individual incentive scheme

Dependent Variables
PQ_{1999} = Product quality improvement in 1999
(1) Units of defects as a percentage of units inspected (at final inspection)
(2) Cost of scrap as a percentage of total manufacturing cost
(3) Units reworked as a percentage of units inspected (at final inspection)
(4) Units returned as a percentage of units sold
(5) Warranty cost as a percentage of sales dollars

PC_{1999} = Product cost improvement in 1999
Extent to which product costs have improved for the year 1999

Control Variables
PC_{1997} = Product cost improvement in 1997
Extent to which product costs have improved for the year 1997

PQ_{1997} = Product quality improvement in 1997
(1) Units of defects as a percentage of units inspected (at final inspection)
(2) Cost of scrap as a percentage of total manufacturing cost
(3) Units reworked as a percentage of units inspected (at final inspection)
(4) Units returned as a percentage of units sold
(5) Warranty cost as a percentage of sales dollars

IND = SIC Code within industry
1 = SIC-code 3630 (household appliances)
2 = SIC-code 3665 (radio, television, and communication equipment)
3 = SIC-code 3670 (electronic components and accessories

SIZE = Plant size
Number of employees working at the plant

Research Model and Testing Procedures

Hypotheses 1 and 2 posit a two-way interaction between the two predictors to affect performance. We tested the hypotheses by regressing the dependent variables against the control and independent variables.[2] The use of multiple regression analysis to study single or joint contributions of one or more independent variables on a dependent variable is commonly applied in contingent-type of studies (e.g. Cohen & Cohen, 1983; Cronbach, 1987; Govindarajan & Fisher, 1990; Hirst, 1983; Schoonhoven, 1981). More specifically, to insure that the relationship between performance and benchmarking/incentive interaction was significant, a hierarchical regression analysis was used. Performance was regressed on the control and independent variables in the first step. In the second step, the interaction benchmarking/incentives was entered in the regression. Following these approaches, the following regression models were initially employed to test the two hypotheses:[3]

$$\mathrm{Pi}_{1999} = \alpha_0 + \alpha_1 \mathrm{Pi}_{1997} + \alpha_2 \mathrm{IND} + \alpha_3 \mathrm{SIZE} + \beta_1 \mathrm{BENCH} + \beta_2 \mathrm{INC} + \varepsilon \quad (1)$$

$$\mathrm{Pi}_{1999} = \alpha_0 + \alpha_1 \mathrm{Pi}_{1997} + \alpha_2 \mathrm{IND} + \alpha_3 \mathrm{SIZE} + \beta_1 \mathrm{BENCH} + \beta_2 \mathrm{INC} + \beta_3 \mathrm{BENCH} \times \mathrm{INC} + \varepsilon \quad (2)$$

where

Pi_{1999} = product cost improvement in 1999 or product quality improvement in 1999
Pi_{1997} = Product cost improvement in 1997 or product quality improvement in 1997
IND = SIC-Code within the industry;
SIZE = plant size
BENCH = extent of benchmarking implementation
INC = incentives
α_0 is the intercept; α_1, α_2, α_3, β_1, β_2, and β_3, are regression coefficients, and ε is the error term.

We make three assumptions when interpreting the estimation results of the models. First, we assume that some organizations have not chosen their benchmarking and incentives optimally, so that organizational performance will vary cross-sectionally with the observed benchmarking and incentive choices. Second, we assume that our variables have low measurement error and the functional form of the models is appropriate. Finally, we assume benchmarking and incentives constructs are exogenous, making the coefficient estimates for our model consistent.

RESULTS

This section has two parts. The first part reports the descriptive statistics. The second part presents results related to hypotheses testing.

Descriptive Statistics

Table 3, Panel A presents the minimum, maximum, Cronbach alphas, means and standard deviations of the variables. Table 3, Panel A also indicates that the

Table 3.

Variable		Cronback Alpha	Min	Max	Mean	Std. Dev.
Panel A: Cronbach Alpha, Minimum, Maximum, Mean and Standard Deviation						
Product quality improvement in 1997	PQ1997	0.78	3.20	6.80	5.27	0.84
Product cost improvement in 1997	PC1997	NA*	1	4	2.65	1.21
Extent of benchmarking implementation	BENCH	0.92	2.20	6.60	4.33	1.43
Incentives	INCENT	NA**	0.00	1.00		
Product quality improvement in 1999	PQ1999	0.73	2.40	6.40	4.25	1.54
Product cost improvement in 1999	PC1999	NA*	1.00	6.00	3.32	0.98
Business Unit Size	SIZE	NA*	78.00	321.00	167.15	78.47
Business Unit SIC-Code	IND	NA**	1	3	–	–

Incentive Type	PC1997	PQ1997	BENCH	PQ1999	PC1999	SIZE
Panel B: Sub-sample Analysis						
Individual Incentive Scheme						
Mean	2.94	5.23	3.00	4.27	3.33	174.42
Std. Deviation	1.24	0.77	0.91	1.49	0.92	81.32
Group Incentive Scheme						
Mean	2.48	5.30	5.06	4.23	3.31	163.17
Std. Deviation	1.17	0.89	1.10	1.58	1.02	77.22

	BENCH	INCENT	PQ1999	PC1999	PQ1997	PC1997	IND
Panel C: Pearson Correlation Matrix for the Variables in the Study							
INCENT	0.69						
	0.00						
PQ1999	0.19	−0.01					
	0.06	0.90					
PC1999	0.19	−0.01	0.94				
	0.06	0.94	0.00				
PQ1997	−0.05	0.04	−0.03	−0.03			
	0.62	0.70	0.78	0.80			
PC1997	0.06	−0.18	0.09	0.11	−0.25		
	0.54	0.07	0.37	0.26	0.01		
IND	0.17	0.20	−0.15	−0.10	0.07	0.08	
	0.10	0.05	0.15	0.32	0.51	0.44	
SIZE	−0.05	−0.07	0.22	0.24	−0.02	0.15	0.19
	0.64	0.50	0.03	0.02	0.88	0.13	0.07

*Single-item measure.
**Categorical variable.

reliabilities of the variables, as measured by the Cronbach alpha, were high. Table 3, Panel B reports the means and standard deviation by type of incentive (i.e. individual incentive scheme and group incentive scheme). Table 3, Panel C reports the intercorrelations among the variables. The bivariate correlations between past performance measures (PC-1997 and PQ-1997) and their corresponding dependent variables (PC-1999 and PQ-1999) are not significant. However, the correlation between the two dependent variables (PC-1999 and PQ-1999) is significant. In addition, the correlation between benchmarking and incentive is significant. One interpretation of the significant correlations is that improvement of product quality (PQ-1999) may be accompanied by improvement of product costs (PC-1999), and that benchmarking may be accompanied by incentive scheme.

Hypotheses Tests

We obtained interaction terms by multiplying benchmarking initiatives with incentives. In an initial assessment the control variables were regressed against the dependent variables. There were no significant industry or past performance effects ($p > 0.10$). Therefore, given the small sample size and degrees of freedom required when control variables were included, we removed industry and past performance variables in order to provide additional power for the hypothesis tests.

Next, we hierarchically constructed a regression model for each dependent variable. In the first step, we entered size. In the second step, we entered size and the two independent variables; and the interaction term was added in the third step. The results are reported in Tables 4 and 5.

First, we checked for multicolinearity. Tables 4 and 5 show that the variance inflation factors (VIF) were low (i.e. <10) (Hair et al., 1987). Therefore, multicolinearity was not an issue.

Hypothesis 1 predicts a significant and positive two-way interaction between benchmarking and incentive affecting manufacturing product cost improvement. Results in Table 4, Eq. (3), show that the addition of the interaction to Eq. (2) was significant and positive ($t = 2.12$, $p = 0.037$) with and increase in R^2 of 0.039. The model explains 17.2% of the variance. The regression results indicate that there is a significant interaction between benchmarking and incentives to improve product cost. Therefore, H_1 is supported.

Hypothesis 2 suggests that there is significant two-way interaction between benchmarking and incentive affecting manufacturing product quality. Results in Table 5, Eq. (3), show that the interaction was significant and positive ($t = 1.989$, $p = 0.050$) with an R^2 change of 0.035. The model explains 15.6% of the variance. The evidence provided support for H_2 that product quality improvement is an interactive function of benchmarking and incentives.

Table 4. Regression for Product Cost Improvement (PC_{1999}).

	Equation (1)					Equation (2)					Equation (3)				
	B	Std. Error	*t*	Sig.	VIF	*B*	Std. Error	*t*	Sig.	VIF	*B*	Std. Error	*t*	Sig.	VIF
Constant	2.824	0.227	12.452	0.000		2.024	0.377	5.370	0.000		2.611	0.462	5.647	0.000	
SIZE	0.003	0.001	2.406	0.018	1.000	0.003	0.001	2.484	0.015	1.005	0.003	0.001	2.188	0.031	1.027
BENCH						0.263	0.091	2.892	0.005	1.928	0.088	0.121	0.728	0.468	3.565
INCENT						−0.524	0.270	−1.940	0.055	1.932	−0.883	0.315	−2.805	0.006	2.716
BENCH × INCENT											0.159	0.075	2.120	0.037	4.980
F		5.789						4.847					4.893		
p-value		0.018						0.004					0.001		
R^2		0.056						0.133					0.172		
$R \times 2$ change								0.077					0.039		

Note:

INCENT = type of incentive

BENCH = extent of benchmarking implementation

BENCH × INCENT = interaction term

VIF = variance inflation factor

Table 5. Regression for Product Quality Improvement (PQ_{1999}).

	Equation (1)					Equation (2)					Equation (3)				
	B	Std. Error	*t*	Sig.	VIF	*B*	Std. Error	*t*	Sig.	VIF	*B*	Std. Error	*t*	Sig.	VIF
Constant	3.543	0.359	9.864	0.000		2.310	0.598	3.865	0.000		3.187	0.735	4.333	0.000	
SIZE	0.004	0.002	2.167	0.033	1.000	0.004	0.002	2.230	0.028	1.005	0.004	0.002	1.945	0.055	1.027
BENCH						0.409	0.144	2.841	0.006	1.928	0.149	0.193	0.773	0.441	3.565
INCENT						−0.836	0.429	−1.951	0.054	1.932	−1.372	0.501	−2.739	0.007	2.715
BENCH × INCENT											0.237	0.119	1.989	0.050	4.979
F		4.695						4.354					4.356		
p-value		0.033						0.006					0.003		
R^2		0.046						0.121					0.156		
$R \times 2$ change								0.077					0.035		

CONCLUSION AND DISCUSSION

This study seeks to provide empirical evidence about the effect of the interactive effect of benchmarking and incentives on manufacturing unit performance. Specifically, we tested hypothesized complementarity effects between benchmarking and incentives. Based on survey data obtained from a sample of manufacturing units within the electronics industry, the results of this paper suggest that there is a synergistic interaction between benchmarking and incentives affecting product cost improvement and product quality performance.

The results of this study should be assessed in light of five limitations. First, the cross-sectional design of this study examined the interactive impact of benchmarking and incentive on business performance at the same point in time and does not consider the difference between short-term and long-term effects. A longitudinal research design would allow researchers to examine dynamic effects of implementing benchmarking and incentive strategies. Second, this study focuses on one industry, which affects the generalizability of the findings. Thus, further research needs to examine whether the relationships found here hold in other industries. Third, the use of the questionnaire survey method used in this study also has some inherent limitations. Hidden biases and random errors both potentially can inflate associations (Bagozzi et al., 1991). Fourth, this survey study relied on self-report measures. Secondary sources were not available to verify the reported data. Finally, this study used two types of incentives. Additional features of incentives could be investigated. Future research also could consider other types of performance measures.

This research makes the important point that the incentive structure impacts the success of benchmarking programs designed to improve firm performance. Thus inferences from this research are that: (1) researchers need to be aware of the important role incentives can play in determining the effectiveness of any "intervention" in contemporary manufacturing environments; and (2) companies seeking to make substantial improvements by learning from the "best-of-the-best" should make sure to modify the social environment to complement the new performance standards.

NOTES

1. We used discriminant analysis to compare respondents to the first mailing, the early respondents, to those responding to the second mailing, the late respondents. Results revealed that the two groups did not differ significantly in either the level of the variables or in the relationship between the variables at the 0.05 level. This suggests that non-response bias may not be a problem.

2. A first analysis was carried out with 107 respondents. However, when the jackknife procedure was used to detect the impact of outliners on the analysis (Ang, 1998), this approach led to a sample size of 99. This final data was used to test the hypotheses.
3. See results section for further modifications of the equations.

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APPENDIX A

Survey Questionnaire

Part I

1. Please indicate the degree to which each of the following is present in your benchmarking initiatives (i.e. analyzing the best products and processes of leading competitors in the same industry, or leading organizations in other industries, using similar processes).

		1 = extremely low	7 = extremely high
(1)	Emphasis on benchmarking competitors' products and processes	1 2 3 4 5 6 7	
(2)	Effectiveness of benchmarking on product quality improvement	1 2 3 4 5 6 7	
(3)	Effectiveness of benchmarking on product cost reduction	1 2 3 4 5 6 7	

2. Please indicate how your plant workers are currently being compensated? (please circle one).
   (a) Group incentive scheme (worker's reward is dependent on his/her entire team performance).
   (b) Individual incentive scheme (worker's reward is dependent on his/her performance relative to the performance of other workers).
   (c) Other (please specify) ______________________________

Part II

1. Please indicate the extent to which product costs have improved for the years 1997 and 1999 (please circle one)

1 = extremely low improvement	7 = extremely high improvement
1999	1997
1 2 3 4 5 6 7	1 2 3 4 5 6 7

2. Please indicate the extent to which waste (or non-value added activities) has improved for the years 1997 and 1999

		1 = extremely low improvement 1999	7 = extremely high improvement 1997
(1)	Units of defects as a percentage of units inspected (at final inspection)	1 2 3 4 5 6 7	1 2 3 4 5 6 7
(2)	Cost of scrap as a percentage of total manufacturing cost	1 2 3 4 5 6 7	1 2 3 4 5 6 7
(3)	Units reworked as a percentage of units inspected (at final inspection)	1 2 3 4 5 6 7	1 2 3 4 5 6 7
(4)	Units returned as a percentage of units sold	1 2 3 4 5 6 7	1 2 3 4 5 6 7
(5)	Warranty cost as a percentage of sales dollars	1 2 3 4 5 6 7	1 2 3 4 5 6 7

Part III

(1) Please indicate your plant SIC code____________
(2) How many employees work at your plant?___________
(3) Please indicate your position___________

End of Survey

Thank you for your time and cooperation.

ORGANIZATIONAL CONTROL AND WORK TEAM EMPOWERMENT: AN EMPIRICAL ANALYSIS

Khim Ling Sim and James A. Carey

ABSTRACT

Simons (1995b) suggests that most writing on empowerment often fails to recognize that empowerment requires greater control. Accordingly, we investigate the type of control via rewards and punishment systems, which fits best in the context of empowered work teams. Specifically, we hypothesized that empowerment will lead to improvement in manufacturing performance only *when rewards are based on group performance, i.e. a situation where the collective benefit of both individual team members and those of the firm are maximized. Utilizing a survey methodology, four compensation types were examined, including fixed pay,* fixed + non-*monetary incentives, individual-based incentives, and group-based incentives. Results show that the favorable effect of work team empowerment was not observed under fixed-pay,* fixed + non-*monetary incentives, or individual-based incentives. In many instances, fixed-pay or individual-based incentives interact with work team empowerment to produce a negative effect on manufacturing cost, manufacturing lead time, or non-value-added-activities. On the other hand, manufacturing plants which use group-based incentives were able to reap the benefit of work team empowerment and translate that into enhanced performance.*

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INTRODUCTION

> A fundamental problem facing managers in the 1990s is how to exercise adequate control in organizations that demand flexibility, innovation, and creativity . . . A new theory of control that recognizes the need to balance competing demands is required. Inherent tensions must be controlled, tensions between freedom and constraint, between empowerment and accountability, between top-down direction and bottom-up creativity, between experimentation and efficiency. These tensions are not managed by choosing, for example, empowerment over accountability – increasingly, managers must have both in their organizations (Simons, 1995a, p. 80, b, p. 4).

The traditional approach of "command and control" management style is now being criticized as being too rigid and counterintuitive to the philosophy of organizational learning, continuous improvement, and total customer satisfaction (Alles et al., 1997; Drake et al., 1998; Raiborn et al., 1996; Sarkar, 1997; Simons, 1995a, b). Understanding how to control empowered employees in a highly competitive global economy is important for organizational theorists and practicing managers. Thus, a major challenge facing management in the 1990s is the design and implementation of effective internal control systems (Jensen, 1993).

In an empowered setting, workers are given decision making autonomy to manage their work. Such a transfer of authority can be beneficial for the firm only if empowered workers manage themselves better than they could be managed by a supervisor (Alles et al., 1997). Thus, allowing workers to obtain and use information which, by definition, is not readily observable to managers, creates information asymmetries within the firm. Thus, this may put the organization at risk, particularly if the interests of the workers diverge from those of management (Holmstrom, 1979).[1] On the other hand, behavioral theorists often associate intrinsic motivation with empowerment, i.e. responsibility for work outcomes and decision-making autonomy. According to behavioral theorists, intrinsic motivation often increases job satisfaction, which in turn improves job performance. Although the principal-agent model and the organizational job model appear to be at odds with one another, they deal with the very core of human nature. Thus, one question that arises under empowerment is what assumptions should we make with respect to human nature when designing management control systems?

Interestingly, Simons (1995b, p. 163) notes "most writing on empowerment fails to recognize that empowerment requires greater control. The control systems used, however, must balance empowerment and control in such a way that empowerment does not lead to a control failure, and correspondingly, control does not lead to an empowerment failure." Consequently, he suggests that new control systems are often needed when workers are empowered. Indeed, this view point is consistent with the contingency theory which recognizes that failure to consider matches when making strategic choices may lead to a negative impact on performance (e.g. Kaplan, 1983; MacDuffie, 1995; Milgrom & Robert, 1990, 1995; Wruck & Jensen, 1994). Thus, the next issue that arises under empowerment is the type of organizational control that is most appropriate for handling the inherent tensions.[2] Understanding "control" within the context of empowerment may increase the likelihood that empowerment can be used as a tool for enhancing a firm's returns. Taken together, the objective of this study is to examine the type of control via rewards and punishment systems, which fits best in the context of empowered work teams within a manufacturing setting.

THEORETICAL DEVELOPMENT

One underlying assumption about empowerment is that workers' knowledge, intelligence, and most important of all, freedom for creativity, are critical for continuously improving product and process innovation. It is, however, important to recognize that empowerment does not occur as a standalone practice in a manufacturing setting. Rather, it is one of the elements in modern, lean, or flexible manufacturing. This means that it is essential for us to understand the transition or process which gives rise to workers' empowerment. Thus, the following section addresses the transition from mass production to modern or lean manufacturing. Next, we explain what empowerment means. Finally, we provide the underlying theories used in framing our hypotheses.

Mass Production Versus Modern/Lean Manufacturing

Mass production typically involves the assembly or manufacture of standardized products in high volumes using special-purpose machinery and semi-skilled or unskilled labor. Disruptions to production processes such as equipment breakdown or production line interventions prevent the realization of economies of scale and are discouraged. Thus, buffers such as extra inventories are needed. In addition, workers are closely supervised and often perform narrowly defined manual tasks requiring little skill while responsibility for quality often lies with a separate quality control department.

The biggest problem with buffer inventories, besides the carrying and storing costs, is that they hide problems. When inventories are high, a defective part can easily be replaced. On the other hand, when inventory is kept low, as in Just-In-Time (JIT) systems, a defective part must be dealt with immediately. For example, when there are no buffers, any defective part can bring the production system to a standstill. To prevent this from happening, there is an incentive to drive quality defects toward zero, and to build or inspect quality into the production. This means that stopping a production line to fix problems under modern/lean manufacturing actually increases uptime and productivity. In addition, since buffers of in-process inventories are kept low and lot sizes are small under modern/lean manufacturing, there will be fewer defective parts that must be discarded if a problem is caught downstream. In summary, a lower buffer stock, building or inspecting quality into production, or stopping production lines to fix problems, translate into lower manufacturing costs. This, however, creates a demand for skilled workers. Indeed, commentators often suggest that the gradual displacement of mass production is made possible with workers' empowerment (Johnson, 1992; Womack et al., 1990).

Empowerment – Decentralization of Production Responsibility

In modern or lean manufacturing, workers assume a more central role than in mass production. To identify and resolve problems on a day-to-day basis, workers must have both the conceptual knowledge of the production process and the analytical skills to identify the root cause of problems. Consequently, workers are crossed-trained, multi-skilled, and often work in teams. More specifically, workers are provided with off-the-job and on-the-job training. In addition, job rotation within and across teams is a common practice. Moreover, skills are also acquired through "off-line" group problem-solving activities such as quality circles. Most important of all, in order to develop a clear understanding of the production system, it requires that workers encounter problems directly through some decentralization of production responsibilities such as quality inspection, equipment maintenance, statistical process control, or job specifications. For example, under modern manufacturing, problem-solving efforts are not limited to quality matters; teams of production workers have responsibility for developing, recording, and modifying job specifications which are as detailed as any industrial engineering time study (Adler, 1993; Cole, 1979; MacDuffie, 1995).

While many definitions of empowerment exist in management literature, the definition used in this paper is that from Kruse (1995). Empowerment is defined as a means of giving the authority to make decisions to that level or people in the organization which, by virtue of available knowledge and closeness to the activity concerned, is most able to make a correct, quick, and effective decision. Anecdotal evidence suggests that many organizations have achieved improvements in business performance as a result of empowering their work force. These companies include NUMMI, Saturn, Xerox, Hewlett-Packard, and U.S. Steel (Heaton, 1998).

Control Systems in an Empowered Environment

Simons (1995b) suggests that new control systems are often needed when workers are empowered. Motivated by Simons' work, this study seeks to identify the type of organizational control, via the reward and punishment systems, which is most appropriate when workers are empowered. Given that the role of management control systems is to influence employees' behavior such that organizational goals will be achieved, one question which needs to be addressed under empowerment is what assumptions should we make with respect to human nature prior to identifying the appropriate control systems? Accordingly, organizational theories that make references to human nature are discussed in the next section.

The Principal-Agent Model vis-à-vis Organization Job Model

A basic principal-agent economic model assumes subordinates, or agents are inherently risk and effort averse; they often seek to maximize their utility. The principal will incur monitoring costs or exercise careful control through incentives to minimize the problems of moral hazard (Holmstrom, 1979). As a result, an incentive contract is often used as a form of monitoring device to minimize the problem of free-riding. These principal-agent issues become more apparent when manufacturing firms switch from mass production to modern manufacturing. For example, under mass production, workers are closely supervised, making the opportunity for shirking minimal. On the contrary, under modern or lean manufacturing, empowered workers have an information edge over management, while management often cannot observe the workers' input to the work processes. This suggests, perhaps, there is a greater need for an incentive contract in the form of monitoring device to reduce the problem of moral hazard when workers are empowered. Accordingly, the basic agency theory model assumes that unless a proper control mechanism is in place, empowerment may not lead to enhanced performance (Alles et al., 1997; Simons, 1995b).

On the contrary, the organizational job model often assumes that intrinsic motivation, job satisfaction, and work performance are promoted by including meaningful work and responsibility for work outcomes into the design of work activities. Responsibility often involves decision making authority and autonomy as far as how the work is accomplished. (e.g. Hackman & Oldham, 1980; Herrenkohl et al., 1999; Lawler, 1988). Hitchcock and Willard (1995) posit that teams designed around work *processes* yield the greatest improvements in performance. Thus, it is how work gets done, the manner in which work systems become interrelated and interdependent, and the manner in which workers fully participate in work activities that lead to performance gains and competitive advantage. The assumption underlying the organizational job model is that intrinsic motivation inherent in the decentralization of production responsibility (i.e. empowerment) should lead to improved performance.

Taking a somewhat different direction, Wageman (1995, p. 173) suggested that reward programs, or extrinsic motivation, were pivotal in "shaping individuals' preferences, their behavior, and the impact of those rewards on their performance." In terms of team-based design, this prompts the need to structure work activities and reward systems that foster cooperative behaviors while abating unnecessary individualistic competition. In a later study, Wageman (1997) suggested that reward systems are critically important to the autonomy and self-management capabilities of work teams, implying that both intrinsic and extrinsic motivations are essential elements for organizational success.

Merchant's (1985) Management Control Model

Our assumption is that, as an organization gets more diverse or simply larger, a broad range of motivating mechanisms would need to be applied since it is

Exhibit 1. Merchant's (1985) Control Mechanisms.

Type of Control	Is The Control Relevant to this Study?
(1) Results Control – (a) Defined the dimensions in which results are desired (e.g. earning per share, level of customer satisfaction, rate of on time delivery. (b) Providing rewards (or punishment) to encourage (or discourage) that will lead to those results.	(1) Yes. Manufacturing performance can be identified and people are induced to behave so as to maximize their chances of producing the results the organizations desire because these results are also, not coincidentally, those that will maximize workers rewards.
(2) Action Control – Require individuals perform (or do not perform) certain actions that are beneficial (or harmful) to the organization.	(2) No. Empowered workers were given discretions in decision making, i.e. process improvement activities often involve non-routine procedures and they are often carried out on a "as needed" basis.
(3) Personnel Control – Often individuals do what is best for the organization because they are self-directed or because they are influenced by group norms. Managers often take steps to increase the chances that those positive forces are present, the managerial actions are often known as personnel controls.	(3) Yes. Implementation of Empowerment is one of the managerial actions taken to promote intrinsic motivation, which in turn should have a positive impact on performance.

likely that some employees may be intrinsically motivated, while others may be motivated by monetary incentives. As such, the use of job design to promote intrinsic motivation and further typing workers' performance to their reward is consistent with both the behavioral theories of motivation and the economic theory of moral hazard. These are also the bases of simultaneous controls as suggested by Merchant (1985) as depicted in Exhibit 1. The above discussions serve as important guidelines in building the hypotheses in the next section.

HYPOTHESIS DEVELOPMENT

Reward and Punishment Systems as a Mechanism for Control

Many aspects of the modern organization can be classified under the rubric of management control systems. None might be as important as the compensation or reward systems designed to direct employee behavior toward productivity gains, continuous improvement, and the cooperative interdependence prevalent in modern lean manufacturing environments (Baker et al., 1988; Kerr, 1975, 1995). For example, Jensen and Meckling (1976) suggest that the fit of reward systems is a vital concern for firms seeking productivity improvements. More recently, Ittner et al. (1997) show that reward systems can either promote or inhibit the adoption of a flexible manufacturing strategy.

Fixed-Pay vis-à-vis Contingent Pay

Despite quite an extensive research development, behavioral control systems in the form of employee incentive plans often remain a complex issue and a problem for most practitioners and academics (Baker et al., 1988). It is perhaps a long-held axiom of management that people will do what they are rewarded for. Many organizations, however, have found it a significant challenge to adequately structure pay-for-performance compensation plans (see, e.g. Baker et al., 1988; Crosby, 1989; Jensen & Meckling, 1976; Kerr, 1975, 1995; Lawler, 1990; Wruck & Jensen, 1994). For example, TQM proponents ordinarily deride pay for performance incentive plans. Deming (1986) suggests extrinsic rewards diminish the intrinsic value and motivation of the work. Moreover, he posited that the system, or design of work and work processes, accounted for over 90% of the variation in work outcomes. If so, it would then appear to make little sense to provide incentives to workers who control such a small portion of their end productivity. Similarly, Kohn (1993) indicates that rewards typically undermine the intended processes; i.e. rewards, or extrinsic motivation, often do not alter the attitudes that underlie behaviors, and the effects, if any, are not enduring. Hackman and Wageman (1995) and Wageman (1995), on the other hand, counter Deming's arguments by noting that it is possible to design work and reward systems such that both intrinsic and extrinsic motivation are promoted. Similarly, Wruck and Jensen (1994, p. 276) noted that TQM advocates misinterpret reward systems as incompatible with empowered job design, leading them to reject their use, a proposition said to damage the very organizations they are trying to help. Thus, one question that prompted our attention is, will pay for performance incentive system diminish the intrinsic motivation embedded in empowered job design leading to lower performance? If so, perhaps pay for performance incentive system should not be used in conjunction with empowerment.

In a study of flexible manufacturing, MacDuffie (1995) showed that interrelated elements of human resources practices contribute most to assembly plant productivity and quality when they are integrated with manufacturing policies. Thus, MacDuffie (1995) argued that multiple skills and conceptual knowledge developed by the work force under new work practices are of little use unless workers are motivated to contribute mental as well as physical effort. That is, workers will only contribute discretionary effort to problem-solving if they believe that their individual interests are in congruence with those of the company's. MacDuffie (1995), however, did not examine workers' empowerment.

At least two additional pieces of anecdotal evidences suggest the importance of profit sharing in an empowered setting. In a study of Caterpillar Inc., Miller and O'leary (1994, p. 17) wrote "within these units, empowered individuals and groups are called upon to bring a creative focus to bear on the quality and enhancement of the product and the desires of the customer, and thereby to optimize their own personal and economic well being, the profitability of the firm, and the competitiveness of the nation." Thus, it appears that jointly optimizing the economic well being of individuals with that of the firm is an important factor when employees are empowered. Similarly, the experience of Lexmark (formerly owned by IBM) International Inc., shows that empowerment does not work until employees believe that they can truly take ownership of what empowerment produces and that they are rewarded accordingly. At Lexmark, workers voluntarily put their heads together when a problem arises. Among other things, they also decided on avenues that led to a 100% accuracy delivery rate. All of these positive actions resulted in a 25% reduction in production cost, an increased in inventory turns, and a 40% drop in warranty repairs. At Lexmark, everyone was in an incentive plan that included stock options and bonuses. Performance was rewarded based on overall corporate earnings and departmental/unit results as well as team performance (Flanagan, 1994). Thus, it appears that recent empirical and anecdotal evidence suggests that incentive pay is more desirable when workers are empowered where continuous improvement in manufacturing processes is critical for business success.

From the standpoint of a basic economic model, however, there is always a concern that empowered workers may take actions that increase workers' utility at the expense of the firm. Thus, in the absence of control over inputs or processes, as in the case of decentralization of decision making, workers must be held accountable for their output or performance (Simons, 1995b). Consequently, making workers' rewards contingent upon their performance, or holding workers "accountable" for their output or results will maximize the welfare of both the workers and the organization and should lead to goal congruence. It follows that the use of job design to elicit intrinsic motivation (i.e. personnel control, see Exhibit 1) and further tying workers' performance to their rewards (i.e. results control, see Exhibit 1) is consistent with both the behavioral theories of motivation and the economic theory of moral hazard. This in turn is consistent with Merchant's suggestion of simultaneous use of multiple controls to enhance organizational effectiveness. Accordingly, the following hypotheses are generated:

H1. Because of a lack of accountability and an absence of extrinsic motivation under the fixed-pay system, the favorable effect of work team empowerment on performance will not be observed when fixed-pay is used.

H2. Because of an absence of extrinsic motivation under the non-monetary incentive system (Fixed + non-monetary reward), the favorable effect of work team empowerment on performance will not be observed when non-monetary incentive pay is used.

Contingent Pay: Individual-based vis-à-vis Group-based Incentives

The major advantage of group-based incentives is that they provide an incentive for cooperation. The down side is that they induce free-riding. Free riding arises with group-based incentives because slackers will get the same amount of reward as contributing members of the group. Accordingly, there may be instances where very large group reward systems, such as organizational-wide profit sharing, fail. On the other hand, individual-based incentives, although without free-riding problems, have often been shown to be counterproductive in situations where determining individual contributions is impossible, as in the case where jobs are highly interdependent. Individual incentive plans also have been shown to be ineffective when there is an unclear link between performance objectives and the specific behaviors desired by management or when there is a structural inability of employees to sufficiently control their own performance outcomes (Crosby, 1989; Deming, 1986; Wageman, 1995). Thus, the use of individual-based incentives could be problematic in organizations utilizing techniques such as TQM programs and JIT management systems, where work team empowerment, task interdependence, and workers' cooperation are essential for successful implementation. This is because the competition inherent in individual-based incentives results in a win-lose perspective, causing workers to view others as adversaries. Competition also damages work relationships (Hitchcock & Willard, 1995; Lawler, 1992). Thus, the use of individual-based incentives may lead to dysfunctional behavior when jobs are highly interdependent. In fact, Drake et al. (1998) showed that independent innovations were greatest under individual-based incentives while cooperative innovations were highest under group-based incentives. Because of this potential conflict, we do not expect improved performance when empowerment is used in conjunction with individual-based incentives. Accordingly, the following hypothesis was generated:

> **H3.** Because workers will be competing against each other when individual-based incentives are used, the favorable effect of work team empowerment on performance will not be observed when individual-based incentives are used.

Several authors, including Fama and Jensen (1983), Weitzman and Kruse (1990), Kandel and Lazear (1992), suggest that group-based incentives may avoid free-rider problems by increasing peer pressure and mutual monitoring. For example, social psychological evidence has shown that free-riding is reduced when the contributions of individuals to collective performance can be observed by group members, such as in a small group setting like quality circles or work teams (Williams et al., 1981). Very similar observations were also put forth by Levine and Tyson, "Suppose workers are divided into work groups or teams on the basis of the interdependence of their work, pay is based on team output, and the teams help organize their work. By working together, team members recognize their mutual interests and observe how shirking by one can hurt the group. Shirking or free riding now imposes an observable cost directly on all co-workers, so that social sanctions may be rationally applied against workers who deviate from the cooperative work norm" (Levine & Tyson, 1990, p. 187). There are various reasons why group-based incentives could be beneficial (see Milgrom & Roberts, 1992). For example, people who work together have various ways of helping one another, exchanging favors, covering for one another, or helping out with extra effort when a member of the group is absent. Group incentives encourage cooperation and the possibility of withholding help from slackers can be very effective in providing incentives for members of the group to adhere to the group norms. Finally, there are instances where members of a team may resist their employer's directives if the employer's interests conflict with those of the team. In this case, group incentives could be used to conjoin group members' interests, making members of the team more willing to cooperate. All of these are expected to result in a higher level of satisfaction, cooperation, and productivity when group-based incentives are used.

In a more recent study, Wageman and Baker (1997) demonstrated that the efficacy of work design, if unaccompanied by changes in the design of the reward system, did not translate into better performance. More specifically, their results showed that when tasks were highly-interdependent, the subjects engaged in high cooperation *regardless* of reward system design.[3] However, it was the reward system which reaped the benefits of cooperation and had translated them into better performance. Consequently, Wageman and Baker (1997) interpreted their results as the subjects simply enjoying the work more and thus working harder at it when the rewards were *jointly* determined. This leads us to hypothesize that empowerment will lead to improvement in firm performance *only* when rewards are based on group performance, i.e. a situation where the collective benefit of both individual team members and those of the firm are maximized. This implies that simultaneous use of multiple controls (i.e. personnel control and results control) should enhance the management control processes. Thus, the following hypothesis was generated:

H4. Performance is an interactive function of group-based incentives and work team empowerment.

RESEARCH METHOD

Sample Selection

It was expected that a high tech industry such as the electronic industry would have more early adopters of new work practices such as TQM, JIT management, or empowered work teams. As a result, the electronic industry was chosen as the primary industry for this study. Letters requesting participation in this research study were sent to the directors of manufacturing of 1,500 randomly selected plants located within the United States. A total of 126 plants agreed to participate in this study, and three plants wished to review the questionnaire prior to making a commitment to participate.[4] As a result, a total of 129 questionnaires were mailed. About 50% of the firms replied within four weeks. Six weeks after the initial mailing of the questionnaires, a status report, together with a reminder to complete the questionnaire, were sent to all 129 plants. In total, 83 out of 129 of the requested surveys were received. This represents a 5% response rate based on initial sample asked to participate.

Questionnaires

The questionnaire solicited information pertaining to manufacturing practices, workplace practices, as well as several aspects of manufacturing performance. Two stages were involved in a pilot test of the questionnaire. First, three production engineers from a semiconductor plant were asked to fill out the questionnaire. Since information provided was based on the same plant, the responses were compared, and found to be consistent. Next, the questionnaire was reviewed by four experts in the area of process improvement to check for relevancy or possible ambiguity in the instrument. Feedback from the pilot test resulted in no major changes, except for rephrasing of some statements. Appendix A provides detailed information about the questionnaire.

Dependent Variable Measures

In an empowered work environment, day-to-day operations are placed under the control of work teams. Thus, the performance measures to be focused upon are those of operational, mainly internal efficiency. As a result, a total of three internal efficiency measures were used. They were non-value-added activities, manufacturing lead time, and setup time. Setup was dropped from our analysis because a significant number of respondents did not answer this question.[5] Appendix A shows a detailed breakdown of these measures. The measure of non-value-added activities consisted of five items, which included cost of scrap, units of rework, defects, warranty cost, and sales returns which were aggregated into a single measure, "waste" or non-value-added activities. Measure of manufacturing lead-time, on the other hand, consisted of a single item. Respondents were asked to provide performance ratings on each of the six attributes based on 1992 and 1994 ratings. The ratings for 1994 were then used as dependent variables while those for 1992 were used as control variables (i.e. prior performance). Since non-value-added activities consist of multiple items, an average rating was calculated for each of the two years. Consistent with the model of performance pyramid (see, Lynch & Cross, 1991), improvement in the internal efficiencies should translate into better financial results. Thus, we test for a reduction in manufacturing cost. As such, we also examined change in manufacturing cost in the last three years. Change in manufacturing cost was measured on a 5-point Likert scale, anchored from 1 = "decreased tremendously" to 5 = "increased tremendously."

Independent Variable Measures

Work Team Empowerment

Empowerment was operationalized using four items on a 7-point Likert scale of 1 = "Strongly Disagree" to 7 = "Strongly Agree." The four individual items include: "Daily problems have been handled primarily by the group" (item 1), "Group members actively provide input to both product and process design" (item 2), "Vacation, back-up process, or unexpected changes in schedule are decided by work group members" (item 3), and finally, "Members of the team are encouraged to generate input for hiring decision within their work teams" (item 4). Using principal component analysis, all four items loaded onto the same factor, with 56% of variance explained and a Cronbach's alpha of 0.73.

Compensation Type

Compensation for plant workers had 4 levels – fixed-pay only (Comp-F), fixed plus non-monetary incentives (Comp-Non-$), fixed plus individual-based incentives (Comp-I), and fixed plus group-based incentives (Comp-G).

Control Variables

Organizational context such as firm size, technology, or workplace practices tend to affect a plant's performance. As a result, these factors should be considered in our model. As discussed earlier, it is important to recognize that empowerment does not occur as a standalone practice in a manufacturing setting. Rather, it is one of the elements in modern, lean, or flexible manufacturing. This means manufacturing plants that empower their workers often implement TQM, JIT management, and teams as well. Thus, firm size, TQM, JIT management, and teams were used as control variables in this study.[6] Firm size was measured in terms of annual sales, while TQM and JIT management were measured using the scale adapted from Sim and Killough (1998), which was a modification of the scale from Snell and Dean (1992).

Measures of Total Quality Management consisted of 10 items while measures of JIT management consisted of nine items (see Appendix A). The TQM and JIT management constructs assume that manufacturing excellence is often based on a foundation of overlapping practices, such as employee involvement, preventive maintenance, supplier relationship, attention to quality and advanced manufacturing technology. Specifically, TQM is built around the philosophy of continuous improvement with the aim of eliminating waste in every form; while JIT management focuses on reducing lot sizes and buffer stock. Smaller lot sized lead to shorter manufacturing cycle times and indirectly help to reduce scrap and rework associated with process failure. Likewise, a lower buffer stock calls for doing things right the first time. This means a tighter quality system enhances successful implementation of JIT management. As a result, TQM and JIT management work in concert with one another.

The measure for teams was adapted from Banker et al. (1993). Literature often suggests that successful implementation of team requires support from management (i.e. management should provide an environment that encourages participation by all group members). As a result, this item was added to the adapted scale from Banker et al. (1993). Consequently, teams was measured using four-item Likert scale (1 = "Strongly Disagree" to 7 = "Strongly Agree," see Appendix A). Using principal component analysis with varimax rotation, all four items loaded onto the same factor with 73% of the variance explained and a Cronbach's alpha of 0.88.

Research Model and Testing Procedures

We hypothesized that empowerment would lead to improvement in firm performance *only* when group-based incentives are used. In order to test the match between work team empowerment and compensation-type, the match was operationalized using cross-product interaction terms. The overall regression model used to test the hypotheses was:

$$\begin{aligned} Perf_t = f(&Size_t, Perf_{t-2}, TQM_t, JIT_t, Team_t, Comp\text{-}I_t, Comp\text{-}Non\text{-}\$_t, \\ &\times Comp\text{-}F_t, Empowerment_t, Empowerment_t \times Comp\text{-}I_t, \\ &\times Empowerment_t \times Comp\text{-}Non\text{-}\$_t, Empowerment_t \times Comp\text{-}F_t) \end{aligned} \tag{1}$$

Expected Signs: Negative except for $Perf_{t-2}$, i.e. a lower percent of waste, lower manufacturing cost, or lower manufacturing lead time represents better performance.

Perf represents either non-value-added activities (waste), manufacturing lead time, or change in manufacturing cost. *Size*, $Perf_{t-2}$, *TQM, JIT management*, *and team* are control variables while the remaining variables are explanatory variables. The t indexes organization performance or practices for the year 1994, and $t-2$ indexes the organization performance for 1992.

Past performance was included based on the following assumptions. First, we assumed that organizational performance followed a first order auto-regressive process. Second, by including past performance, we removed firm-specific factors that were unrelated to current practices. Third, current practices only accounted for changes in performance (Ittner & Larcker, 1995), thus prior performance was included. Testing of the hypotheses for each type of performance focuses on the interaction effects between empowerment and incentive type. Since there are three types of performance, a total of three regression analyses were used to test the hypotheses. Significant interactions were further presented in graphical form (Snell & Yount, 1995; Stone & Hollenbeck, 1984).

RESULTS

Validity Checks

First, the median (mean) for teams is 5.75 (5.51) while only 12 plants (i.e. 16%) scored below 4.75 (1–7 scale). This suggests that team-based practices are quite common in the electronic industry making it an appropriate industry for studying team-based practices. Second, it is possible that some plants may form teams to carry out various activities, but they may not give as much autonomy to their work teams (i.e. high in teams but lower in work team empowerment), but not *vice versa*. As a result, the second validity check deals with this issue. Except for one response, the score for empowerment was consistently lower than that of team.[7] In sum, the responses survived the validity checks.

Descriptive Statistics

Table 1 – Panel A presents descriptive statistics on workplace practices examined in this study. Twenty four plants did not have a formal TQM program and there were 15 plants with more than four years of TQM implementation. Thirty plants did not have a formal JIT management system while only 13 plants had implemented JIT management for more than four years. It is important to state that implementation of TQM or JIT management is seldom an "all or nothing" event, the classification, however, allows us to conduct some manipulative checks.[8] Finally, more than 50% of the plants (37 plants) still used fixed pay only for workers' compensation, with seven plants using fixed + non-monetary cash reward, 13 plants using fixed + individual-based incentive plan, and the remaining 26 plants using fixed + group-based incentive plans. Table 1 – Panel B presents respondents' job titles.

Table 1.

Variables	No Formal Program	1–2 years	3–4 years	>4 years
Panel A: Descriptive Statistics – Workplace Practices				
Years of TQM Experience	24	19	18	15
Years of JIT Experience	30	21	12	13
	Fixed Pay	Fixed + Non Monetary Reward	Fixed + Individual-based Cash Reward	Fixed + Group-based Cash Reward
Compensation Type	37	7	13	26
Job Title Used by Respondents	Number of Respondents	Percentage		
Panel B: Job Title of Respondents				
Plant Manager, Manufacturing Manager, or Operations Manager	23	30%		
VP of Operations, VP or Engineering, VP of Manufacturing, or VP of Quality	22	29%		
Director of Operations, Director of Manufacturing, or Director of Manufacturing and Engineering	13	17%		
CEO, President and CEO, Executive VP, or President	5	7		
Miscellaneous Titles Used – e.g. Material Manager, Test Manager, Sourcing and Fabrication Manager, or Product Integrity Manager				
No Information on Job Title	6	7.5%		
Total Respondents	76	100%		

As noted, a majority of the respondents are closely associated with manufacturing operations.

Table 2 shows results of means, standard deviations, Cronbach alphas and Pearson's correlations. All alphas are above 0.50. First, evidence from Table 2 indicates that sample plants which implement TQM or JIT management tend to have teams as well. Note, however, only those plants which focus more on TQM tend to empower their work teams. More specifically, although plants which scored high in JIT management also scored high in teams, these plants tend not to empower their workers and they tend to use individual-based incentives when rewarding their workers. Second, TQM, JIT management, and team were negatively associated with fixed-pay, suggesting the use of contingent pay for these plants. Third, although most plants have teams (a mean score of 5.5 on teams on a scale of 1–7), a majority of these plants have not delegated decision making authority to their workers (a mean score of 3.9 on empowerment on a scale of 1–7). Fourth, plants which implemented a work team concept tended to use group-based incentives for workers' compensation. Fifth, individual-based incentive is negatively related to empowerment, suggesting that individual-based incentive plan may not be a right match with empowerment. Sixth, there is little correlation between the percentage of waste, manufacturing lead time, or changes in manufacturing cost, suggesting that these performance measures should not be aggregated. Finally, neither incentives nor empowerment are individually correlated with any performance measure; their interactive effect, however, was subsequently demonstrated to be associated with better performance.

This study is interested in the performance effect of empowering workers under a matched incentive plan. Thus, exploratory analyses such as chi-square test, simple frequency, and *t*-tests were conducted when appropriate. These results are presented in Table 3. First, firms were split into two groups, i.e. high empowerment and low empowerment using the median as a cut-off point. There were three plants with the median value, resulting in a total of 80 plants in this analysis. Next, we further categorized them by compensation type. Since there are four types of compensation in this study, this resulted in a total of eight groups. Next, the number of plants in each cell and the performance means were generated. First, we assume that choices of compensation type should support a firm's strategy, which means this decision is non-random. A chi-square likelihood test shows a statistical difference at $p = 0.01$. Recall that it was hypothesized that when workers are empowered, a matched incentive plan should be group-based incentive. A directional t-test was supported at $p = 0.05$ for plants using group-based incentive. Although no significant differences were detected for plants that use fixed pay and fixed + individual-based incentives, the expected direction was supported. Note that this is a survey study, which means that firms normally engaged in a number

Table 2. Means, Standard Deviations, Alphas, and Pearson's Correlations for Study Variables.

Variable	Mean	S.D.	Alpha	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Size	2.72	1.25	N/A	–												
2. TQM	4.17	0.93	0.83	0.08	–											
3. JIT	4.69	0.65	0.63	0.17	0.58^{***}	–										
4. TEAM	5.55	1.07	0.88	0.05	0.50^{***}	0.29^{**}	–									
5. Comp-F	0.45	0.50	N/A	−0.05	-0.25^{*}	-0.26^{*}	-0.36^{***}	–								
6. Comp-Non$	0.08	0.28	N/A	0.07	0.17	0.14	0.15	-0.27^{*}	–							
7. Comp-I	0.16	0.37	N/A	−0.14	0.10	0.24^{**}	0.11	-0.37^{***}	−0.13	–						
8. Comp-G	0.31	0.47	N/A	0.13	0.09	0.01	0.21^{*}	-0.61^{***}	−0.20	-0.29^{**}	–					
9. Empowerment		3.99	1.27	0.73	−0.09	0.34^{**}	0.20	0.58^{***}	−0.07	0.17	-0.21^{*}	0.14	–			
10. W92		4.76	4.17	0.63	0.23^{*}	0.19	0.16	0.17	−0.17	−0.07	0.14	0.11	0.05	–		
11. LEAD92	50.54	75.2	N/A	0.25^{*}	−0.07	−0.02	−0.12	0.02	−0.09	0.03	−0.01	−0.13	0.26^{**}	–		
12. W94		2.83	2.43	0.56	0.30^{**}	0.05	0.02	0.07	−0.15	−0.06	0.07	0.14	−0.04	0.73^{***}	0.18	–
13. LEAD94	34.11	56.1	N/A	0.15	−0.10	−0.09	−0.16	0.01	−0.10	0.04	−0.02	−0.15	0.20	0.96^{***}	0.17	–
14. MCOST	2.11	1.01	N/A	−0.01	-0.31^{**}	−0.15	-0.26^{*}	0.17	−0.16	−0.05	−0.05	−0.02	-0.29^{**}	0.12	−0.15	−0.16
	0.05 (0.21−0.25)		0.01(0.26−0.29)		0.001(>0.30)											

Note: ($n = 83$).
$^{*}p \leq 0.05$.
$^{**}p \leq 0.01$.
$^{***}p \leq 0.001$.

Table 3. Manufacturing Cost[a] by Empowerment and Compensation Type.

	N = 80			
	Fixed Pay only	Fixed + Non Cash Reward	Fixed + Individual-based Cash Reward	Fixed + Group-Based Cash Reward
Low Empowerment[b]	$\bar{x} = 2.14$	$\bar{x} = 1$	$\bar{x} = 1.78$	$\bar{x} = 2.44$
$n = 40$	$n = 21$	$n = 1$	$n = 9$	$n = 9$
High Empowerment	$\bar{x} = 2.48$	$\bar{x} = 1.67$	$\bar{x} = 3$	$\bar{x} = 1.81$
$n = 40$	$n = 15$	$n = 6$	$n = 3$	$n = 16$
t-statistic	−0.86	N/A[c]	−1.19	1.68*
	$n = 36$	$n = 7$	$n = 12$	$n = 25$

Notes: Manufacturing cost anchored on 1 = decreased tremendously, 3 = no change, 5 = increased tremendously.

[a] This analysis was not done for non-value added activities and manufacturing lead time because *prior* performance has to be considered (see the statistical model in Table 4). Also, an alternate approach of using "change in performance" does not produce an optimal model. For detailed explanation please see "Research Model and Testing Procedure" within the text.

[b] The median (empowerment = 4.0) was used to split the sample into two groups, there are 3 firms with the median value, resulting in a total number of 80 firms in this analysis.

[c] Since there is only one firm in the cell of "Low Empowerment, Comp-non$ reward," no t-test can be generated.

of job enhancement activities concurrently, thus a multiple regression model that controls for other mitigating factors, as presented in the next section should provide more reliable results. Nevertheless, the exploratory analyses present information in an easy readable format.

Tests of Hypotheses

Hypotheses 1, 2, and 3 predicted that the favorable effect of work team empowerment will not be observed under fixed-pay, fixed + non-monetary reward, and individual-based incentives. On the other hand, Hypothesis 4 predicted that performance is an interactive function of group-based incentives and work team empowerment. As a result, incentive-type is coded in a way that the intercept represents the performance mean for firms that use group-based incentives. The results of hypothesis testing were tabulated in Table 4 . Note that only seven plants used fixed + non-monetary reward, thus making inferences almost impossible. Consequently, we took a very conservative approach when interpreting the results. Because of the very small number of plants related to Hypothesis 2, the findings

Table 4. Multiple Regression of Manufacturing Performance.

	Beta (t-statistics)		
	Non-Value-Added Activities	Manufacturing Lead Time	Change in Manufacturing cost
Intercept	6.1 (2.89)**	57.96 (2.70)**	4.54 (3.76)***
Perf92	0.44 (9.28)***	0.73 (27.8)***	N/A
Size	0.45 (2.64)**	−3.93 (−2.35)*	0.04 (0.52)
TQM	0.08 (0.30)	1.59 (0.60)	−0.27 (−1.70)*
JIT	−0.36 (−0.96)	−3.80 (−0.97)	0.08 (0.38)
Comp-F	−5.72 (−3.19)**	−33.59 (−1.79)*	−1.26 (−1.26)#
Comp-Non $	−3.62 (−0.73)	−17.60 (−0.64)	−1.58 (−0.98)
Comp-I	−2.42 (−1.34)#	−18.52 (−1.01)	−1.85 (−1.77)*
TEAM	−0.44 (−1.57)#	−4.00 (−1.42)#	−0.28 (−1.80)*
Empowerment	−0.58 (−1.80)*	−3.11 (−1.0)	−0.06 (−0.31)
Comp-I × Empower	0.54 (1.24)	4.15 (0.92)	0.53 (2.04)*
Comp-F × Empower	1.26 (3.00)**	6.59 (1.53)#	0.31 (1.36)#
Comp-Non$ × Empower	0.77 (0.80)	3.34 (0.58)	0.27 (0.80)
R^2	0.65	0.93	0.21
Overall F	9.91***	72.59***	1.76#
n	76	74	83

Notes: Outliers greater than 3 standard deviations were deleted. No data point was deleted for change in manufacturing cost, two outliers each were deleted from regressions for non-value-added activities and product development time. Due to missing information, the n varies somewhat.

All t-tests were one-tailed tests.

$p \leq 0.10$.

* $p \leq 0.05$.

** $p \leq 0.01$.

*** $p \leq 0.001$.

were discussed first. Hypothesis 2 was not supported, i.e. the interaction effect between empowerment and fixed + non-monetary reward was not significant in all three regressions. The sign of the interaction term, however, was as predicted, i.e. performance drops with increasing level of empowerment.

The results for fixed pay and individual-based incentives were as predicted. For example, fixed-pay interacts with work team empowerment to produce a negative effect on non-value-added activities, manufacturing lead time, and manufacturing cost with p-values of 0.002, 0.07, and 0.09, respectively. Similarly, individual-based incentives interact with work team empowerment to produce an adverse effect on manufacturing cost with a p-value of 0.02. Consequently, Hypotheses 1 and 3 were partially supported. The intercepts (which represent group-based incentives) were statistically significant for all three regressions, however, work team empowerment was statistically significant with a p-value of 0.04, only for non-value-added activities. Note that work team empowerment in all three regressions had the expected signs. Consequently, Hypothesis 4 is weakly supported.

Results from Table 4 are further presented in graphical form for easier interpretation, as presented in Figs 1 through 3. These figures illustrate the "form" of interactions, which is important to demonstrate the underlying theories (see, Arnold, 1984; Champoux & Peters, 1987, p. 244; Hartmann & Moers, 1999; Jaccard et al., 1990, p. 22; Stone & Hollenbeck, 1984). Specifically, based on the results in Table 4, holding everything constant, performances when empowerment = 1 and empowerment = 7 were generated for all 4 types of compensation. The *p*-values were those generated under SAS output, as shown in Table 4. Figure 1 illustrates that the best performance is associated with low empowerment and the use of fixed-pay. Performance, however, deteriorates at

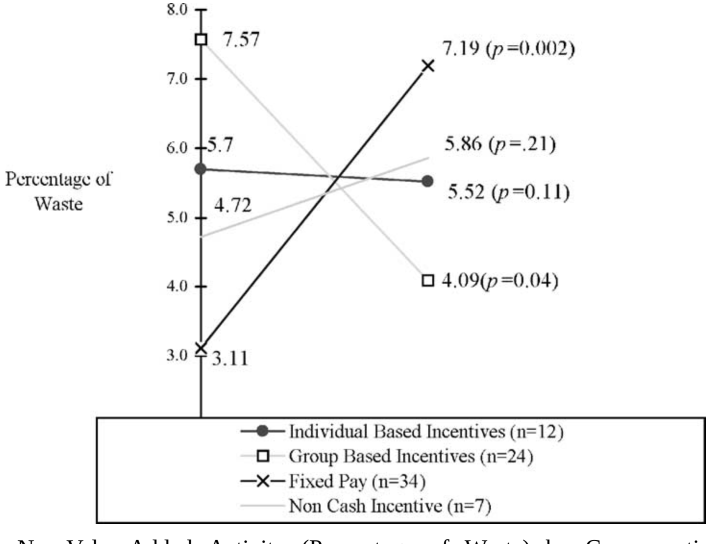

Fig. 1. Non-Value-Added Activity (Percentage of Waste) by Compensation Type and Empowerment.

Note: Figures 1 through 3 present least square means for manufacturing performance when empowerment ranges from 1 to 7 (the scale for empowerment ranges from 1 to 7). These results and their *p*-values were based on the parameters derived from the OLS models as reported in Table 4. The graphical presentations allow comparisons be made across the four types of incentive. Specifically, the graphs help to answer the research question of did performance improve at an increasing level of empowerment when fixed pay/non-monetary reward/individual-based incentives/group-based incentives were used.

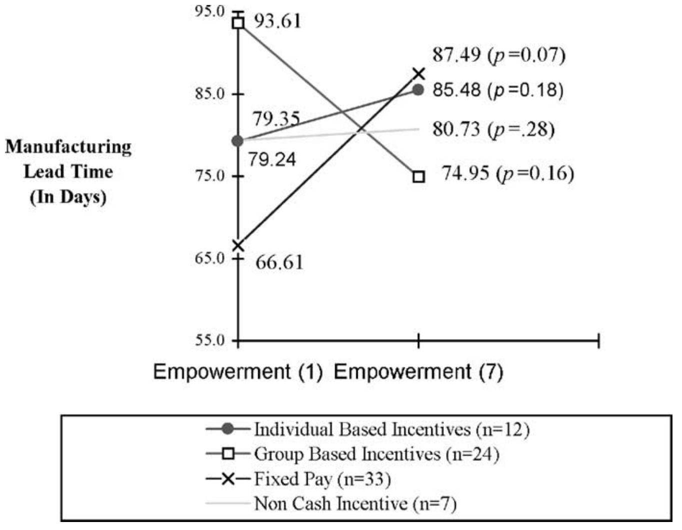

Fig. 2. Manufacturing Lead Time by Compensation Type and Empowerment.

an increasing level of empowerment with a p-value of 0.002. On the other hand, plants which use group-based incentives were able to reap the benefit of work team empowerment ($p = 0.04$). Note that very similar patterns exist with Fig. 2. In Fig. 3, it appears that manufacturing cost deteriorates at an increasing level of empowerment for plants that use fixed pay or individual-based incentives (p-values are 0.09 and 0.02 respectively). Again, although not statistically significant, only plants which use group-based incentives show improvement in manufacturing cost with increasing level of empowerment.

Taken together, our results suggest that successful implementation of work team empowerment is contingent upon incentive type; better performance is associated with the right match, while conflicting systems tend to lead to even lower performance. Findings also suggest that to enhance performance, group-based incentives should be used when workers are empowered. These findings are supplemented with additional telephone interviews.

Post Analysis Interview

To strengthen our findings and to mitigate some of the research designs in this study, we conducted post analysis telephone interviews. Ten companies were randomly selected from the pool of 83 responses. A two-page executive summary report was attached to a cover letter in which we requested a short telephone

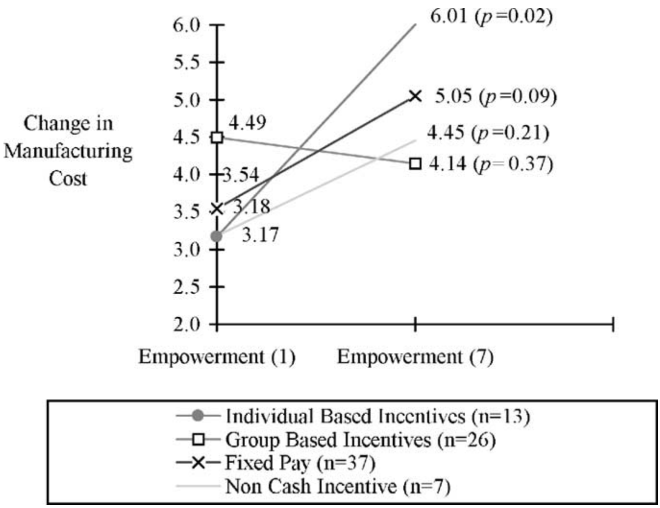

Fig. 3. Change in Manufacturing Cost by Compensation Type and Empowerment.

interview. Two packages were returned as undelivered, while two respondents agreed to have short telephone interviews with the first author. There are two major purposes for the telephone interview. First, we intend to get a more precise information on workers' compensation package. Second, we would like to see how manufacturing performances have changed since the survey was conducted. To preserve the anonymity of the two companies, these company will be addressed as Company West (located in the West Coast) and Company East (located in the East Coast).

Company West

Company West is a Fortune 500 computer chip equipment maker company with annual sales of about $1 Billion with more than 1000 employees. Company West (hereafter, Dr. West, for the interviewee) has 15% of supplier which is certified and implemented JIT management since the early 1990s and have begun to register for ISO9000 certification since the middle part of the 1990s. Company West scored slightly below the mean for team work and work team empowerment. Workers were placed on an incentive plan based on group-based monetary reward. According to the survey data, performance shows an improving trend. Dr. West said "Incentives for the workers were based on group performance. That is, once the desired performance is attained, the group will get × percent of bonus. However, to motivate individual, discretionally bonus may be given." Dr. West added, "Pay is important for the entry level workers. Beyond that, decision making, autonomy, and chances to advance should increase the satisfaction of the employees. These are equally important. Yes, for us empowerment is the direction to go. To manage empowered workers, we ask the workers to set goals. We gave them power (autonomy), and help them if needed." When asked about how to control empowered workers, Dr. West reassured the first author that "The control process is through setting goals and tying rewards to the goals."

Company East

Company East was a wholly owned subsidiary of IBM just prior to the completion of the survey. Accordingly, information presented in the survey were associated with the IBM's management style. Since then, Company East (hereafter, Mr. East for the interviewee) has been acquired by a smaller company and then by a Fortune 100 Company, all in less than three years.

The manufacturing operations are categorized as broad-based, full-service, and they provide manufacturing of some of the world's leading-edge Department of Defense products. The manufacturing operations have SEI Level 5 Capability Maturity Model rating, a level that places Company East in an elite class throughout the world. Company East has slightly above 300 employees on site which were organized into about 50 teams. Product design, parts procurement, as well as engineering and support services were delivered in house. Mr. East is a well-versed veteran who started his career in the earlier 1980s with IBM. Mr. East recalled that they do not have empowerment back then. According to Mr. East, IBM started the "production employee of the future" in 1988, mostly for statistical process control (SPC) purposes during that time. The program was a winner, they produced complex parts in-house and have suppliers to do more simpler parts. Mr. East said, "IBM won, we cut down our suppliers from 14 to 2." Mr. East continued by saying that IBM attracted the best people, they provided good training and there is always a commitment to quality. They let the workers do their work, there was no limit for job advancement, the only limit is the sky.

In 1992, Company East started to introduce a profit sharing plan with its employees. Initially, rewards were based on site performance. Later, the reward structure was 30% site, 40% project, and 30% group (for manufacturing). During that time, performance recognition, such as "employees of the month" which was group-based was also practiced. (Note, it was checked as group-based incentive in the survey despite the practice of non-monetary rewards as well). With this plan there was very little increase in the base salary. Nevertheless, people were happy, they worked hard and they were rewarded for doing a good job. Then came what Mr. East described as the number 1 problem, things changed when they were acquired. The new management was unionized and a huge corporation with not much flexibility when it comes to the reward structure. The incentive plan was taken away and the base salary was increased by 5%. Mr. East is no longer with the manufacturing division. Thus, detailed or specific performance questions could not be addressed. Nevertheless, he commented that continuous improvement is an on going thing, but people are less happy now, this sentiment could easily be picked up from the hallway. "We are located within the same valley as IBM, last year they have a 24% bonus, what will you do?"

SUMMARY AND CONCLUSIONS

If flexibility, innovation, and creativity are tools for better competition, then moving decision making authority from higher to lower levels in organizations becomes a necessary condition for creating more responsive or proactive organizations (Flanagan, 1994; Simons, 1995b). Increasingly, the redistribution of decision rights, or the use of multi-person decision making has gained attention particularly in team-based organizations or manufacturing firms utilizing concepts such as manufacturing cells or process re-engineering. Empowerment implies that workers have, or will develop, an information edge over management (see, Alles et al., 1997); while Simons (1995b, p. 162) suggests, the ceding of decision authority to subordinates can be dangerous. It is in this spirit that we have examined these issues.

It was predicted that the favorable effect of work team empowerment will not be observed under fixed-pay, non-monetary rewards, and individual-based incentives. Findings were not supported for non-monetary rewards. As discussed earlier, because of the extremely small number of plants using this type of reward, no inferences can be made from the study. Results indicate that the use of fixed-pay or individual-based incentives in conjunction with empowered work teams is often associated with loss in productivity. These results provide possible explanations to what was happening in the real world. For example, prior to IBM selling off its Lexington printer division (i.e. Lexmark), individual suggestions that linked to individual cash awards was implemented. As a result, in many instances, suggestions were submitted in privately sealed envelopes. This plan, however, did not work out. According to Marvin L Mann, CEO, "If you're going to get paid for individual ideas, you aren't going to mention them at team meetings where we want ideas to be refined and improved. Getting rid of the individual suggestion program was one of the smartest things we did. It also opened the floodgates for worker participation, allowing Lexmark to tap into what Hopwood terms 'the mental resources of employees." Today, the employees at Lexmark International Inc., relish the fact that IBM visits Lexmark to learn its secrets, According to Mann, "Empowerment doesn't mean I can do anything I want to do when I want to do it. Instead it means making the positives outweigh the negatives and backing them by both financial and emotional rewards." Team performance is also tied to bonuses and is a criteria for performance review (Flanagan, 1994). Indeed, results in this study show that empowerment in itself does not lead to better performance, i.e. empowerment enhances firms' performance *only* when workers are held accountable for their output *and* when their collective welfare is maximized.

Thus, our findings have implications for management controls. For example, Simons (1995b) asserts that people desire to achieve and contribute, to do things right, add value and innovate, and that lapses or the divergence of self interests are due to organizational blocks. Similarly, Merchant (1985) suggests simultaneous use of multiple controls to safeguard organizational resources. Thus, firms may want to carefully design their control systems in order to remedy problems associated with empowered teams. These controls should tap both intrinsic and extrinsic motivation in order to achieve goal congruence.

Black and Lynch (1997) showed that although almost 75% of their sample have some form of TQM program in place; on average, only about 54% of employees in their sample are involved in some sort of regular meeting to discuss workplace issues. Black and Lynch's study was based on a cross-sectional and panel data (covering a period of 1987–1993) from the Educational Quality of the Workforce National Employers Survey and the Bureau of the Census' Longitudinal Research Database. Their results also indicated that adopting a TQM program, per se, did not raise productivity. Rather, giving greater autonomy to employees is what seems to matter most. Our findings, in part, are somewhat consistent with Black and Lynch (1997), i.e. although team-based work design is a common practice within the electronic industry, our results indicate that many plants in our sample have not delegated decision autonomy to their workers. Nevertheless, our telephone interviews with two of the respondents suggest that empowerment has gained more acceptance as time progresses. Thus, as more plants are in the process of delegating decision making to their workers, these plants may be faced with control issues as presented here. To this end, results from this study suggest that, amongst others, accountability could be a viable form of organizational control.

The results of the study, while providing some insight into the design of controls under empowerment, leave many unanswered questions that could be pursued by future research. For example, although our hypotheses were supported in most cases, the reward structure seems to be overly simplified. For example group-based incentives could be based on group performance or plant-level performance. No distinction, however, was made in this study. Similary, a hybrid system may be used, while it was not listed as one of the choices. Post analysis telephone interviews, however, appear to have mitigated some of the shortcomings. For example, when an incentive plan involves a larger proportion of plant's or group's performance, even when non-monetary rewards are presence, the respondents appears to be able to classify that as group-based incentive plan. Future research may warrant asking for the specific reward formula used, such that a weighted average approach could be incorporated in the research model. Finally, opponents of incentive plans often criticized that extrinsic motivation does not have a long lasting effect. Our model, does not allow us to address this issue since we looked at a short window, i.e. changes in performance within the last three years. Thus, future research should look at a longer window.

On a lesser note, we focused primarily on manufacturing performance, i.e. we did not examine more aggregate firms' performance such as return on assets or return on sales which are important measures for long term survival of firms. Likewise, it is possible that task complexity may have accounted for the differential improvement rate. We, however, did not control for this variable. By incorporating personnel control and results control, findings appear to have supported Merchant's (1985) notion of multiple controls. Other commentators have suggested simultaneous use of belief, boundary, diagnostic, and interactive systems for better strategic success (Fisher, 1995; Norton & Kaplan, 1996; Simons, 1995a, b). Thus, future research may want to investigate the effect of the concurrent use of these systems on organizational performance. While the field data presented here are rich, a limitation of our study is the sample size that precludes us from doing more powerful analysis such as the creation of causal models. More importantly, because of the small sample size, we were not able to make inferences with respect to non-monetary reward systems. Thus, future research would warrant a larger sample. Finally, the use of self-report measures could be improved by incorporating firm level performance from some existing archival data.

NOTES

1. For example, as part of the initiatives under Total Quality Control, Applied Materials discovered that its empowered workers were doing their own thing with little regard for departmental or organizational objectives.
2. For example, tensions between freedom and constraint or between empowering employees and holding them accountable for their actions.
3. When rewards were not jointly determined, a higher level of cooperation exists; however, there is no improvement in performance.
4. A total of 173 respondents were received from the 1,400 requests. Nineteen plants indicated that they were either not a manufacturing plant or their manufacturing was done overseas. Thus, they were not the correct pool for our sample. Twenty-five firms indicated that they would not participate in this study.
5. Twenty-seven percent (22 out of 83 questionnaires received) of the respondents did not reply to this question.
6. If a simple relationship between two variables is spurious, i.e. it is due to some common cause or a third factor, the relationship should disappear when the common cause or the third factor is controlled. Thus, control variables improve the validity of results.

7. Even for that plant, the mean score for empowerment was only half a point higher than the mean score for team.

8. The respondents were asked whether they have a formal TQM or JIT management program. If so, they were asked the year when the program was implemented. We then use these responses as a manipulative check, i.e. "years of implementation" is expected to be positively related to TQM or JIT management's score, i.e. the longer a plant practices TQM, the higher is the score.

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APPENDIX A

Construct Measurement Instruments

(∗ = Reverse coding)

1. Performance Measures

(i)	Non-Value-Added Activities (Waste)	YEAR ENDED 1992	YEAR ENDED 1994
	Cost of scrap as a percentage of total manufacturing cost	_______________%	_______________%
	Units reworked as a percentage of units inspected (at final inspection)	_______________%	_______________%
	Units of defect as a percentage of units inspected (at final inspection)	_______________%	_______________%
	Warranty cost as a percentage of sales dollars	_______________%	_______________%
	Units returned as a percentage of units sold	_______________%	_______________%
(ii)	Manufacturing Lead Time	YEAR ENDED 1992	YEAR ENDED 1994
	Manufacturing lead time (defined as the number of days from which receipt of raw material until customer receipt of products)	_______________Days	_______________Days

2. Other Performance
   (Anchored by 1 = Decreased Tremendously, 3 = No Change, 5 = Increased Tremendously)
   (i) Manufacturing Cost
3. Teams
   (Anchored by 1 = Strongly Disagree, 4 = Neither Disagree Nor Agree, and 7 = Strongly Agree)
   (1) Our plant forms teams to solve problems.
   (2) In the past three years, many problems have been solved through small group sessions.

(3) During problem solving sessions, we make an effort to get all team members' opinions and ideas before making a decision.
(4) Management provides an environment for participation by all members in the group.

4. Empowered Work Teams
(Anchored by 1 = Strongly Disagree, 4 = Neither Disagree Nor Agree, and 7 = Strongly Agree)
(1) Daily problems have been handled primarily by groups.
(2) Group members actively provide input to both product and process design.
(3) Vacation, back-up process, or unexpected changes in schedule are decided by work group members.
(4) In our plant, group members are encouraged to generate input for hiring decisions within their groups.

5. Compensation-Type
How are plant workers currently being compensated? (please circle only one).
(a) Strictly individual fixed pay only.
(b) Individual fixed pay + non-monetary reward.
(c) Individual fixed pay + individual-based monetary incentives.
(d) Individual fixed pay + group-based monetary incentives.

6. Total Quality Management
(Anchored by 1 = Very little or None, 4 = Moderate, and 7 = A Great Deal or Consistent Use)
(1) How much time does the plant management staff devote to quality improvement?
(2) How much time is spent working with suppliers to improve their quality?
(*3) How would you describe your current approach to providing quality products?

Built In		Some of Each			Post Production Inspection	
1	2	3	4	5	6	7

(4) How much effort (both time and cost) is spent in preventive maintenance to improve quality?
(5) How much effort (both time and cost) is spent in providing quality related training to the plant's employees?
(6[a]) What percentage of the plant's manufacturing processes are under statistical quality control? _____%

(7[a]) What percentage of the plant's employees have quality as a major responsibility? ______%

How would you describe the level of use within your plant of the following quality improvement methodologies? (Anchored by 1 = Little or None, 4 = Moderate Use, and 7 = Consistent Use)

(8) Quality Function Deployment
(9) Taguchi Methods
(10) Continuous Process Improvement

[a] The numeric number reported was divided by 14.3 (i.e. 100/7 = 14.29%) in order to convert the % to a scale of 1–7.

7. Just in Time

(Anchored by 1 = Not at All or Very Little, 4 = To Some Extent, and 7 = Completely or A Great Deal)

(1) Are products pulled through the plant by the final assembly schedule/master production schedule?
(2) How much attention is devoted to minimizing set up time?
(3) How closely/consistently are predetermined preventive maintenance plans adhered to?
(4) How much time is spent in achieving a more orderly engineering change by improving the stability of the production schedule?

How much has each of the following changed in the past three years? (Anchored by 1 = large Decrease, 4 = Same, and 7 = Large Increase)

(*5) Number of your suppliers
(6) Frequency of the deliveries
(*7) Length of product runs
(*8) Amount of buffer stock
(*9) Number of total parts in Bill of Material

8. Plant Size

(i) The average annual sales is about ___________

(If a specific sales level is not available, please check ( ) one of the following)

______ Below $10 Million	______ $201 Million – $500 Million
______ $10 Million – $50 Million	______ $501 Million – $1 Billion
______ $51 Million – $100 Million	______ $1 Billion – $2 Billion
______ $101 Million – $200 Million	______ Above $2 Billion

EFFECTS OF UNCERTAINTY, PARTICIPATION, AND CONTROL SYSTEM MONITORING ON THE PROPENSITY TO CREATE BUDGET SLACK AND ACTUAL BUDGET SLACK CREATED

Leslie Kren

ABSTRACT

This study extends prior research by proposing a more complete model of the process by which budget slack is created in the organization. The research model proposed in this study suggests that there is an ex-ante as well as an ex-post process by which budget slack is created. In the ex-ante process, environmental uncertainty and budget participation are linked to managers' propensity to create slack through job-relevant information (JRI). In the ex-post process, the control system determines the slack in the final budget by providing information to superiors about a manager's performance capability. Thus, the propensity to create slack determines actual slack to the extent that the organization's control system fails to provide an effective assessment of the manager's performance capability.

Contrary to expectations, the ex-ante model indicated that participation has a direct, negative effect on propensity to create slack. The largest

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effect on propensity to create slack, however, was a direct positive link from environmental uncertainty. In the ex-post process, the link between propensity to create slack and segment slack (actual slack created) was moderated by the organization's control system capabilities. When propensity to create slack is low (high), control system monitoring has little (a great) effect on segment slack created. This finding is consistent with arguments that publicly available information about a manager's performance capability motivates a higher budget standard.

INTRODUCTION

Managers acquire private information because they are closer to the decision environment than their superiors. The resulting information asymmetry can form an environment in which budget slack can be created. Budget slack is defined as budget resources controlled by a manager in excess of optimal to accomplish his or her objectives. It is evident as overstated expenses, understated revenues, or underestimated performance capabilities. A related concept is organizational slack, which may be created for strategic purposes. Cyert and March (1963), for example, suggest that organizational slack may serve a positive function by absorbing fluctuations in an uncertain environment. The concept of budget *achievability* is also related to slack. Merchant and Manzoni (1989) concluded that superiors sometimes allow 'achievable' budgets to increase the predictability of earnings, reduce time spent on control of profit center operations, and reduce the risk of dysfunctional subordinate behavior. Budget slack, the focus of this study, is distinguished from organizational slack and achievable budgets allowed by superiors because budget slack is concealed from superiors and exceeds allowable levels. While both organizational slack and achievable budgets are (perhaps implicitly) accepted by superiors, budget slack is hidden.

Budget slack can benefit managers because they often perceive that their performance will look better to their superiors when a cautious budget is surpassed than when an aggressive budget is not met (Baiman & Demski, 1980; Cyert & March, 1963; Kren, 1997). From the organization's perspective, however, budget slack can hinder coordination of business unit activities (Baiman, 1982; Choudhury, 1985; Onsi, 1973; Tiessen & Waterhouse, 1983).

A variety of factors, particularly budget participation and environmental uncertainty, have been examined in prior behavioral research on managers' *propensity* to create budget slack (Govindarajan, 1986; Kren, 1997; Merchant, 1985; Onsi, 1973). The level of actual slack created has not been examined in field research. Despite these efforts, however, a cohesive model of budget slack behavior has not emerged.[1] This study extends prior field research by developing and testing a more complete model of the process by which budget slack is created in a participative budgeting setting. In addition to examining managers' *propensity* to create slack, an attempt is also made to measure the level of *actual* slack created. Prior field research has not attempted to link the *propensity* to create slack to *actual* budget slack created.

The next section provides a discussion to develop the hypothesis. Subsequent sections contain a description of the research method, an analysis of the results, and a summary and conclusion.

HYPOTHESIS DEVELOPMENT

Background and Prior Literature

Participative budgeting provides an opportunity for managers to disclose their private information in budgets, allowing improved resource allocation, planning, and control (Baiman, 1982; Tiessen & Waterhouse, 1983). Slack budgets are not consistent with full disclosure of private information and can lead to lower firm returns from suboptimal resource allocation decisions (Onsi, 1973). Chalos and Haka (1990) demonstrated empirically that gains to the organization can result from improved resource allocation when private information is disclosed in budgets. Planning and control is also hampered because the organization is in the awkward position of not being able to determine the true profit potential of its segments since it cannot effectively evaluate the desirability of decisions that were based on the manager's better private information that has not been revealed in the budget (Choudhury, 1985).

Behavioral accounting theorists have traditionally argued that budget participation will motivate managers to reduce budget slack, i.e. reveal their private information in their budgets (e.g. Becker & Green, 1962; Schiff & Lewin, 1970). This argument is based on the premise that participation allows "positive" communication between superiors and subordinates, reducing the 'pressure' to create slack. A series of behavioral empirical studies have supported this premise by examining managers' propensity to create slack (not actual slack). Onsi (1973), for example, reported a negative main effect for budget participation on propensity to create budget slack. Merchant (1985) also reported a negative relation between participation and propensity to create budget slack. Merchant (1985) further suggested a joint effect of participation and uncertainty on the propensity to create budget slack. Merchant concluded that, "... participation may diminish managers' propensities to create slack in relatively predictable settings only" (p. 207). Govindarajan (1986) similarly found a negative link between participation and propensity to create slack that was affected by environmental uncertainty. Govindarajan argued that environmental uncertainty imposed greater information processing needs which could be dealt with by increasing either participation or slack.

These behavioral studies generally ignored the effects of budgeting managers' self-interest on their slack behavior (propensity to create slack). Later research has argued that managers are unlikely to limit budget slack unless it satisfies their own self-interest (Baiman & Evans, 1983). In fact, managers are motivated to insert budget slack because it can be used as a mechanism to obtain excess resources, to shirk more effectively (Baiman & Demski, 1980; Kaplan & Atkinson, 1989), and as a hedge against uncertainties that affect outcome-based performance measures (Cyert & March, 1963; Schiff & Lewin, 1970). Thus, managers have incentive to take advantage of participation to increase budget slack. A series of agency theory-based laboratory experiments examining the budget slack problem have provided consistent evidence that managers will insert slack into their budgets when given the opportunity (Chow et al., 1988, 1991, 1994; Waller, 1987; Waller & Bishop, 1990). In a field study, Dunk (1993) similarly argued that participation gives managers the opportunity to create slack. However, Dunk's findings were the opposite of predictions. These results were later clarified in Dunk and Perera (1997) where they demonstrated a negative participation-slack link and concluded that the relation was affected by a variety of ethical and personal factors.

The above research has addressed only managers' *propensity* to create budget slack. However, regardless of their *propensity* to create slack, managers are deterred from inserting *actual* slack into their budgets by the organization's control system. By providing information to superiors about a manager's performance capability, the organization's control system can allow slack to be more easily uncovered and sanctions to be applied (Waller, 1987). Young (1985) demonstrated in an experiment that 'social pressure' can limit slack because a budgeting manager does not want to be viewed as a shirker or one that misrepresents information. This is consistent with the argument that a superior's knowledge about how well a manager can perform can motivate a higher budget standard. Merchant (1985) also provide survey evidence that control system characteristics that can detect slack can prevent it. Examples of control system capabilities that enhance monitoring ability include pre-action reviews, budgeting and variance analysis systems, and policy and procedure practices (Merchant, 1998).

Research Model and Hypotheses

Based on the above discussion, a research model is proposed in this study suggesting that there is an ex-ante as well as an ex-post dimension to the process by which budget slack is created. In the ex-ante process, environmental uncertainty and budget participation are linked to managers' *propensity* to create slack through job-relevant information (JRI). In the ex-post process, the control system determines the slack in the final budget by providing information to superiors about a manager's performance capability. Thus, the *propensity* to create slack determines *actual* slack to the extent that the organization's control system fails to provide an effective assessment of the manager's performance capability. The research model is shown in Fig. 1 and the conceptual framework for the linkages in the model is discussed below.

Environmental uncertainty (Z_1), which is defined as change or variability in the organization's external environment, is presumed to generate the demand for participation (Z_2) (link P_{21}). Organizational theorists have argued that greater participation in decision-making by lower-level managers is required as uncertainty increases because greater uncertainty requires that decisions must be made at lower hierarchical levels in the organization to deal with numerous exceptions which can otherwise overwhelm the organization's information system (Galbraith, 1973; Simons, 1987). When uncertainty is low, however, fewer exceptions occur and rules and procedures are adequate to specify managers' behavior. Govindarajan (1986) and Hopwood (1976) extended this reasoning from participative decision making in general to participation in budgeting, concluding that greater budgetary participation should be found in organizations facing greater uncertainty. Govindarajan (1986) and Hopwood (1976) provided empirical evidence supporting such a positive uncertainty-participation link. Govindarajan (1984) also concluded that participation was more useful when environmental uncertainty was high, arguing that more decisions are routine when uncertainty is low and involving subordinates in decisions with obvious solutions is a waste of time.

The link (P_{32}) between budget participation (Z_2) and job-relevant information (JRI) (Z_3) is based on the premise that budgetary participation creates an environment that encourages the acquisition and use of JRI (Kren, 1992). Participation provides an opportunity to influence the budget before it is finalized so managers must assume more active roles in participatory budgets. Participating managers become more involved in considering and evaluating alternative budget goals and may spend more time thinking about budgetary objectives and alternative means-end approaches (Early et al., 1987; Lawrence & Lorsch, 1967; Locke et al., 1986). Results of field research provide supporting evidence (Lowe & Shaw, 1968; Simons, 1987) as does the research on budget-related behaviors

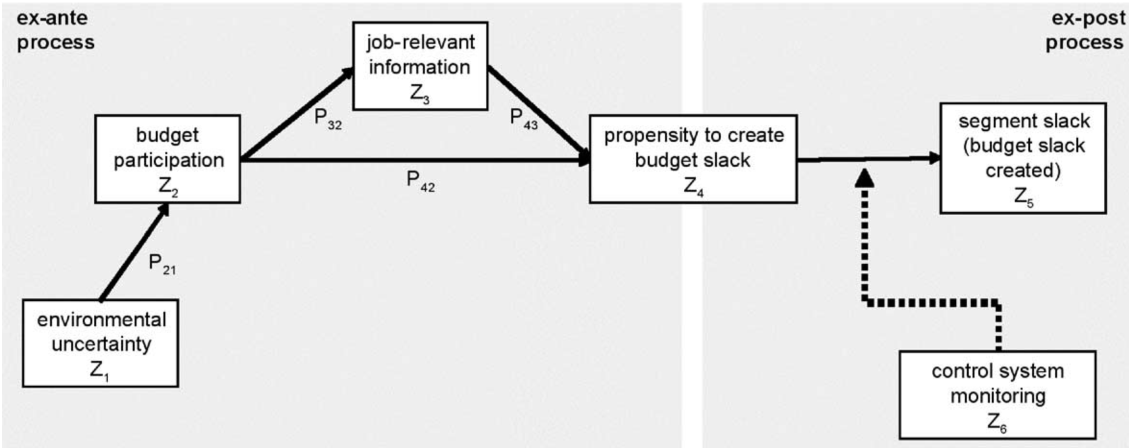

Fig. 1

Research Model. *Note:* Segment slack is measured as the sum of average capital expenditures plus research and development expenditures divided by segment sales. Uncertainty is measured as first differences over the sample period of: (1) market volatility, the coefficient of variation of net sales; (2) technological volatility, the coefficient of variation of the sum of research and development and capital expenditures divided by total asstes; and (3) income volatility, the coefficient of variation of profits before taxes. Other variables are self-reported scales as described in the paper.

(Merchant, 1984). For example, Simons' (1987) field study of the Johnson & Johnson Company provides detailed descriptions of how budgetary participation promotes extensive JRI search activities by managers, and these activities appear to occur primarily because the budgetary process is participatory rather than imposed.

The final links in the ex-ante model are between propensity to create slack (Z_4) and budget participation (Z_2). A direct link (P_{42}) between participation and propensity to create budget slack has not found consistent support in the literature, as described above. The premise in this research model is that the link is moderated by JRI (Z_3). Thus, participation's effect on the propensity to create budget slack is indirect through JRI (P_{32}–P_{43}). Participation has not been consistently linked to slack in prior research because participation does not always have the same cognitive benefits to managers to develop JRI. Thus, the link between participation and slack depends on the level of JRI developed from the participation process. Higher levels of JRI provide more opportunity to create slack. Managers who are unable to acquire JRI from participation have less information on which to base slack. Those managers who find that participation is more useful to acquire JRI, are in a better position to create slack in their budgets.

In contrast, the mechanism for the direct link between participation and the propensity to create slack (link P_{42}) arises from the premise found in some behavioral research (discussed above) that participation allows "positive" communication between superiors and subordinates, thereby reducing the pressure to create slack. It seems likely that the indirect participation-slack link through JRI will dominate the direct link.

Overall, these links provide the mechanism for a positive relation between participation and propensity to create slack through JRI. Implicit in this model is the assumption that managers have incentive to create slack. The incentive can arise from explicit budget-based incentives, or simply from a manager's perception that his or her performance will look better when a cautious budget is surpassed than when an aggressive budget is not met. The following hypothesis is proposed.

> **H1.** The relationship between uncertainty, participation, JRI, and the propensity to create budget slack will be explained by sequential linkages whereby uncertainty is positively associated with budget participation which is in-turn positively related to JRI and the propensity to create budget slack.

The ex-post process in the research model in Fig. 1 suggests that the actual level of slack created is dependent on the organization's control system. The presumption is that managers with a greater *propensity* to create slack would create greater *actual* slack if there were no constraints on their actions. However, as argued by Waller (1988), an important factor that prevents managers from putting slack into their budgets is the superior's knowledge of the manager's performance capability.

If superiors know how well the manager can perform, slack can be more easily uncovered, and sanctions can be applied. Young (1985), for example, demonstrated in a laboratory experiment that one effective sanction is "social pressure" which can motivate the choice of a higher budget standard because the budgeting manager does not want to be viewed as a shirker or one that misrepresents information.

Since a more effective assessment of the manager's performance capability can be made if superiors can monitor a manager's actions and decisions, and effective control system can improve inferences about whether budgets contain slack (Kren, 1993). Control system capabilities that enhance monitoring include, for example, pre-action reviews, budgeting and variance analysis systems, and policy and procedure practices (Merchant, 1985). Thus, an important factor determining an organization's ability to control slack is the extent to which information is available about a budgeting manager's actions and decisions. The following hypothesis is proposed.

H2. The link between *propensity* to create budget slack and *actual* budget slack created is moderated by control system monitoring.

METHODOLOGY

Sample

The objective of the sample selection procedures was to identify executive-level profit center managers for whom objective, archival financial information to measure segment slack was available at the profit-center level. To this end, the titles of managers listed in the 1997 fiscal year-end proxy statements for all *S&P* 500 firms were cross-referenced with each firm's segment-level disclosures in the *Compustat Industry Segment* data file. Managers were retained in the initial sample if they could be identified from their job titles as managers of profit centers that clearly corresponded to segments listed in the *Compustat* segment disclosures. By this procedure, an initial sample was developed of 111 managers in 70 companies who were unambiguously profit center managers of reportable segments.

A cover letter and a questionnaire were mailed to each manager in the initial sample. A follow-up letter and another copy of the questionnaire were sent after approximately three weeks. All remaining non-respondents were later contacted by telephone and another questionnaire was mailed to the specific attention of the personal assistant that worked with the respondent. Repeated follow-up phone calls were subsequently made to the respondent's personal assistant.

Follow-ups of the original 111 managers revealed that 19 had retired, left the company, or had changed to new positions. Of the remaining 92 potential respondents, 49 usable responses were received (a response rate of 53.3%). Forty-four different companies were represented. There were two respondents for each of five companies. Respondents were promised anonymity, but organizational affiliation was tracked to allow measurement of segment slack, as described below. Based on segment-level SIC codes, three of the 49 managers in the final sample were in mining and construction (SIC 0-1799), 37 were in manufacturing (SIC 1999-3999), one was a utility (SIC 4800-4992), four were in wholesale-retail (SIC 5000-5999), three were in banking (SIC 6000-6399), and one was in miscellaneous services (SIC 6400-9999).

Measurement of Variables

The appendix contains an abbreviated copy of the research questionnaire used to measure the self-reported variables in this study. The reliability coefficient (Cronbach's Alpha) for each of the self-reported scales exceeded 0.80.

Budget participation was measured using the Milani (1975) six-item measure. The validity of this scale has been assessed several times in prior research, including Brownell (1983). For this study, factor analysis confirmed the single-factor structure of the scale, showing only one factor with an eigenvalue greater than 1. For subsequent analysis, the six items were summed.

The *propensity* to create slack was measured using the three-item scale used in Kren (1993) and adapted from Merchant (1985). Merchant's original four-item scale was examined by Hughes and Kwon (1990) and they suggested deleting one item to improve the scale's reliability which was done for this study. Factor analysis for this scale also revealed only one factor with an eigenvalue greater than 1. For subsequent analysis, scale items were summed.

Prior accounting field research has not attempted to measure *actual* slack created by segment managers. Thus, a proxy for *actual* slack, denoted *segment slack*, was developed for this study based on the concept of organizational slack which has been widely studied in the management literature (Greeley & Oktemgil, 1998). Organizational slack, generally defined as 'excess' resources controlled by the organization (Sharfman et al., 1988), and segment slack are related concepts. The latter, of course, is intended to proxy for excess resources controlled by the *segment manager* rather than by the organization as a whole. A variety of financial accounting variables related to cash flow, credit lines, inventory, and machine capacity have been used to proxy for organizational slack.

Developing financial accounting measures of *segment* slack is more difficult than *organizational* slack because of the limited disclosures that are available in the *Compustat* segment data file.[2] The data file contains segment sales, capital expenditures, depreciation, employee headcount, research and development, assets, and operating profit.[3] For this study, the sum of capital expenditures plus research and development expenditures divided by segment sales is used to proxy for resources controlled by a segment manager, and segment slack (i.e. 'excess' resources) is measured by comparing this variable to other segments in the same industry, with the presumption that managers controlling more resources (per dollar of sales) than their industry peers hold higher levels of slack. A positive (negative) measure indicates that resources available to the segment manager exceed (are less than) the resources available to other segments in the same industry. Industry is defined as 4-digit SIC industry reported in the *Compustat Industry Segment* data file.[4] A sample segment was excluded in the calculation of its corresponding industry mean. For each segment and its industry, the sum of capital expenditures plus research and development expenditures divided by segment sales was averaged over the three-year period 1995–1997.[5]

A measure of control system characteristics based on Kren (1993) was used, based on Merchant's (1998) characterization of control system design. Merchant classified control system tools into three categories based on the object of control: (1) specific action controls; (2) results control; and (3) personnel controls. As described above, a more extensive control system provides more information about the activities of the manager, so more information is available to evaluate the performance capability of managers and their areas of responsibility. Merchant's characterization is normative and does not provide guidance for operational measurement, however, it is useful as a framework for the control system scale developed by Kren (1993).

Specific action controls were measured with four items asking about the extent to which approval limits for capital expenditures and head-count, formal pre-action reviews for specific projects and day-to-day activities, and policies and procedures manuals affected decision-making on the job. Behavioral constraints, such as security measures were included in Merchant's description but not included in this measure because they did not seem relevant. Results controls were measured with two items that asked about the extent to which meetings to review decisions, and variance explanations affected the division manager's decision-making. This seemed appropriate since these are the settings in which standard setting occurs and results accountability is established. Personnel controls, according to Merchant, involve attempts to encourage self and social control through upgrading individual capabilities (e.g. training) and through positive peer influence. Personnel controls also include improved communication, which is of interest in this study. Thus, personnel controls were measured with an item asking about the extent to which informal contacts with superiors affected decision-making. Given the interrelationships among control tools (Merchant, 1985), some overlap in the items used to measure them should be expected. For personnel controls, for example, improved communication is likely to result from the application of control tools in other categories, such as formal meetings, pre-action reviews, and so forth. The capabilities of the organization's information/reporting system were also measured. Merchant suggested that information for control should be precise and timely so two items in the questionnaire asked about the level of detail in control reports and the frequency of reporting. A factor analysis of scale items is shown in Table 1 . Two factors were found, with the information system characteristics loading on a separate factor from the other monitoring scale items. The results reported in the paper are based on an overall monitoring measure constructed using the sum of all items in the scale.

The measure of job-relevant information (JRI) is intended to assess the extent to which managers perceived information availability for effective job-related decisions. Managers with adequate JRI are expected to perceive and report that they have adequate information to accomplish their job-related objectives and to evaluate important decision alternatives. The scale used in this study was from Kren (1992), which was adapted from O'Reilly's (1980) information overload index with the wording modified to fit a budgeting context (Roberts & O'Reilly, 1974). A factor analysis indicated that only one factor was present, explaining 83.0% of the variance. For subsequent analysis, scale items were summed.

The final measure for this study is environmental uncertainty, defined as change or variability in the organization's external environment (Tung, 1979). Organizational theorists (Downey & Slocum, 1975; Duncan, 1972; Tosi et al.,

Table 1. Factor Structure of Monitoring Variables.

Specific Action Controls		
Approval limits for capital expenditures	0.913	
Approval limits for headcount	0.876	
Pre-action reviews for specific projects	0.803	
Pre-action reviews for day-to-day activities	0.779	
Results Controls		
Formal meetings to review decisions	0.925	
Required explanations for variance from plan	0.905	
Personnel Controls		
Informal contacts with superior(s)	0.735	
Information System Control		
Detail in control reports		0.922
Reporting frequency for control reports		−0.946
Percentage of variance	65.2%	15.6%
Eigenvalue	5.86	1.41

1973) have generally included two components in descriptions in an organization's external environment: (1) diversity, the range of environmental factors faced by an organization and (2) volatility, the change or variability among these factors. Leblebici and Salancik (1981) argued that diversity is more predictable because it can be anticipated and managed using institutionally formalized procedures. Volatility, however, is stochastic in nature and cannot be easily anticipated. Previous studies of environmental volatility have focused on variability of accounting variables (e.g. sales or income) at the industry level. Tosi et al. (1973) argue that more stable patterns in such measures across time indicate more stable environments and thus are easier to predict (Bourgeois, 1985). Based on these arguments, the measure of uncertainty in this study is based on the following three variables used by Tosi et al: (1) market volatility, the coefficient of variation of net sales; (2) technological volatility, the coefficient of variation of the sum of research and development and capital expenditures divided by total assets; (3) income volatility, the coefficient of variation of profits before taxes (used as a composite measure to capture other sources of volatility). The coefficient of variation (the variance is standardized by the magnitude) is used because it allows comparisons across industries of different sizes. First differences are used, as suggested by Bourgeois (1985), who argued that the coefficient of variation of first differences provides a better measure of discontinuities because a high, but constant, and thus predictable, rate of change could produce a high coefficient of variation. However, it is not only the rate of change that creates volatility, but also the unpredictability of the change (Downey & Slocum, 1975; Milliken, 1987). This measure of uncertainty was also used in Kren (1992).

For each firm in the sample, industry-level statistics were calculated by using all other segments listed on the *Compustat* data file with the same four-digit SIC code, not including the sample segment. In conformance with previous research, industry-level measures were used because they seem most relevant to the key dimensions of a company's external environment (Bourgeois, 1985; Tosi et al., 1973; Tung, 1979). The three variables were summed to provide an overall measure of uncertainty.

Empirical Procedures

The analysis proceeds in two stages. First the ex-ante process (Hypothesis 1) is examined using path analysis. Next, the ex-post process (Hypothesis 2) is examined using regression.

Path analysis is appropriate for estimating the relations between a series of interrelated variables (Wonnacott & Wonnacott, 1981). For this study, it allows analysis of the direct link between propensity to create slack (Z_4) and participation (Z_2) (link P_{42}) and indirect link through JRI (Z_3). The path coefficients, P_{ij}, indicate the impact of variable j in explaining the variance in variable i in units of standard deviation.

A series of regressions are used to estimate the path coefficients, according to the following,

$$\text{participation}(Z_2) = P_{21}(\text{uncertainty}), \tag{1}$$

$$\text{job-relevant information}(Z_3) = P_{32}(\text{participation}) + P_{31}(\text{uncertainty}), \tag{2}$$

$$\begin{aligned}\text{propensity to create slack}(Z_4) &= P_{43}(\text{JRI}) + P_{42}(\text{participation}) \\ &\quad + P_{41}(\text{uncertainty})\end{aligned} \tag{3}$$

The path coefficients can be used to decompose the total relation between two variables (i.e. propensity to create slack and participation) into direct and indirect (or spurious) effects, as described below. The total relation is measured with the zero-order correlation coefficient, r_{ij}. Thus,

$$\text{participation/uncertainty}(r_{12}) = P_{21} \tag{4}$$

$$\text{JRI/participation}(r_{23}) = P_{32} + \text{spurious effect from uncertainty} \tag{5}$$

$$\begin{aligned}&\text{propensity to create slack/participation}(r_{24}) \\ &\quad = P_{42} + \text{indirect effect through JRI}\end{aligned} \tag{6}$$

The subscripts 1, 2, 3, and 4 refer to environmental uncertainty, participation, JRI, and propensity to create slack, respectively (Fig. 1). Model (5) allows decomposition of the total relation between JRI and participation (r_{23}) into a direct effect (P_{32}) and a spurious effect. The spurious effect results from environmental uncertainty, which is a common antecedent of both variables. Model (6) allows decomposition of the total relation between participation and propensity to create slack (r_{24}) into a direct effect (P_{42}) and the indirect effect through JRI. Hypothesis 1 posits that the indirect effects of participation through JRI, will predominate.

Hypothesis 2, the ex-post relation between segment slack, propensity to create slack, and control system monitoring, will be examined using the following regression model.

$$\begin{aligned}\text{segment slack} &= \beta_0 + \beta_1(\text{propensity to create slack}) \\ &\quad + \beta_2(\text{control system monitoring}) \\ &\quad + \beta_3\,(\text{propensity to create slack} \\ &\quad \times \text{control system monitoring}) + \varepsilon\end{aligned} \tag{7}$$

Hypothesis 2 predicts a negative coefficient for β_3, because greater propensity to create slack will lead to a higher level of segment slack which will be reduced by higher monitoring.

RESULTS

Table 1 provides descriptive statistics and correlations for measured variables in the study. Mean segment slack is positive. Thus, on average, most of the sample firms have a greater level of resources available than the mean resources available to other segments in the same industry on *Compustat*. In fact, segment slack is negative for only 11 (22.4%) of sample firms. However, a Wilcoxon test did not show a statistically significant difference ($p > 0.10$) in slack between the population of *Compustat* firms and the sample firms. Both segment slack and uncertainty are positively skewed, but it is not overly serious since the means fall within the quartiles.

There are several significant correlations in Table 1. These relations will become more clear in the multivariate analysis discussed next. Of note is the positive relation between propensity to create slack and segment slack, supporting the validity of the measures. The absence of a significant correlation between propensity to

Table 2. Descriptive Statistics and Correlations for Segment Slack, Propensity to Create Slack, Participation, JRI, Uncertainty, and Control System Monitoring for 49 Segments.[a]

	Mean	Median	sd	Correlations (decimals omitted)				
				2	3	4	5	6
1. Propensity to create slack	8.8	8.0	4.6	169	−074	360**	−232	269*
2. Job-relevant information	14.8	14.0	4.9		331**	066	−098	−016
3. Participation	25.4	28.0	14.4			238*	230	020
4. Uncertainty	0.22	0.07	0.64				−126	−193
5. Control system monitoring	31.7	32.0	11.8					−236
6. Segment slack	0.05	0.02	0.10					

[a] Segment slack is measured as the sum of average capital expenditures plus research and development expenditures divided by segment sales. Uncertainty is measured as first differences over the sample period of: (1) market volatility, the coefficient of variation of net sales; (2) technological volatility, the coefficient of variation of the sum of research and development and capital expenditures divided by total assets; and (3) income volatility, the coefficient of variation of profits before taxes. Other variables are self-reported scales as described in the paper.

$^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

create slack and participation is inconsistent with the results of prior behavioral field research (Govindarajan, 1986; Merchant, 1985; Onsi, 1973). A positive relation was found between participation and environmental uncertainty ($p < 0.10$), consistent with the arguments above that increasing uncertainty increases the demand for participation as managers attempt to secure JRI (Kren, 1992). These relations will be explained more clearly by the regression analysis discussed below.

Ex-ante Process – Path Analysis

To examine the ex-ante model (Hypothesis 1), the results of estimating models (1), (2), and (3) are shown in Table 2. In model (1), the results indicate a significant ($p < 0.10$) direct path from environmental uncertainty (P_{21}) to participation,

Table 3. Path Analysis Results for 49 Sample Segments.[a]

$$\text{Model 1: participation}(Z_2) = P_{21}(\text{uncertainty}) + \varepsilon$$

$$\text{Model 2: JRI}(Z_3) = P_{31}(\text{uncertainty}) + P_{32}(\text{participation}) + \varepsilon$$

$$\text{Model 3: prop. to create slack}(Z_4) = P_{41}(\text{uncertainty}) + P_{42}(\text{participation}) + P_{43}(\text{JRI}) + \varepsilon$$

	Dependent variable (t-statistics in parentheses)					
	Participation (model 1)		JRI (model 2)		Prop. to create slack (model 3)	
	Estimate	Coeff.	Estimate	Coeff.	Estimate	Coeff.
Uncertainty	0.238 (1.68*)	P_{21}	−0.013 (−0.09)	P_{31}	0.403 (2.93***)	P_{41}
Participation	–	–	0.334 (2.33**)	P_{32}	−0.244 (−1.68*)	P_{42}
JRI	–	–			0.223 (1.56)	P_{43}
R^2	0.06		0.11		0.20	
F-stat.	2.82*		2.83*		3.76**	

[a] Segment slack is measured as the sum of average capital expenditures plus research and development expenditures divided by segment sales. Uncertainty is measured as first differences over the sample period of: (1) market volatility, the coefficient of variation of net sales; (2) technological volatility, the coefficient of variation of the sum of research and development and capital expenditures divided by total assets; and (3) income volatility, the coefficient of variation of profits before taxes. Other variables are self-reported scales as described in the paper.

*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

consistent with Hypothesis 1. In model (2), the direct path from budget participation to JRI is also significant ($p < 0.05$). However, in model 3, the subsequent direct path from JRI to propensity to create slack (P_{43}), predicted by Hypothesis 1, is not present. Unexpectedly, a significant ($p < 0.01$) direct path from environmental uncertainty to propensity to create slack is present (P_{41}).

The implications of these results becomes more clear as the model is decomposed in Table 3 (models 4, 5, and 6). The significant paths supported by this analysis are also shown in Fig. 2. In model 4 (Table 3), the direct link from uncertainty to participation (P_{21}) is positive and significant ($p < 0.10$), as predicted by Hypothesis 1. In model 5, the direct link from participation to JRI (P_{32}) is also significant ($p < 0.05$) and positive, as predicted by Hypothesis 1, and the spurious effect (from uncertainty) is small and not significant (0.003; $p =$ ns).

The most interesting relation proposed in Hypothesis 1 is that the link from participation to propensity to create slack would be indirect through JRI, and positive, rather than a direct (behavioral) link. However, as shown in model (6), the indirect effect through JRI (0.169; $p =$ ns) is not significant. The direct effect, however, is significant and negative ($P_{42} = 0.243$; $p < 0.05$). This finding of a negative direct effect of participation on propensity to create slack is consistent with arguments in early behavioral research (discussed above) that participation allows "positive" communication between superiors and subordinates, thereby reducing

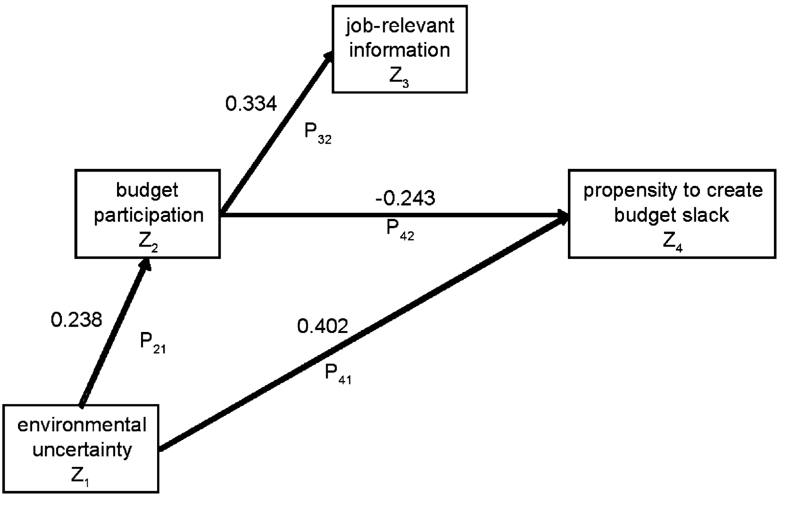

Fig. 2. Test of Hypothesis 1. Path Analysis Relations (Significant Paths Shown).

the pressure to create slack. Thus, the prediction that participation leads to greater propensity to create slack is not supported.

Another unexpected finding is shown in model 7, which follows from model (3) and decomposes the link from uncertainty to propensity to create slack. The prediction of Hypothesis 1 is for an indirect link through participation and JRI. However, a strong positive relation between uncertainty and propensity to create slack is present, with a large direct effect (0.402; $p < 0.01$), relative to the indirect effect (0.042; $p =$ ns). For every standard deviation increase in environmental uncertainty, propensity to create slack increases by 0.402 standard deviations. Thus, the most important statistical factor determining manager's propensity to create slack in the ex-ante process was uncertainty. As environmental uncertainty increases, managers have a greater propensity to create slack. Whether, in

Table 4. Decomposition of Path Analysis Relations for 49 Sample Segments.[a]

$$\text{Model 4: participation/uncertainty}(r_{12}) = P_{21}(\text{uncertainty})$$

$$\text{Model 5: JRI/participation}(r_{23}) = P_{32} + \text{spurious effect from uncertainty}$$

$$\text{Model 6: prop. to create slack/participation}(r_{24}) = P_{42} + \text{indirect effect through JRI}$$

$$\text{Model 7: prop. to create slack/uncertainty}(r_{14}) = P_{41} + \text{indirect effect through participation and JRI}$$

Dependent variable/link to	Total effect, r_{ij}	Direct effect, P_{ij}	Indirect effect
Model 4			
Participation/uncertainty	0.238*	0.238*	–
Model 5			
JRI/participation	0.331**	0.334**	0.003
Model 6			
Prop. to create slack/participation	–0.074	–0.243*	0.169
Model 7			
Prop. to create slack/uncertainty	0.360**	0.402***	0.042

[a] Segment slack is measured as the sum of average capital expenditures plus research and development expenditures divided by segment sales. Uncertainty is measured as first differences over the sample period of: (1) market volatility, the coefficient of variation of net sales; (2) technological volatility, the coefficient of variation of the sum of research and development and capital expenditures divided by total assets; and (3) income volatility, the coefficient of variation of profits before taxes. Other variables are self-reported scales as described in the paper.

*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

fact, they create more slack is addressed in analysis of the ex-post process (Hypothesis 2).

Ex-post Process – Regression Analysis

The estimates for the regression analysis of Hypothesis 2 are shown in Table 4. Hypothesis 2 predicts a negative coefficient for β_3, because greater propensity to create slack will lead to a higher level of segment slack which will be reduced by higher monitoring. As predicted, there is a statistically significant interaction between propensity to create slack and control system monitoring on segment slack created ($p < 0.10$). The nature of this interaction is shown in Fig. 3.

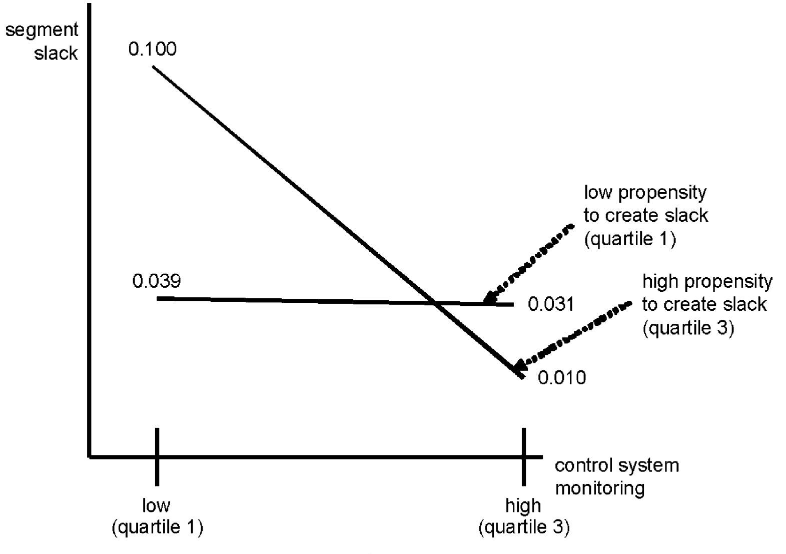

Fig. 3

Propensity to Create Slack and Control System Monitoring Interaction on Segment Slack Created. Endpoints in This Interaction Plot Represent Cell Means for Segment Slack at the Indicated Levels of the Treatment Factors. *Note:* Segment slack is measured as the sum of average capital expenditures plus research and development expenditures divided by segment sales. Uncertainty is measured as first differences over the sample period of: (1) market volatility, the coefficient of variation of net sales; (2) technological volatility, the coefficient of variation of the sum of research and development and capital expenditures divided by total asstes; and (3) income volatility, the coefficient of variation of profits before taxes. Other variables are self-reported scales as described in the paper.

Table 5. Regression Analysis Results for 49 Sample Segments (*t*-statistics in parentheses; coefficients $\times$ 10^2).[a]

$$\text{Model: segment slack} = \beta_0 + \beta_1(\text{prop. to create slack}) + \beta_2(\text{control system monitoring}) + \beta_3(\text{prop. to create slack} \times \text{control system monitoring}) + \varepsilon$$

Propensity to create slack	1.98
	(2.41**)
Control system monitoring	0.26
	(1.05)
Interaction	−0.05
	(−1.95*)
R^2	0.17
F-stat.	3.16**

[a] Segment slack is measured as the sum of average capital expenditures plus research and development expenditures divided by segment sales. Uncertainty is measured as first differences over the sample period of: (1) market volatility, the coefficient of variation of net sales; (2) technological volatility, the coefficient of variation of the sum of research and development and capital expenditures divided by total assets; and (3) income volatility, the coefficient of variation of profits before taxes. Other variables are self-reported scales as described in the paper.

*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

Endpoints on the interaction plot represent cell means for segment slack at the upper and lower quartiles of the predictor variables. When propensity to create slack is low (quartile 1), control system monitoring has little effect on segment slack created. When propensity to create slack is high (quartile 3), control system monitoring has a strong negative relation to segment slack created. This represents a “blocking” form of interaction as described by Joyce et al. (1982). The nature of the interaction is that control system monitoring ‘blocks’ the effect of propensity to create slack on segment slack created (Table 5).

SUMMARY AND CONCLUSION

The objective of this study is to examine a more complete model of the process by which budget slack is created in the organization. The predictions of the ex-ante model were that the propensity to create slack would be positively linked to participation through JRI. In the ex-post model, predictions were that actual slack created would be that the link between *propensity* to create budget slack and *actual* budget slack created would be moderated by control system monitoring.

In the ex-ante model, the results do not support a sequential path from budget participation through JRI to propensity to create slack. Instead, participation was found to have a direct, negative effect on propensity to create slack. This is consistent with the arguments of behavioral accounting theorists who have argued that budget participation will motivate managers to reduce budget slack because participation allows "positive" communication between superiors and subordinates, reducing the 'pressure' to create slack. This finding is consistent with a series of prior behavioral studies (Govindarajan, 1986; Merchant, 1985; Onsi, 1973) that similarly found a negative participation-slack relation.

The largest effect on propensity to create slack was found to arise from a direct positive link from environmental uncertainty. This direct effect was sizable. For every standard deviation increase in environmental uncertainty, propensity to create slack increased by 0.402 standard deviation. These findings are consistent with arguments discussed above that managers create slack as a hedge against uncertainties in the environment.

As expected, in the ex-post process the link between propensity to create slack and segment (actual) slack was moderated by characteristics of the organization's control system. When propensity to create slack is low (high), control system monitoring has little (a great) effect on segment slack created. The interaction was of the 'blocking' type (Joyce et al., 1982), whereby control system monitoring 'blocks' the effect of propensity to create slack on segment slack created. This finding is consistent with arguments that a control system can improve inferences about whether budgets contain slack. Additional information about a manager's performance capability motivates a higher budget standard.

NOTES

1. A series of experimental studies based on an agency theory framework employing laboratory experiments has also examined budget slack behavior. The focus of this research has been on the effect of Budget-based incentive schemes and budgeting managers' risk preferences (Chow et al., 1988, 1991, 1994; Waller, 1987; Waller & Bishop, 1990).
2. In accordance with FAS 14 (AICPA, 1976), seperate reporting is required for any segment which accounts for more than 10% of consolidated sales, profits, or assets. Each segment is assigned a four-digit SIC code by Standard & Poors.
3. Of these measures, employee headcount is not often discolsed in the *Compustat Industry Segment* data bases nor are segment-level headcount data availability directly from SEC filings.
4. For one segment in the sample, there were less than three other firms in the same 4-digit SIC so the 3-digit SIC average was used.

5. In calculating the industry mean, outlier segments with three-year average capital expenditures plus research and development expenditures exceeding twice segment sales were deleted.

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APPENDIX

Abbreviated Research Questionnaire

Participation
(response anchors: 1 = strongly disagree, 7 = strongly agree)

Q(1) I am involved in setting all of my budget
Q(2) My superior clearly explains budget revisions
Q(3) I have frequent budget-related discussions with my superior
Q(4) I have a great deal of influence on my final budget
Q(5) My contribution to the budget is very important
Q(6) My superior initiates frequent budget discussions when the budget is being prepared

Propensity to Create Slack
(response anchors: 1 = strongly disagree, 7 = strongly agree)

Q(1) To protect himself, a manager submits a budget that can safely be attained
Q(2) In good business times, your superior is willing to accept a reasonable level of slack in the budget

Q(3) Slack in the budget is good to do things that cannot be officially approved

Information Asymmetry
(response anchors: 1 = strongly disagree, 7 = strongly agree)

Q(1) In comparison to my superior, I have better information regarding the activities in my area of responsibility
Q(2) In comparison to my superior, I am more familiar with the input-output relations in my area of responsibility
Q(3) In comparison to my superior, I am more familiar with the performance potential of my area of responsibility
Q(4) In comparison to my superior, I am more familiar technically with my area of responsibility
Q(5) In comparison to my superior, I am better able to assess the impact of external factors on my area of responsibility
Q(6) In comparison to my superior, I have a better understanding of what can be achieved in my area of responsibility

Control System Characteristics
Q(1) To what extent do the following items affect your decision-making on your job? (response anchors; 1 = very little, 7 = a great deal)
(1) approval limits for capital expenditures
(2) approval limits for headcount
(3) pre-action reviews for specific projects
(4) pre-action reviews for day-to-day activities
(5) policies and procedures manuals
(6) formal meetings to review your decisions
(7) required explanations for variance from plan
(8) informal contacts with your superiors
Q(2) How much detail is included in control reports to managers at your superior's level, such as reports showing budget and actual data? (response anchors; 1 = aggregated, summaries only; 7 = highly detailed, breakdown by unit and task).
Q(3) What is the reporting frequency of control reports to managers at your superior's level, such as reports showing budget and actual data? (responses = daily, weekly, biweekly, monthly, quarterly, longer).

Job-Relevant Information
(response anchors: 1 = strongly disagree, 7 = strongly agree)

Q(1) I am always clear about what is necessary to perform well on my job.

Q(2) I have adequate information to make optimal decisions to accomplish my performance objectives.

Q(3) I am able to obtain the strategic information necessary to evaluate important decision alternatives.

A MANAGEMENT ACCOUNTING TAXONOMY FOR THE MASS CUSTOMIZATION APPROACH

Mohamed E. Bayou and Alan Reinstein

ABSTRACT

The traditional product-costing continuum is too limited to account for the new mass customization approach currently used by many corporations in many industries. Mass customization has changed the nature of many transactions, activities and, indeed, the very essence of many manufacturing companies, who have become more of assemblers than manufacturers. These new developments necessitate establishing new way of accounting for proper planning and control. After tracing the development of the mass customization approach from modular manufacturing into common platforms applied in one firm, and then shared by a group of firms, the paper explains the benefits of these approaches to both manufacturers and their suppliers. The central theme of this paper is to develop a product costing system for mass customization. *It begins with the traditional product-process matrix in operations management literature and adds to it two elements: firm size and the modular manufacturing method. The rationale for this addition is that modular manufacturing is the best mass customization method; firm size and mass customization are inherently related as indicated by the typical evolutionary pattern of production processes. At this point, the operations management taxonomy is renamed the modular-process matrix; this*

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matrix displays three groups of major activities: manufacturing, supplemental manufacturing, and assembling activities. These three activity groups provide the basis for developing a new set of accounts and a ledger system to account for specific customer orders developed by mass-customization processes.

INTRODUCTION

Management accounting literature posits job-order and process costing as extreme systems on a continuum, and operation costing as a hybrid system in between (Garrison & Noreen, 2000; Horngren et al., 2000). In job-order costing, products are customized and usually produced in low volumes; in process costing, products are highly standardized and produced in large volumes. This taxonomy has two limitations. First, it ignores such basic systems as project, batch and line flows. Second, it mixes product plans with process flows and depicts the mixture in one dimension. Accordingly, it is unable to account for mass-customization systems adopted by such companies as General Motors, Ford, Daimler-Benz, Microsoft, Black and Decker, and many construction and service companies. Assembling flexible modules and interfaces, mass customization collapses the entire product-costing continuum into a point where custom-made products (of job-order) are mass-produced (with process costing methods).

To account for mass customization, controllers need a taxonomy that links product plans and manufacturing processes in a two-dimensional structure. This linkage helps controllers determine the costs of alternative product-process choices, thereby advising management on the optimum choice. The management-operations discipline has developed this taxonomy (Berry et al., 1991; Boynton & Victor, 1991; Hayes & Weelwright, 1979a, b; Pine, 1997; Safizadeh et al., 1996; Schmenner, 1998). However, this taxonomy – often called the product-process matrix – does not account for mass customization. To fill this gap, this paper improves this matrix to include mass customization strategies and develops a cost accounting system to account for the resulting taxonomy. The first section presents the product-process matrix. The second section explains the major characteristics and methods of mass customization. To enable the product-process matrix to account for mass customization in small and large plants, in the third section, the best mass-customization method and firm size are incorporated into this matrix. The fourth section develops a ledger system for the improved matrix followed by a summary and conclusions.

LINKING PROCESS FLOWS TO PRODUCT PLANS

The product-process matrix links different manufacturing processes to a variety of product plans. Let us examine these dimensions separately before combining them into the matrix.

Process Flow Patterns

Operations management literature often arranges five manufacturing processes on a spectrum from unique to highly standardized processes: project, job shop, batch, line flow, and continuous flow (Schmenner, 2000, p. 4) (Fig. 1). Schmenner (1998, p. 4) calls these systems "pure." Many factories combine two (sometimes more) of these processes. Common hybrids include the batch flow-line flow used by auto engines, furnaces, air conditioning, and furniture companies, and the batch flow-continuous flow used by breweries and many high volume consumer products whose raw materials are made in batches, such as photographic film (Schmenner, 2000, p. 4). Figure 1 also shows the traditional management accounting's product-costing continuum with two "pure" costing systems, job order and process costing, and a hybrid, operation costing, system. The five process flow patterns are briefly described as follows (Schmenner, 2000, pp. 2–4).

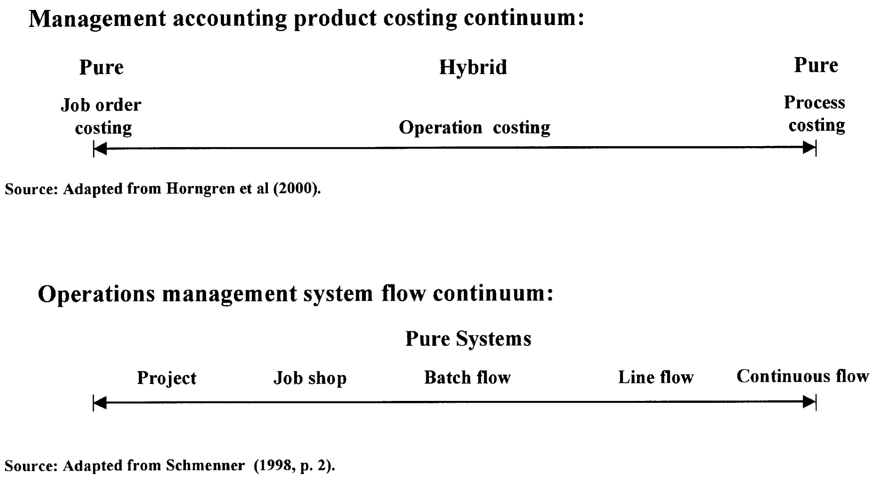


Fig. 1. Comparing the System Flow Continuums of Management Accounting and Operations Management.

Project. A project, e.g. building a skyscraper or making a movie, focuses usually on a unique job.

Job shop. Machine shops, tools and die shops, and many plastic-molding operations are job shops, working to fulfill particular customer orders. A job shop may produce a wide variety of products in large quantities; typically, a project does not produce in large volumes.

Batch flow. The batch flow operation usually produces a set of menu products in lot sizes. It is somewhat more standardized than the job shop, particularly as it relates to routings and costing. Much of the chemical industry, semiconductor fabrication, apparel, much of the steel industry, and huge chunks of the metal bending, forming, and machining industry use batch flow operations.

Line flow. Moving assembly lines in the automobile industry and in the electronics and computer industries are examples of line flow. This process is closer to the continuous flow than to the batch flow pattern.

Continuous flow. Materials in this process move constantly from one process operation to another. Sugar and oil refining, food processing, papermaking, and light-pulp fabrication use continuous flow processes.

The five process flows differ in several respects including costs, equipment, activity focus, technological basis, degree of flexibility, process-life cycle, work-in-process inventory and product kinds. Table 1 compares the operations management spectrum's extreme processes, project and continuous flow.

Product Plans

The product dimension of the product-process matrix includes different plans (Hayes & Wheelwright, 1979a; Safizadeh et al., 1996; Schmenner, 2000), as follow:

(1) Unique, one of a kind.
(2) Low volume, low standardization, many products.
(3) High volume, several major products.
(4) Very high volume, highly standardized products.

The product-process matrix links these product plans and process flows as follows (Fig. 2). (Following the operations management literature, the project alternative is excluded from this matrix due to some similarity between project and job shop flows (see Schmenner, 1998, p. 11).)

Table 1. Comparing Extreme Points of the Manufacturing Process Spectrum.

	Project	Continuous Flow
Examples	Build a skyscraper or ship; make movies	Ford's Model T; sugar refining; food processing
Costs		
Variable costs	Higher	Lower
Fixed costs	Lower	Higher
Changeover	Lower	Higher
Type of equipment	General Purpose	Special purpose
Focus of activity	Coordination among teams	Materials moving through departments
Technological basis	More labor intensive	More machine intensive
Process flexibility	More flexible	Rigid
Process life cycle	Shorter	Longer
Work-in-process	Lower	Higher
Volume of product	Lower	Higher
Nature of product	Heterogeneous; customized	Homogeneous; standardized
Quality of emphasis	High performance design	Speed of delivery
Design changes	More frequent	Less frequent
Demand predictability	More uncertain	Less uncertain

Source: Adapted from Schmenner (1998, pp. 2–3), Safizadeh et al. (1996, p. 1579), Hayes and Wheelwright (1979a, p. 134).

The Product-Process Matrix

Proposed by Hayes and Wheelwright (1979a, b), the product-process matrix helps controllers and management choose the process that achieves the target degree of product customization and volume. To the right of the matrix diagonal is greater product diversity and to the left are fewer, more stable products. Above the matrix diagonal are less capital-intensive processes, and below the diagonal are more mechanized, cost-efficient, and rigid processes. Each process has a reasonable degree of customization. For example, it is often thought that customization and job shop flow, as in commercial paper, are compatible, but mass manufacturing of standardized products and job shops are not (Safizadeh et al., 1996, p. 1577). Thus, Hayes and Wheelwright (1979a, p. 135) warn that when a company decides to drift from the matrix diagonal without understanding the consequences, it is "asking for trouble."

The product-process matrix has received support from at least two sources. First, deductively, the economics of production processes, e.g. economies of scale and the typical pattern of process evolution, as explained below, favor operating along the

Product Plans

Process Flow	Low volume low standardization one of a kind	Low volume many products	High volume several major products	Very high volume highly standardized products
Job shop: jumbled flow	Commercial printer			
Batch flow: disconnected line		Heavy equipment		
Line flow: connected line, worker paced			Automobile assembly	
Continuous flow: automated, rigid flow				Sugar refinery

Fig. 2. The Product-Process Matrix. *Source:* Adapted from Hayes and Wheelwright (1979a, p. 128).

matrix diagonal. Second, several empirical studies in the 1980s and 1990s provide evidence for the matrix implications. For example, Safizadeh et al.'s (1996, p. 1589) study of 144 U.S. manufacturing companies concludes that "manufacturing performance suffers when there is a mismatch between product plans and process choices." However, their study (p. 1581) excludes plans to produce customized products in mass volumes or multiple standardized products in low volumes. To account for mass customization, two elements must be introduced into the product-process matrix: firm size and modular manufacturing. But before discussing this development, mass customization is explained, as follows.

THE MASS CUSTOMIZATION APPROACH

What is mass customization? Mass customization is "the capability, realized by a few companies, to offer, individually tailored products or services on a large scale" (Zipkin, 2001, p. 81). Anderson (1997, p. 91) adds the advantages of cost and speed when he defines mass customization as "the ability to build, in any volume, products that are customized to individuals or market niches *at mass production cost and speed*" (italics in the original). Mass customization is often compared with mass production. (See for example, Zipkin, 2001, p. 82.) Mass production, or *Fordism* (shorthand for Henry Ford's invention for producing the Model T) is usually illustrated by the line flow and continuous flow alternatives in Fig. 2 and explained in Table 1. As a highly mechanized, capital intensive, rigid system, mass production seeks low costs primarily through economies of *scale* – lower unit costs of a single product or service through greater volume of output and faster throughput of the production process. Zipkin (2001, p. 81) explains that mass customization entails richer information flows and more-stringent requirements for process flexibility. These characteristics of information richness and process flexibility should result in low costs. But, how can this be done? Pine (1993, p. 48) explains that low costs in mass customization are achieved primarily by economies of *scope* – the application of a single process to produce a greater variety of products or services more cheaply and quickly. In practice, several methods of mass customization are used, explained as follows.

Methods of Mass Customization

Pine (1993, Chapter 8) explains five methods of mass customizing products and services. Together, these methods form an organization's value chain – development, production, marketing, and delivery. The order of the listed methods progresses from the simplest, where few changes are incorporated into the mass production (process costing) system, to the most advanced by reconstructing the entire value chain on the bases of modular manufacturing and assembly. These methods are listed below and explained briefly in Table 2 (Pine, 1993, p. 185).

(1) Customizing around standardized output.
(2) Creating customizable output.
(3) Point-of-delivery customization.
(4) Quick response throughout the value chain.
(5) Using modules and interfaces to customize output.

Pine (1993, p. 196) explains that the fifth method, "Using modules and interfaces to customize output," is the best mass-customization method because it offers:

(a) both economies of scale and economies of scope,
(b) rich information, and
(c) more process flexibility.

Therefore, improving the product-process matrix, as discussed below, is based on the fifth method.

IMPROVING THE PRODUCT-PROCESS MATRIX TO ACCOUNT FOR MASS CUSTOMIZATION

To improve the product-process matrix to enable it to account for mass customization, two elements are introduced into this matrix: firm size and modular manufacturing.

Firm Size and Process Choice

A correlation among mass customization, process choice, and firm size emanates from the evolutionary pattern of the production process. The production process typically grows though a series of major stages (Hayes & Wheelwright, 1979a, p. 134). Beginning with a highly flexible, cost inefficient process, the process evolution proceeds toward increasing standardization, mechanization, automation, and cost efficiency. As capital investments increase, firms grow from small to large. The product-process matrix has two marked rectangles (Fig. 2). The first, at the top left, often pertains to system choices of such small and medium-size firms as craft, job shops, and some batch-flow firms. The bottom right-hand marked rectangle in Fig. 2 usually includes large companies in automobile assembly, sugar

Table 2. A Comparison between the Five Methods of Mass Customization.

Method	Relevant Areas in Value Chain	Key Features	Type of Products and Companies Using the Method
(1) Customizing around standardized output	Marketing; delivery	– The easiest and most popular method – Output is mass produced; customized later	– IBM System/360 in 1964: classic example – Airlines: meals, drinks, movies, radio headphones – Hotels: smoking/non-smoking, king size/double bed, different floors
(2) Customizable (self-service) output	Development; marketing	– Often customizable by each customer	– Gillette's Sensor Razor (1991) – Shoes industry: Reebok's Pump; Ganefeet of Boca Raton, FL – Office furniture, automatically adjustable office desks – Computers and their applications – Washing machines
(3) Point-of-delivery customization	Marketing	– Customizing occur at the point of sale	– Men's suits, T-shirts: tailored; cut to fit – Sporting goods: bowling balls, tennis rackets, ice skates – One-hour services: Eyeglasses, photograph developing, shoe repair, printing, copying, dry cleaning
(4) Quick response throughout the value chain	All areas of the value chain	– Spreads in a chain reaction effect from delivery back to development	– Instant response services: ATMs, Minitel

Table 2. *(Continued)*

Method	Relevant Areas in Value Chain	Key Features	Type of Products and Companies Using the Method
		– Provides the means for time-based competition	– Peerless Saw Company: using a computer-driven laser system for cutting saws reduced delivery time from 14 to 3 weeks
		– It requires for its success instant communication linkages, common databases, and multifunctional teams	– The US apparel industry: has reduced the replenishment cycle time from 25 to 6 weeks with a states "ideal" of 2 weeks
(5) Modules and interfaces to mass customize output	All areas of the value chain	– The best method for achieving mass customization	– Bally Engineered Structures: produces only one basic module, the engineered panel, from which an infinite variety of structures can be produced
		– Both economics of scale and of scope are achievable	– Black and Decker: produces from a small set of modules, 122 basic tools.
		– It applies to discrete manufacturing, or components as in Black and Decker. It also applies to process industries that mix materials as paint, chemicals, and fertilizer for different customer specifications	– The automotive industry – Software industry

Source: Summarized from Pine (1993, Chapter 8).

and oil refining, fast food, soft drink, and beer bottling industries. The amounts of investment in equipment and technology required in continuous and line flow processes often are so significant that small firms cannot afford them.

Incorporating firm size into the product-process matrix has two implications:

(1) Many small firms are unable to compete with large firms in the lower-right rectangle due to the large investments required to own and operate continuous flow factories. However, in the top left area, these small firms can compete better than large corporations due to their closer relationships with customers, which enable them to customize their products more effectively (Business Week, 1989; Peters, 1992; Zenger, 1994).
(2) Large firms can compete effectively with small firms in product customization (the top-left rectangle) if they decrease their plant size and use flexible modular manufacturing, as discussed below. For this reason, numerous companies, including AT&T, FMC, and General Electric, have replaced their huge manufacturing complexes with new, smaller plants (Brush & Karnani, 1996, p. 1065). Modular manufacturing systems offer several capabilities that have dramatically changed the nature of this competition, discussed as follows.

Modular Manufacturing

Mass customization has changed the nature of many transactions, activities and, indeed, the very essence of many manufacturing firms. To proscribe a system to account for these new changes, we need to understand how mass customization developed from modular manufacturing into common platforms applied in one entity, and how these common platforms have now expanded into a mode of production shared by different companies, as explained below.

Mass customization is best achieved by modular manufacturing systems (Oliver, 2000, p. 12; Pine, 1993). Economies of scale are gained through the modules rather than the products; economies of scope are achieved by using the modules over and over in different products; and customization is accomplished by configurations of unlimited product derivatives (Oliver, 2000, p. 12; Pine, 1993, p. 196). Modular manufacturing involves the entire value chain (Table 2) if products are designed around common parts, versatile modules, standardized interfaces, common fixturing geometrics, and standard processes (Anderson, 1997, p. 25).

The management literature has devoted much more space discussing the benefits of modular systems to manufacturing companies than to these companies' suppliers. Suppliers also can benefit significantly from these systems. According to Southwood J. Morcott (2000, p. 431), the ex-chairman of Dana Corporation, suppliers of automotive parts also benefit from modular manufacturing as it "provides the opportunity to increase content, provide value-added services, advance technology and further develop systems integration expertise." In 1998, global automakers spent around $490 billion on the components they assembled into their vehicles. Of that, about 55% ($280 billion), was outsourced to suppliers like Dana Morcott (p. 433) calculates that "[I]f just one more percentage point of automotive components were outsourced, it would add nearly $5 billion more in business for suppliers. That's quite a chunk of change to be gained."

A key condition in this system is manufacturing flexibility, which requires concurrently designing products and processes to eliminate such unnecessary setup costs as kitting, retrieving parts or tools, changing fixtures, manually positioning parts, or finding instructions (Anderson, 1997, p. 26; Olexa, 2001, p. 49). For a high-volume parts machining, the modular system's flexibility can reduce parts inventory. For example, as Olexa (2001, p. 49) explains, "If part volumes exceed what it was originally designed for, no problem, just make some minor modifications like bolting in another machining module."

When a modular manufacturing system reaches a high level of a firm adoption, it gains the status of a "common platform manufacturing" and its methodology is often called the "platform approach." Meyer and Lehnerd (1997, p. xii) explain that using of the platform approach to product development "dramatically reduces manufacturing costs and provides significant economies in the procurement of components and materials, because so many of these are shared among individual products." General Motors pioneered the technique of building a variety of cars off common platforms in the 1930s (Flint, 1999, p. 82). The platforms were then called "frames," used as a skeleton into which the drive train, the passenger compartment and all the parts are put. Thus, GM built Chevrolets, Pontiacs and Oldsmobiles from one frame. It built Cadillacs and the large Olds from a second frame. Up until 1950, GM used two frames (or platforms) for most of its product lines (Flint, 1999, p. 82).

The use of common platforms has expanded from one firm to several automakers, which now share common modules, interfaces and components. For example, Renault and its Japanese partner Nissan Motor Company strive to share 10 common platforms, and jointly purchase 70% of their components (Winter, 2001, p. 66). Similarly, Daimler-Chrysler and Mitsubishi plan to build one common platform for the new Smart four-seat/four door model and future Mitsubishi minicar (Ostle, 2001, p. 26 FF). Recently, GM announced it would buy V6 engines from Honda, while it plans to sell diesels from its Isuzu subsidiary (Morcott, 2000, p. 434).

The Internet significantly affects mass customization that uses the platform approach. A key characteristic of today's economy is the increasing demand for speed of delivery. Morcott (2000, p. 432) explains that more customers are buying via the Internet (nearly 30% of cars sold in 2010 will be purchased on-line) since speed of delivery is important for this type of customers. However, if customization is production-according-to-specification, which can take time, how can mass customization improve the *speed of delivery*? Oliver (2000, p. 12) explains how this speed is accomplished. Parts from thousands of Tiers I and II manufacturers are consolidated into large subassemblies by subcontractors, thus, leaving the factory to assemble the final steps of the car. The retail dealer could become the final place for assembly. This trend has enabled Toyota to boast that it will make a custom car in five days, a revelation that stunned U.S. and European automakers, which thought that 12 days was the shortest time possible (Oliver, 2000, p. 12).[1] Mass customization and its platform approach entail different types of transactions and other activities that require a different system of accounting, explained as follows.

A DIFFERENT SYSTEM OF ACCOUNTING FOR MASS CUSTOMIZATION

Transactions and other activities of a manufacturing plant that mass customizes its products and services by using modular systems are classified into three major groups (Fig. 3):

(1) Manufacturing activities: These activities produce modules, interfaces, and other components in the company's plants.
(2) Supplemental manufacturing activities: Instead of producing the modules, interfaces, and other components internally, these activities pertain to purchasing these items from suppliers. By these transactions, a manufacturer resembles a merchandising firm, rather than an assembler as Hoyer (2001) argues, especially when suppliers preassemble large subsections of a product.
(3) Assembling activities: These activities combine manufactured and purchased modules, interfaces, and other components using different configurations to produce customized products and services and numerous product derivatives. Different product derivatives are designed to satisfy different customer specifications and different needs of market segments: high-performance/high-price, medium-performance/medium-price, and low-performance/low-price (Fig. 3) (Meyer & Lehnerd, 1997, p. 54).

Incorporation of these three activity groups into the product-process matrix occurs in two steps. First, the matrix is renamed module-process matrix after changing the column dimension from product plans to module plans. Second, three lines are introduced: the manufactured-modules line, the purchased-modules line, and the

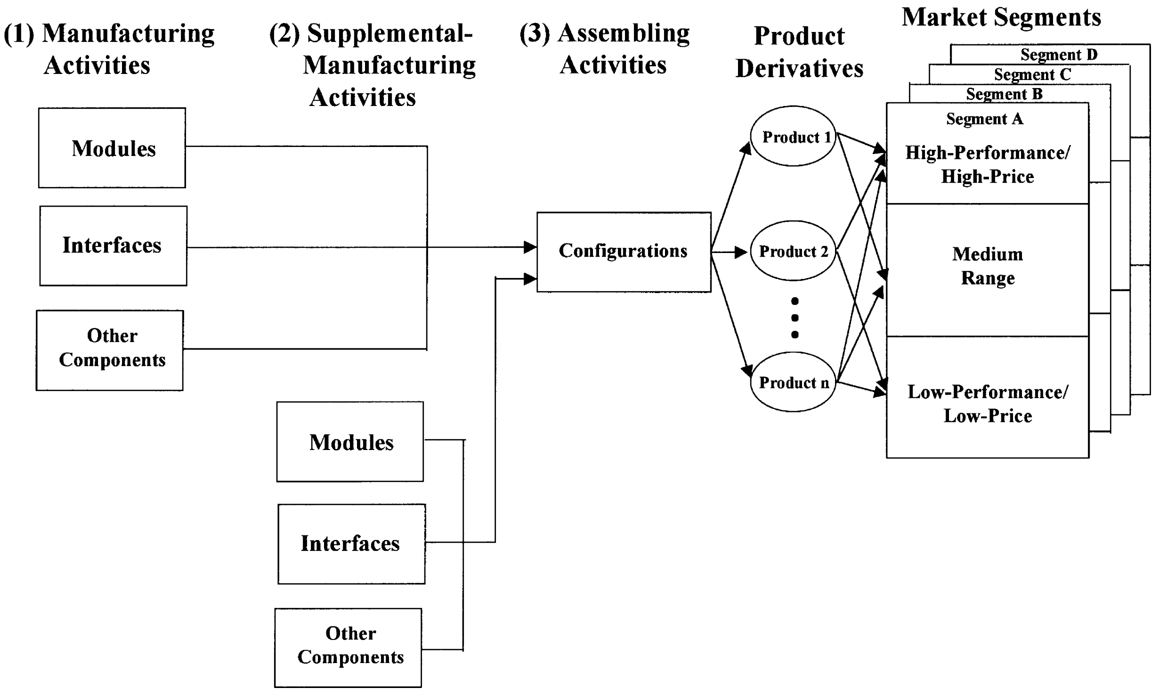


Fig. 3. Segmenting a Manufacturing Plant into Three Major Activity Groups. *Source:* Adapted from Meyer and Lehnerd (1997, p. 54).

assembled-products line (Fig. 4) to account for the three sets of activities of Fig. 3, explained as follows.

- The manufactured-modules line. This line represents the manufacturing-activities group of Fig. 3. Large plants mass-produce the modules and interfaces of this group. The line flow and continuous flow process choices in the module-process matrix (Fig. 4) are economically compatible with high volume, highly standardized modules, as explained above. The thick segment of the manufactured-modules line (Fig. 4) depicts this process choice. For example, in 1970, Black and Decker could produce 122 such power tools as a drill, screwdriver, sander, circular saw, jigsaw, trimmer, polisher, and grinder from a "universal motor" and other relatively small sets of standardized modules (Meyer & Lehnerd, 1997, p. 39; Pine, 1993, p. 198).
- The purchased-modules line. This line represents the second activity group, supplemental manufacturing transactions, in Fig. 3. Purchasing, instead of manufacturing, low-volume, low-standardization (unique) modules is an economically defensible decision. Welch (2001, p. 76B) asserts that, "the modular approach is more than just a way to keep plants open. It's Detroit's best hope to build a better, cheaper car." Currently, automakers purchase thousands of such modules and components as tires, seats, batteries, glass chemical compounds and electronic alarm devices in large volumes from suppliers (Hoyer, 2001, p. 34; Morcott, 2000, p. 433). The thick segment of the purchased-modules line represents these purchase transactions located near the bottom, right-hand corner of the matrix (Fig. 4).
- The assembled-products line. In a modular system, products are simply assembled modules; thus, customization is a matter of degree oscillating on a continuum from a very high to a very low customization extreme points. The points on the assembled-products line (Fig. 4) represent the degree of product customization. Highly customized products are located near the top left-hand corner (the thick segment) on this line, and low customized products are located on this line near the bottom right-hand corner (Fig. 4).

To illustrate, a large company produces highly standardized modules in large volumes, e.g. Black and Decker's universal motor, at point A on the manufactured-modules line (Fig. 4). A special (unique) module necessary to customize a product for a specific customer order would make more economic sense if purchased from an external supplier specialized in producing this special module. Point B on the purchased-modules line represents this choice. When the product is built by assembling the highly standardized modules, the unique (purchased) module, necessary interfaces, and other components, a mass customization order is complete, as represented by point C on the assembled-products line (Fig. 4). It

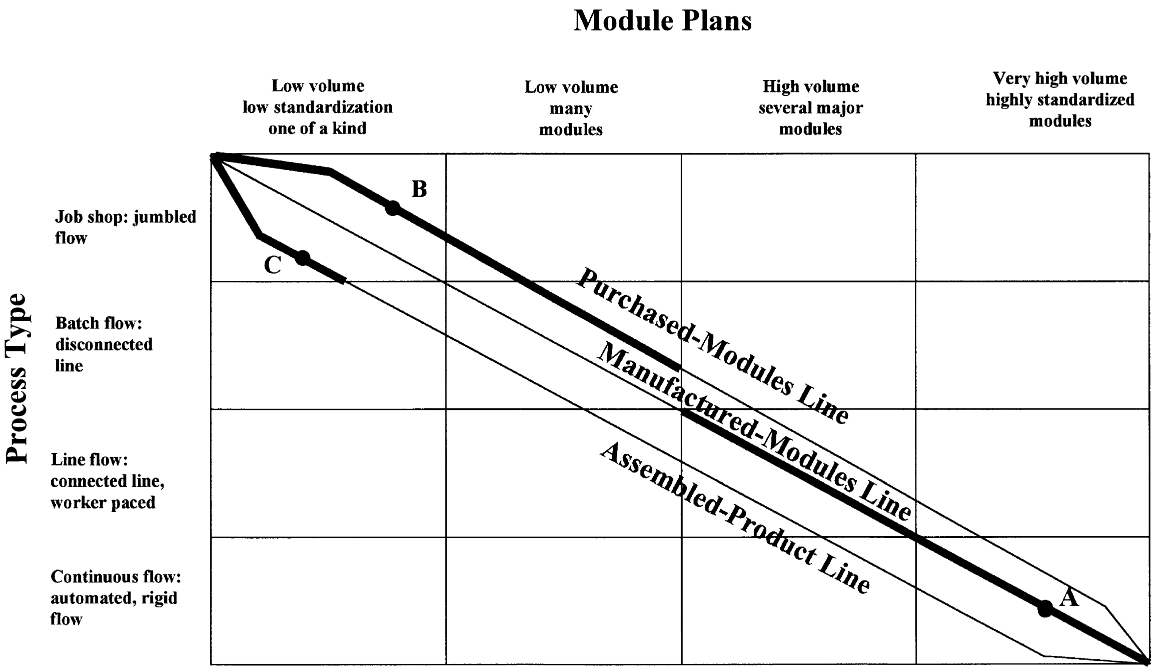


Fig. 4. The Module-Process Matrix for Mass Customization. *Source:* Adapted from Hayes and Wheelwright (1979a, p. 128).

is precisely this aspect of modular manufacturing that causes small firms lose their edge of product customization to large companies. The latter can compete with small companies because both can now produce customized products according to their customers' specifications, thereby, point C is located near the top left-hand corner of the matrix. These transactions and activities require establishing a new ledger system with new accounts and an accounting cycle, explained as follows.

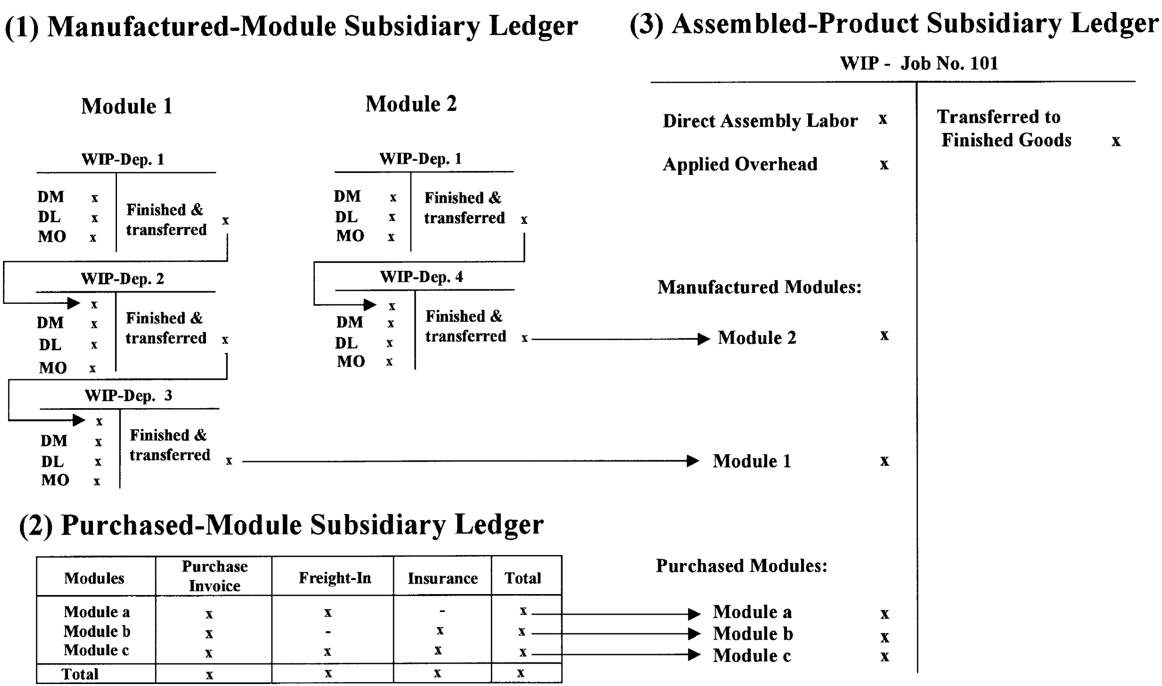
A Ledger System for Mass Customization

Accounting for mass customization using a modular manufacturing process needs a new set of accounts and a ledger system that ties them together.[2] To explain the development of this system, consider the following scenario. A customer places an order that requires a high degree of customization. This order is given the identification number, Job No. 101. The three activity groups (Fig. 3) corresponding to the three lines in the module-process matrix (Fig. 4) provide the basis for developing a system of ledger accounts as applied to Job No. 101 (Fig. 5). Corresponding to the three activity groups are three clusters of subsidiary ledger accounts: manufactured modules, purchased modules, and assembled products. (To simplify the explanation of this system, the first subsidiary ledger has only two modules, Module 1 and Module 2.) Module 1 is mass-produced by the traditional process costing system where the Work-in-Process (WIP) inventory continuously moves from one department to another. The illustration in Fig. 5 shows that Module 1 goes through departments 1–3. Module 2 is also mass-produced, but it goes through only departments 1 and 4. When Modules 1 and 2 are completed, their costs are charged to either:

(1) Finished Module Subsidiary accounts, or to
(2) subsidiary work-in-process accounts, one of which is WIP-Job No. 101 (Fig. 5).

In the first alternative, modules are produced and sent to storage where they remain in inventory until their release to the assembly department. In the second alternative, modules are produced just in time (JIT) when needed for assembling customer orders. This is the approach used in the Fig. 5 illustration.

The second activity group, supplemental manufacturing, is accounted for by the purchased-modules subsidiary ledger (Fig. 5). As Fig. 5 shows, the plant purchased three modules, a–c, from external suppliers. The costs of these modules are accumulated and charged to assembled product subsidiary accounts, one of which is WIP-Job No. 101. The latter account is also charged by the costs of direct assembly labor and applied overhead.



Modules	Purchase Invoice	Freight-In	Insurance	Total
Module a	x	x	-	x
Module b	x	-	x	x
Module c	x	x	x	x
Total	x	x	x	x

Fig. 5. An Accounting Ledger System for Modular Manufacturing.

When Job No. 101 is completed, its total cost is transferred from the WIP-Job No. 101 account to Finished Goods Inventory account. This total cost of Job No. 101 (Fig. 5) corresponds to point C on the assembled-products line in Fig. 4. After completing Job No. 101, the company ships it to the customer and transfers its cost from the Finished Goods Inventory account to Cost of Goods Sold (in a perpetual inventory system), thereby completing the accounting cycle for this job order.

SUMMARY AND CONCLUSIONS

Mass customization has changed the nature of transactions, activities and, indeed, the underlying nature of many manufacturing firms, making them more of assemblers than manufacturers, purchasing many of their modules, interfaces and components ready made and preassembled by their tier I and tier II suppliers. The traditional product-costing continuum is too limited to account for this new mass customization. These developments require modifying how controllers account for the activities of mass customizers. Beginning with the traditional product-process matrix in the operations management literature, this paper adds to this structure two elements, firm size and modular manufacturing method. The rationale for this augmentation is that modular manufacturing is the best mass customization method (Pine, 1993, p. 198) and firm size has a direct influence on the ability to adopt the mass customization approach. These additions lead to: (1) renaming the matrix "the module-process matrix," and (2) segmenting a company into three major activity groups – manufacturing, supplemental manufacturing, and assembling activities.

The three activity groups of a manufacturing plant are represented by introducing three lines to the module-process matrix, which, in turn, provide the basis for developing three sets of subsidiary ledger accounts. A scenario of these activities explains how new accounts for internally-produced modules, purchased modules and other resources flow in a ledger system. The accounting cycle is completed when the customer-order object of mass customization is finished and shipped to the customer.

NOTES

1. The drive toward adopting modular manufacturing systems now has several critics. For example, Hoyer (2001, p. 34) argues that the increasing adoption of three systems can cause companies to lose their essence as manufacturing entities: "Ford Motor Company is hardly in the business of manufacturing anymore . . . Ford is primarily in the assembly

business, and the recent spin-off of many of its parts manufacturing operations as Visteon reinforces that fact only too well." Flint (1999, p. 82) claims that common platforms may work if the different product models are truly different in looks and performance. "Simply making the same car with different nameplates is nothing more than badge engineering." Flint concludes: "Done well, a common platform spreads costs and boosts profits. Done poorly, it creates boring, look-alike vehicles." Zipkin (2001, p. 86) lists four limitations of mass customization:

- It requires a highly flexible production technology.
- It requires an elaborate system for eliciting customers' wants and needs.
- It requires a strong direct-to-customer logistics system.
- People are not willing to pay to have everything customized.

2. The modular manufacturing system has changed the nature of several product costs. For example, direct labor in the traditional manufacturing system *transforms* raw materials into finished products. In the modular manufacturing system, direct labor simply *assembles* different modules and interfaces into different configurations. To help controllers develop better performance evaluation procedures, the ledger system must set up different accounts for these different kinds of direct labor cost in order to differentiate between the transformation and assembly functions of human labor.

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TOP MANAGEMENT INVOLVEMENT IN R&D BUDGET SETTING: THE IMPORTANCE OF FINANCIAL FACTORS, BUDGET TARGETS, AND R&D PERFORMANCE EVALUATION

Alan S. Dunk and Alan Kilgore

ABSTRACT

Organizations are increasingly reliant on their top management to provide research and development (R&D) units with a strategic focus reflecting changes in their competitive environments. However, little research has specifically explored implications arising from top management involvement in R&D budget setting. This study examines empirically the extent to which such involvement is associated with first, an emphasis on financial factors in setting R&D budgets, and second, with the importance of budget targets for R&D managers. Third, the study evaluates the impact of that involvement on R&D performance evaluation. The results of the research provide evidence of the relation R&D budget setting has to these three factors.

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INTRODUCTION

Evidence suggests that organizations are increasingly reliant on their top management to provide research and development (R&D) units with a strategic focus reflecting changes in their competitive environments (Kerssens-van Drongelen & Bilderbeek, 1999). For example, Farrukh et al. (2000) argue that as technology has become a major strategic priority for firms, top management involvement in R&D is essential. Presley and Liles (2000) also stress that as R&D decisions impact organizations as a whole, top management involvement is crucial in decision processes relating to R&D project selection and implementation. In particular, top management involvement in R&D budgeting is critical in establishing the overall magnitude of R&D funding in firms, in order to better determine organizational responses to the influence of competitive pressures and economic conditions at the national and international levels (Rotman, 1994; Senge et al., 2001).

Although reports indicate that top managements are often concerned that their direct involvement in R&D budgeting might limit R&D creativity, their contribution is now considered as essential for more effective R&D cost control (e.g. Shank & Govindarajan, 1992). Roussel et al. (1991) note the need for greater R&D financial management as firms may not have the resources to increase the size of their R&D investments in response to R&D challenges. Sharpe and Keelin (1998) also express concern that without top management involvement, resource allocations to R&D projects may not necessarily depend on their merit. Consequently, the frequent treatment of R&D as a discretionary expense center and the belief that the creativity of R&D personnel should not be constrained by cost concerns (e.g. Perry & Grinaker, 1994) may no longer be sustainable.

However, little research has been designed specifically to explore implications arising from the involvement of top management in R&D budget setting. Although budgeting can often facilitate the balancing of desirable strategic plans against available financial resources, Ellis (1988) reports that scant empirical work has focused on R&D budget setting as few procedures have been developed to determine the optimum level of investment in R&D. Abernethy and Brownell (1997) note more recently that relevant evidence from empirical studies of R&D settings continues to be sparse. Coy (1993) argues in particular that there has been little research on the manner in which top management involvement in R&D budgeting and strategic planning influences the importance R&D managers place on those budgets, or on the evaluation of R&D project performance. Reports suggest that top management involvement may reinforce the importance of budget targets for R&D managers as well as facilitate an evaluation of R&D performance (e.g. Chen et al., 1999; Poh et al., 2001).

The objectives of this study are threefold. The first is to examine empirically the extent to which top management involvement in R&D budget setting and strategic planning is associated with an emphasis on financial factors in setting R&D budgets. The second objective of this study is to investigate the degree to which top management involvement is related to the importance of budget targets for R&D managers, and third, the impact of that involvement on the reliance placed on R&D performance evaluation.

In paying attention to these issues, this paper is one of the first to explore links between top management involvement and R&D budget setting. It addresses issues of contemporary organizational concern and evaluates implications associated with top management involvement in responsibility centers that typically have had little involvement by top management (e.g. Abernethy & Brownell, 1997). Its primary contribution relates to the assessment of top management involvement as a way forward to bringing R&D into a closer association with fundamental organizational processes and to promote R&D accountability. It also makes a contribution by exploring management control system issues in the context of R&D.

The remainder of the paper is structured as follows. In the next section, the literature is reviewed and the hypotheses are developed. The subsequent section describes the data collection method, variable measurement, and related psychometric assessment procedures. The following section presents the results and the final section discusses the conclusions and potential limitations of the study.

LITERATURE REVIEW AND THEORY DEVELOPMENT

Increasingly demanding markets, technological change and greater international competition have made the effective management of R&D essential (De Maio et al., 1994; Li & Atuahene-Gima, 2001). Lau (1998) argues that R&D is a key element in product innovation and a crucial competitive factor in rapidly evolving domestic and international markets. Although evidence suggests that firms can enhance their competitive advantage through R&D in the supply of new products (e.g. Shields & Young, 1994), Nixon (1998) warns there is little evidence that R&D expenditure, productivity, and competitive advantage are necessarily positively related. Chester (1995) argues that top managements must increasingly oversight, plan and direct the R&D function to link its endeavors with organizational strategies. Reasons for doing so arise from concerns that the strategic focus of R&D may be lost in the face of technology-based global competition (Phalow, 1994; Roussel et al., 1991).

Top management involvement in R&D is also increasingly regarded as central to the commitment of sufficient resources to new product development (e.g. Flynn et al., 1995; Gupta & Wilemon, 1990). Moreover, Shields and Young (1994) point to the need for more effective budgetary control in R&D, as mounting R&D costs for personnel, equipment, regulatory compliance, and testing have the potential to significantly affect reported earnings. Given resource constraints, Szakonyi (1994) indicates that the magnitude of R&D budgets has become an issue of increasing organizational concern. Evidence suggests that R&D funding is under some pressure, resulting in top managements examining carefully their investment strategies to ensure the viability of their R&D units (e.g. Carey, 1997; Rotman, 1994). Three factors associated with top management involvement in R&D budgeting are examined in this study, and each will be discussed in turn as follows.

Top Management Involvement and an Emphasis on Financial Factors in Setting R&D Budgets

Schoemaker (1992) argues that top management involvement in budgeting is crucial to enhance the optimal allocation of a firm's limited resources. Top managements have the authority to adjust the overall budget allocations to R&D departments, and calibrate the magnitude of that funding to economic conditions (e.g. Carey, 1997). Gupta and Wilemon (1996) show that top managements increasingly provide strategic vision, resources, and commitment to R&D. Schoemaker (1992) and Shank and Govindarajan (1992) indicate that top managements are becoming more involved in the planning process to identify the array of products R&D should develop. R&D units are under considerable pressure to produce commercially viable results in response to shortened product life cycles against the backdrop of an increasing emphasis on reducing costs and enhancing efficiencies (Corcoran, 1992; Gupta & Wilemon, 1996; Iansiti & West, 1997).

Budgeting is frequently regarded as a fundamental part of an organization's administrative control processes in planning and coordinating the R&D function as well as an integral part of the strategic planning process (e.g. Ittner & Larcker, 1998; Reger, 1999). However, a major concern expressed in the literature is that little is known about the input/output relations of R&D tasks, or of the degree of emphasis on financial factors in setting the size of R&D budgets. Nixon (1997) emphasizes that the nature of R&D activities exacerbates problems in planning, budgeting, and controlling R&D due to the difficulty in obtaining specific knowledge of transformation processes. The conclusion has been drawn that accounting controls such as standard costs, flexible budgets and variance analysis have little applicability to R&D tasks, as the optimal relation between costs and activity levels is typically not known (e.g. Rockness & Shields, 1988).

Various proposals have been put forward in an attempt to enhance the utility of budgets in R&D. However, limitations associated with budgeting have also been signalled. For example, Lin and Vasarhelyi (1980) argue that the budgeting of R&D costs serves primarily as a basis for the determination of expenditure. Anthony et al. (1984) specify that a principal way in which management controls R&D is by planning the scope of jobs, and a common way to represent scope is the dollar size of the expenditure budget. They report that expenditure budgets are important control tools as they monitor the interface between resource flows and authorized spending levels. Rockness and Shields (1988) indicate that expenditure budgets are frequently used in R&D in response to the low level of knowledge of transformation processes, and that expenditure budget control is primarily exercised during planning to set the scope of activities.

Although Abernethy and Brownell (1997) conclude that the frequent lack of routineness of R&D tasks potentially limits the effectiveness of budgetary controls, Carey (1997) reports there is growing evidence that greater budgetary control can act on R&D operations to improve decision processes. In managing R&D costs more effectively, financial factors reportedly are being emphasized more frequently by top managements in R&D budget setting (e.g. Presley & Liles, 2000; Rotman, 1994). Ball et al. (1991) indicate that such factors include the size of the prior year's budget, prior year's sales and profits, as well as expected project costs. Consequently, the literature review suggests that top management involvement in R&D budget setting and strategic planning is likely to be positively related to an emphasis on financial factors in R&D budget setting. This expectation comprises the following hypothesis.

H_1. Top management involvement in R&D budget setting and strategic planning is positively related to an emphasis on financial factors in setting R&D budgets.

Top Management Involvement and the Importance of Budget Targets for R&D Project Managers

Chester (1995) argues that top management involvement in R&D budget setting and strategic planning may also help to enhance the goal congruence between R&D managers and organizational objectives, as a means of facilitating the effective integration of technical with business strategy. Such involvement appears crucial, as Szakonyi (1994) concludes from his examination of 60 R&D departments that R&D managers have difficulty dovetailing their chosen project plans with those made at the corporate level. Moreover, and of considerable concern to top managements, he found that R&D managers are generally not conversant with the financial dimension of the activities of their firms. Given these findings, Gupta and Wilemon (1996) report that R&D planning has become too important to remain primarily the province of R&D units. Carey (1997) warns that pressure is mounting on R&D to be more accountable in terms of focusing their R&D endeavors on more commercially oriented products.

Kren and Liao (1988) propose that top management involvement in budget setting is likely to clarify the importance of budgeted tasks to functional area managers and to encourage them to make decisions consistent with corporate objectives. Chen et al. (1999) emphasize that global competition and technological change necessitate R&D managers aligning their activities more closely to organizational strategy. As a result, considerable responsibility has been placed on R&D managers to justify their project selection in terms of the commercial priorities of their firms (Chen et al., 1999; Presley & Liles, 2000). Rotman (1994) found that R&D managers, in drawing up their budgets with top managements, subsequently are held responsible for ensuring that the goals are achieved. Shields and Young (1994) report that involving R&D managers in budget setting has a considerable effect on developing their awareness of the costs involved in performing R&D tasks. Therefore, the literature review suggests that top management involvement in R&D budget setting and strategic planning is likely to be associated positively with the importance of budget targets for R&D managers. This hypothesis is specified as follows.

H_2. Top management involvement in R&D budget setting and strategic planning is positively related to the importance of budget targets for R&D managers.

Top Management Involvement and R&D Performance Evaluation

Kerssens-van Drongelen and Bilderbeek (1999) conclude that there is growing corporate recognition of the need to assess R&D performance. Evaluating R&D productivity together with measuring and enhancing R&D performance has become a critical organizational objective (Osawa & Murakami, 2002; Szakonyi, 1994). Ittner and Larcker (1998) note that performance measurement systems play a crucial role in the development of strategic plans and the evaluation of organizational objectives. Roussel et al. (1991) report that top managements increasingly seek to quantify the costs and benefits of R&D projects and to monitor progress against project expectations. Reasons for undertaking performance evaluations include first, R&D funding is under pressure in many firms as escalating R&D costs are causing organizations to assess whether their research budgets are cost-effective (Bushee, 1998; Carey, 1997; Chester, 1995; Gupta & Wilemon, 1996). Reports indicate that top managements are increasingly concerned that their R&D investment returns may not justify the magnitude of their financial commitments (Iansiti & West, 1997; Roussel et al., 1991). Second, Chester (1995) stresses that top managements are focusing more heavily on assessing the return on R&D investment commensurate with an increasing emphasis on enhancing shareholder value. As a consequence, top managements' attention is now reported to focus in part on R&D's contribution to competitive advantage (Bommer & Jalajas, 1999; Kerssens-van Drongelen & Bilderbeek, 1999).

Empirical evidence supports a tighter focus on R&D returns. For example, Shields and Young (1994) indicate that top managements are increasingly evaluating R&D departments to enhance profit performance. Rotman (1994) reports that top managements are more frequently using their planning and control strategies to better align R&D with organizational objectives and to link R&D budgets to those strategies. Budget pressure instituted by them has been coupled with top managements' efforts to measure R&D productivity (Liao, 2001; Rotman, 1994). Carey (1997) argues that budgetary pressures are causing top managements to link R&D more closely to business units, and also to put in place a rigorous measurement system that balances risk and potential payoff. Perlitz et al. (1999) conclude that the evaluation of R&D investments is now a crucial aspect of R&D management. This suggests that top management involvement in R&D budget setting and strategic planning is likely to be related positively to R&D performance evaluation, and this proposition is stated as follows.

H_3. Top management involvement in R&D budget setting and strategic planning is positively related to R&D performance evaluation.

METHOD

Sample Selection

The sample consists of a random selection of publicly listed companies conducting R&D in Australia. Organizations reporting R&D expenditure were identified from an examination of their 1995 published financial statements in which R&D expenditure was listed. Companies included in the sample are involved in the production of building materials, chemicals, foodstuffs, mining, pharmaceuticals and whitegoods. Their finance directors were identified by name from corporate listings in *The Business Who's Who of Australia* (1996). Finance directors were targeted because of their frequent responsibility for the planning, management, and control of R&D investments in firms (e.g. Demirag, 1995; Jonnergard et al., 1996).[1]

A total of 74 directors were contacted by telephone and asked to contribute data to facilitate the empirical examination of the issues underlying the study. On gaining their consent, an anonymous questionnaire together with a cover letter was mailed, accompanied by a reply-paid self-addressed envelope. A telephone follow-up was conducted to enhance the response rate. This follow-up also provided considerable assurance that the targeted directors had responded to the questionnaire themselves. A total of 56 directors replied to the questionnaire, representing a response rate of 76%.

Variable Measurement

To undertake this research, measures of the variables were constructed from the Sheffield University instrument that is designed for use in a cross-sectional framework. To retain the integrity of the instrument, it was administered in its entirety. The instrument was developed as a means of undertaking projects focusing on R&D short-term pressures and the management of technological change in the UK, and was used to examine performance pressures and innovation in Australian industry. The paucity of empirical research in R&D (Bommer & Jalajas, 1999) necessarily hampers the availability of psychometrically tested measures that could otherwise be drawn from the literature.

Top Management Involvement in R&D Budget Setting and Strategic Planning

Top management involvement in R&D budget setting and strategic planning was measured by a two-item Likert-scaled instrument anchored by (1) no intervention and (5) active participation. Respondents were asked to rate their top management's involvement in first, the setting of R&D budgets and second, the strategic planning of R&D. As the responses to these items were positively correlated ($r = 0.869$, $p < 0.001$), their scores were summed to provide an overall score for the measure.[2] Descriptive statistics for the instrument are presented in Table 1.

Emphasis on Financial Factors in R&D Budget Setting

A five-item, five-point Likert-scaled instrument was used to measure the degree of emphasis placed on financial factors in determining the size of the R&D budget. Ball et al.'s (1991) empirical study found that the most important factors influencing the size of the R&D budget included the previous year's R&D budget, expected project costs, as well as the previous year's sales and profit. These criteria formed the basis of the measure used in this study. Respondents were asked to rate each of the items in the instrument on a scale anchored by (1) of no importance and (5) crucial with respect to their influence in determining the size of the R&D budget. The results of a factor analysis, as shown in Table 2, indicate that the five items load on a single factor with an eigenvalue of 2.6714, explaining 53.4% of the

Table 1. Descriptive Statistics of the Variables in the Study.

Variable	*n*	Mean	Std. Dev.	Theoretical Range		Actual Range	
				Min	Max	Min	Max
Top management involvement in R&D budget setting and strategic planning	56	7.089	2.525	2	10	2	10
Emphasis on financial factors in R&D budget setting	56	14.607	4.785	5	25	5	23
Importance of budget targets for R&D managers	56	3.500	1.191	1	5	1	5
R&D performance evaluation	56	24.554	6.261	7	35	7	34

variance in the underlying variable. The Cronbach alpha of 0.85 for the measure suggests that its internal consistency is high. Table 1 presents descriptive statistics for the instrument.

Importance of Budget Targets for R&D Managers

The importance of budget targets for R&D managers was assessed by a single-item Likert-scaled instrument anchored by (1) unimportant and (5) crucial, which requested respondents to rate the importance placed on budget targets for R&D managers.[3] Table 1 provides descriptive statistics for the measure.

R&D Performance Evaluation

Although an effective R&D operation may be a major source of competitive advantage, the method of assessing R&D performance remains unclear (Werner & Souder, 1997). Schumann et al. (1995) argue that effective R&D performance measurement requires a combination of internal and external indicators, the latter assessing R&D's market focus. Proxies for R&D return include NPV, benefit-to-cost ratio, IRR, project payback, innovativeness and market development (Demirag, 1996; Perlitz et al., 1999). Even though discounted cash flow

Table 2. Emphasis on Financial Factors in R&D Budget Setting.

Item	Factor Loading	% of Variance	Eigenvalue
Last year's budget	0.6444		
Last year's sales	0.7133		
Last year's profit	0.7651		
Detailed costing/evaluation of projects in hand	0.7802		
Company-wide cash limits	0.7439	53.4	2.6714

Table 3. R&D Performance Evaluation.

Item	Factor Loading	% of Variance	Eigenvalue
Payback	0.8156		
Return on capital invested	0.7886		
Added value	0.8439		
Fit to existing activities	0.8327		
Originality, creativity and innovation	0.6149		
Increased market share	0.7798		
Discounted cash flows	0.5434	56.7	3.9724

approaches are widely recommended, many organizations make extensive use of alternative appraisal methods, such as the payback method (Marsh, 1990).

Top management involvement in R&D budget settings is likely to broaden the range of indicators used in performance evaluation. Abernethy and Brownell (1997) note that control systems comprising accounting and nonaccounting performance indicators are being used in settings where task characteristics limit the utility of accounting-based controls. The literature increasingly emphasizes that nonfinancial measures are expected to supplement those of a financial nature in assessing performance across organizational units (Atkinson et al., 1997; Elnathan et al., 1996; Kaplan & Norton, 2001; Wouters et al., 1999).

A seven-item, five-point Likert-scaled instrument was used to assess R&D performance evaluation. The measure comprises both financial and nonfinancial criteria. Respondents were asked to rate on a scale anchored by (1) of no importance and (5) crucial, the importance their companies attach to each of the criteria in evaluating R&D projects. A factor analysis, as shown in Table 3, revealed that the seven items load on a single factor with an eigenvalue of 3.9724, explaining 56.7% of variance in the underlying variable. The single factor solution suggests that both financial and nonfinancial criteria play a complementary role in project evaluation, consistent with the view of the literature (e.g. Dixon et al., 1990). Furthermore, the Cronbach alpha of 0.89 for the instrument indicates that its internal consistency is high. Descriptive statistics for the measure are presented in Table 1.

RESULTS

The results of the hypothesis tests are presented in Table 4. All hypothesis tests are correlationally based, as there is no theory in place that would suggest which variable is the criterion. Hence, although the variable top management involvement in R&D budget setting and strategic planning forms part of each

Table 4. Correlation Matrix: Assessment of Hypotheses 1–3.

Variable	Top management involvement in R&D budget setting and strategic planning	Emphasis on financial factors in R&D budget setting	Importance of budget targets for R&D managers
Emphasis on financial factors in R&D budget setting	0.608 $p < 0.001$		
Importance of budget targets for R&D managers	0.293 $p < 0.05$	0.118 n.s.	
R&D performance evaluation	0.345 $p < 0.005$	0.444 $p < 0.005$	−0.048 n.s.

hypothesis, the absence of a theory for its classification as a dependent variable necessarily precludes a multiple regression approach.

In testing Hypothesis 1, top management involvement in R&D budget setting and strategic planning were found to be positively related to an emphasis placed on financial factors in R&D budget setting ($r = 0.608$, $p < 0.001$). This result suggests that top management's involvement is strongly linked to a focus on financial factors in R&D budget setting, consistent with the first proposition. The table shows that for Hypothesis 2, top management involvement in R&D budget setting and strategic planning is correlated positively with the importance placed on budget targets for R&D project managers ($r = 0.293$, $p < 0.05$). This finding provides support for the second proposition.

Finally, for Hypothesis 3, top management involvement in R&D budget setting and strategic planning is positively related to R&D project performance evaluation ($r = 0.345$, $p < 0.005$). This result provides support for the third proposition.[4]

CONCLUSIONS

The results of the study provide evidence that the three factors comprising an emphasis on financial factors in setting R&D budgets, the importance of budget targets for R&D managers, and R&D performance evaluation are associated with top management involvement in R&D budget setting and strategic planning. Given the increasing impact of R&D on organizational competitiveness, this evidence, although preliminary, provides insights that have not previously been explored. Importantly, top management involvement clearly provides a degree of reinforcement for an emphasis on financial criteria in setting R&D budgets and the importance of budgets to R&D managers. This suggests that a greater link between R&D and strategy enhances the use of more traditional budgetary techniques in a functional area which reportedly has not been the focus of such tools.

The findings of the study also suggest that an emphasis on financial factors in R&D budget setting is influenced by top management involvement in R&D budget setting and strategic planning along with the use of formal R&D performance evaluation procedures. This indicates that as R&D receives greater strategic attention in organizations, financial criteria are likely to form an increasingly integral part of the R&D budget setting process. The demand for innovation in an increasingly complex global business environment requires new approaches to managing R&D because the requirements for market success have changed in profound ways (Gupta & Wilemon, 1996). Consequently, this suggests that further research should be conducted into those financial and nonfinancial criteria that are central to the management of the R&D function. Moreover, the results support the view that R&D can no longer be considered primarily as a discretionary expense center. The literature review indicates, and the results broadly suggest, that attempts are being made within organizations to better manage the financial dimension of R&D, its focus, and to review whether it delivers against expectations. Further research is required to progress the development of accounting tools and techniques to better calibrate R&D investment levels.

Underscoring the need for further research, Nixon (1998) argues that R&D performance evaluation is a topic neglected in the management accounting literature as it concentrates on the technical dimensions of measurement that can be analysed and quantified. From a management accounting perspective, he claims that there is a relative disregard of the more behavioral and qualitative factors that can influence the design and operation of R&D performance evaluation systems. He proposes that the concepts and techniques of management accounting, especially those falling within the scope of strategic cost management, could usefully be applied to enhance and develop R&D metrics. However, those firms that do measure the success or failure of their R&D efforts use a variety of customer and financial measures, such as customer acceptance and satisfaction, market share, profit margin, and speed to market (Lau, 1998). Although these measures are useful, many of them can be difficult to quantify and many companies have no formal measurement systems in place to track progress or for comparison purposes (Lau, 1998). Consequently, further research in this area is warranted.

Pointing to the need for further research, Table 4 reports that R&D performance evaluation is positively associated with an emphasis on financial factors in R&D budget setting. Although the interpretation of this relation depends on a theory underpinning it, nevertheless it provides some potential additional insight relating to the R&D budgetary process. The growing importance of R&D to organizations suggests that both financial and nonfinancial criteria have a role to play in undertaking a more strategic assessment of R&D performance (e.g. Abernethy & Brownell, 1997; McKinnon & Bruns, 1992). Hoffecker and Goldenberg (1994) warn that performance measurement systems that focus on financial measures shed little light on external constituencies, such as customers and competitors. As the limitations of managing solely with financial measures have been of concern for some time, then focusing on financial indicators may be short-sighted (Elnathan et al., 1996; Kaplan & Norton, 2001). Wouters et al. (1999) argue that nonfinancial measures are receiving considerable attention in the literature, and are widely expected to supplement those of a financial nature in assessing performance.

The results of the study are subject to a number of potential limitations. First, due to the contemporaneous and cross-sectional nature of the research, no causal relations can be implied. Second, data were drawn only from firms in Australia, and hence the results may only be generalizable to that population. Third, as prior reliability and validity coefficients for the instruments used in this study are not available, further psychometric analysis would be advantageous. Nevertheless, the measures used in this study were subjected to both reliability and factor analyses as a means of assessing their internal consistency and dimensionality. Given the importance of R&D to manufacturing industry, future research is crucial.

NOTES

1. Lynch (1999) argues that many organizational initiatives require input from finance directors as they bring cross-disciplinary knowledge and financial skills. Furthermore, finance directors are central to the generation, implementation, and modification of R&D endeavors in organizations (Demirag, 1995; Rotman, 1994).
2. The legitimacy of this procedure is dependent on a significant correlation between the responses to the two items (Brownell, 1985). The magnitude of the relation in this study is considerable, explaining 76% of the variance between the items.
3. Although an assessment of the internal consistency of the instrument could not be made, its validity is not dependent on the number of items it comprises (e.g. Anastasi, 1982).
4. Plots were made of the data in each hypothesis. There was no evidence of outliers that could have driven the results.

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A CROSS-NATIONAL TEST OF THE ROLE OF SELF-INTEREST ON PROJECT CONTINUATION DECISIONS

Paul D. Harrison, Kamal Haddad and Adrian Harrell

ABSTRACT

Prior escalation research (Harrison & Harrell, 1993; Harrell & Harrison, 1994) has supported the prediction that when a project manager has private information and an incentive to shirk (i.e. To protect his/her reputation) he/she will have a greater tendency to continue an unprofitable project than a manager who faces only one or neither of these conditions. Harrison et al. (1999) extended this line of research across cultures to Chinese nationals in Taiwan. The purpose of this paper is to extend the cross-national direction of this line of research by: (1) determining if Mexican nationals who have private information and an incentive to shirk have this same general propensity to continue an unprofitable project when compared to Mexican nationals who experience neither condition, and (2) comparing this general tendency with a sample of U.S. Subjects. The results of this study indicate that the Mexican subjects in the private information, incentive to shirk group also had a tendency to continue unprofitable projects at a rate similar to their U.S. Counterparts. The implications of these results are discussed.

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INTRODUCTION

A large body of research – primarily in Anglo-American contexts – has reported that when decision makers are faced with failing projects, they often are slow to abandon such projects. Instead, they often continue such projects and even increase resource commitment to them. This tendency to "throw good money after bad" has been labeled "escalation," and has been explicitly identified as a mistake to avoid in project-related decisions (Plous, 1993; Russo & Schoemaker, 1989; Yates, 1990).

Research has indicated that the propensity to escalate commitment to failing projects is affected by many factors, including attributes of the organization, project, context, and the decision maker him/herself (Brockner, 1992; Staw & Ross, 1987; Staw, 1997). While all of these factors undoubtedly are important, ultimately it is the individual's interpretation of, and reaction to, the decision environment that determine his or her actions. Pursuing this line of reasoning, Harrison and Harrell (1993) and Harrell and Harrison (1994) have applied an agency theory perspective (Baiman, 1982, 1990; Eisenhardt, 1989) to the escalation phenomenon. Consistent with the tenets of agency theory, they found that managers who had initiated a project, and who also had: (1) private information about the projects expected unfavorable performance (thus, the ability to conceal or delay revelation of this information through project continuance), and (2) an incentive to shirk from concealing this unfavorable information, were more likely to continue an unprofitable project than managers who experienced only one or neither of these conditions.

Recognizing the increasing globalization of economic activities and accumulating evidence on the effects of national culture on individuals' work-related preferences and actions (e.g. Adler, 1996; Chow et al., 1996, 1999; Smith et al., 1996), Harrison et al. (1999) extended the scope of research to a comparison of United States nationals and Chinese nationals from Taiwan. Harrison et al. (1999) found that: (1) when they had private information and an incentive to shirk, both national groups had a greater propensity to continue the unprofitable project, and (2) the Chinese subjects had a lower propensity to continue the unprofitable project than their U.S. counterparts across all conditions present in the study. The authors interpreted the latter finding as being consistent with national culture (specifically, collectivism) having an effect on project-related decision making.

The objective of the current study is to advance extant research by extending the scope of analysis to include Mexican national culture, which has some significant differences from that of the U.S. Understanding how Mexican and U.S. nationals may differ in their job-related decisions is important because Mexico is becoming an increasingly important trading partner of the U.S. (in part due to the North America free trade agreement, NAFTA). Figures from the U.S. department of commerce suggest that from 60 to 80% of U.S.-Mexico commerce is intra-firm trade (Kling et al., 1998), in which U.S. parent companies export intermediary goods to Mexico and then import finished or semi-finished goods back into the U.S. To the extent that such trade requires U.S. and Mexican nationals to work together in joint ventures and/or parent-subsidiary relationships, comparative evidence on Mexican and U.S. nationals can enhance the effectiveness of such collaboration.

Our results indicate that: (1) Mexican nationals with both private information and an incentive to shirk have a greater propensity to continue a failing project than Mexican nationals with public information and no incentive to shirk, and (2) both Mexican nationals and U.S. subjects with private information and an incentive to shirk have similar propensities to continue the failing project. These results provide preliminary evidence that the top management of U.S. firms with operations in Mexico should be aware that Mexican project managers may have this same tendency as U.S. project managers to continue failing projects. The implications of these results are discussed.

The remainder of this report is organized as follows. The next section provides an overview of agency theory and Mexican national culture. This overview provides the basis for presenting two research propositions. Then the method and results are presented, followed by discussion and a summary.

LITERATURE REVIEW AND STATEMENT OF RESEARCH PROPOSITIONS

Agency Theory

Conlon and Leatherwood (1989) have suggested that the project continuation decision should be studied within an agency theory context. Agency theory describes the conditions in a firm in terms of overlapping contracts in which one party (the principal) delegates work to another party (the agent) who performs that work (Eisenhardt, 1989). Our interest is the agency relationship which exists when the firm's senior management (the principal) delegates responsibility to a middle manager (the agent) to manage specific activities of the firm, such as the management of a project (Kaplan & Atkinson, 1989).

Initially, it is assumed that both the principal and agent will reach decisions that are in accordance with their own self-interests. Furthermore, the principal's interests are assumed to be in accord with the profit-maximizing objective of the firm. However, the agent's self-interests may, at times, be in conflict with the interests of the principal. When this occurs, the agent is said to have an incentive to shirk, and be motivated to make decisions which conflict with the profit maximizing interests of the principal.

Two different information conditions may exist within the firm. If a principal has complete information to monitor the agent's actions (public information) information symmetry exists. In this environment, a project manager with an incentive to shirk would not do so because the principal would know he(she) is shirking. Goal congruence would exist in this atmosphere, and an agent would discontinue a failing project, which is in the best interests of the principal.

When an agent has private information about the performance of a particular project, information asymmetry is said to exist. In this situation, the potential for goal conflict exists between the principal and the agent. If, for example, a project manager's reputation were to be damaged by a decision to discontinue a project he(she) had started, the event would negatively impact his(her) future career opportunities. In this situation, the project manager (the agent) has an incentive to shirk, and is expected to reach a decision that maximizes his(her) self-interests (continue the failing project) at the expense of the principal's interests.

Kanodia et al. (1989) provide analytical support for this expectation. They suggest that in the asymmetrical information case, an agent's reputation could be hurt by a decision to discontinue a project that he/she had started. Since a loss of reputation could negatively impact the agents future career opportunities, he/she would have an incentive to continue an unprofitable project even though this is contrary to the firm's interest.

The implications of agency theory for project continuation decisions have been tested by Harrison and Harrell (1993) and Harrell and Harrison (1994). Taken together, their findings support the implication of analytical agency theory that managers who have both private information and an incentive to shirk have a stronger tendency to continue unprofitable projects than if only one or neither of these conditions is present.

Mexican Culture

People from different national backgrounds often differ on various cultural dimensions which "describe basic problems of humanity with which every society has to cope; and . . . different societies do cope with these problems in different ways." (Hofstede, 1980, p. 313). National culture can influence a persons actions either by supplying the values toward which the actions are oriented or by shaping a repertoire of strategies of action in which certain patterns of action are facilitated while others are discouraged (Erez & Earley, 1993; Triandis, 1989).

Numerous ways to operationalize the national culture construct have been proposed (e.g. Hofstede, 1980, 1991; Trompenaars, 1994; Schwartz, 1994). Of these, the taxonomy proposed by Hofstede is arguably the most often cited, validated, and applied in accounting and management research (Bochner, 1994; Harrison & McKinnon, 1999; Sondergaard, 1994; Smith et al., 1996). In turn, this four-dimension taxonomy provides a basis for forming expectations about how Mexican and U.S. nationals may differ in their project-related decisions.

The four national culture dimensions in Hofstede's taxonomy are as follows:

Individualism (*versus Collectivism*): This dimension relates to individuals' self concept: "I" or "we." In a collective culture, the individual is motivated by group interests and values interpersonal harmony. In contrast, individuals from an individualistic culture tend to place their self-interests ahead of those of the group, and prefer interpersonal conflict resolution over conflict suppression.

Uncertainty Avoidance: This cultural dimension relates to the degree to which members of a society feel uncomfortable with uncertainty and ambiguity. People high in uncertainty avoidance tend to prefer avoiding, reducing, or denying uncertainty by relying on written or unwritten rules of behavior, structuring of activities, and standardization of procedures.

Power Distance: This refers to the extent to which people accept that power in institutions and organizations is distributed unequally among individuals. People high on this dimension more readily accept power inequalities.

Masculinity (*versus Femininity*): This dimension relates to the preference for achievement, material success, and assertiveness (masculine) rather than relationships, modesty, and quality of life (feminine).

Using Hofstede's (1980, 1991) taxonomy, Schuler et al. (1996) identified the following scores on Hofstede's dimensions for U.S. and Mexican national cultures:

	United States	Mexico
Power distance	40	81
Individualism	91	30
Uncertainty avoidance	46	82
Masculinity	62	69

A study by Fernandez et al. (1997) reexamined Hofstede's country classification. Their results indicated the U.S. has shifted from being a weak uncertainty avoidance country to a relatively high uncertainty avoidance country. The Mexican subjects in their study had shifted to the weak uncertainty avoidance side of the scale.

The directional differences for power distance and individualism are consistent with other observable characteristics of U.S. versus Mexican institutions, customs, and practices. Mexico's higher power distance is reflected in the hierarchical structure which is present in Mexico's businesses. Most firms have a bureaucratic structure with power vested at the top. Senior managers reporting to the president are expected to show him proper respect, and usually have the authority to make decisions pertaining to their division. But employees below these levels have little authority. Additionally, the Mexican management style is more authoritative. Traditionally, there is very little delegation of authority (Morris & Pavett, 1992).

Hofstede's individualism (or, conversely, collectivism) cultural dimension relates to individuals' self-concept: the extent to which they derive their personal identities as individuals or members of some collective group, and the degree to which they are motivated by their individual versus the group's interests. The relatively lower individualism (or, conversely, higher collectivism) of Mexican culture is reflected in workers' expectation to be treated as the 'extended family' of the boss, and to receive a wider range of services and benefits than is typically provided by firms in the U.S. (Schuler et al., 1996). Another manifestation of their higher collectivism is Mexican organizations' preference for harmony over open expression of conflict, with Mexicans being far less tolerant of abrasiveness and insensitivity in managerial styles than are U.S. nationals (Stephens & Greer, 1995).

Together, these characteristics of Mexican culture, and the way in which they differ from U.S. culture, suggest that there may be differences between how the two national groups would approach project continuance decisions. Indeed, Lu et al. (1999) have discussed the effects of power distance and collectivism on individuals' tradeoffs between their personal interests and those of the collective. Lu et al. (1999) assert that "(b)ecause employees from high power distance nations accept inequality of power, they are also more apt to place the interests of the company above their own" (Lu et al., p. 95). They further assert that when "confronted with a conflict of interests between themselves and their company, collectivists tend to devalue and sacrifice their personal interests for the good of the company" (Lu et al., p. 95). If these assertions are valid, then they would imply that in general, Mexican nationals, with their higher power distance and collectivism than U.S. nationals, also would be less inclined to act in their own self-interests at the expense of their company, and would be more inclined to discontinue an unprofitable project.

However, the Lu et al. (1999) analysis may be incomplete due to omitting some countervailing influences. Specifically, as a result of a collective culture's need for group affiliation, members of such cultures tend to have a high concern for the maintenance of face. Ho (1976, pp. 876, 871) explains: "A person's face is assessed in terms of what others think of him . . . face may be lost when conduct or performance falls below the minimum level considered acceptable." Further, "face is always attached to status . . . at stake is nothing less than the effective maintenance of one's standing in society" (Ho, 1976, p. 871). In contrast, in individualist cultures people are supposed to look after themselves. Hofstede (1980) and Triandis (1989) observe that as a result, an individual's self-respect can be preserved regardless of what other people think about his/her performance. Thus, while maintaining the respect of peers still is important in an individualist culture, it is less so than obtaining "inner directed" satisfaction (Harrison, 1993). Redding and Wong (1986, p. 286) note that while concern with face is a human universal, for a collective culture the degree of concern is particularly high.

There is evidence to suggest that the concern for face is particularly high among Mexican nationals, thus potentially offsetting, or perhaps even overwhelming, the effects of collectivism in project-related decisions. For example, Stephens and Greer (1995) have pointed out that Mexican workers and managers, as a group, are more likely to emphasize form over substance than do U.S. Employees. This tendency often leads to a reluctance to admit failure or error: "Mexicans will never tell you they don't know. They will never tell you they made a mistake. They will never tell you any bad news" (Stephens & Greer, 1995, p. 44). They go on to indicate that "they may also filter contradictory information through their own perceptions, define projects losses as personal failures, and try to keep others from learning of mistakes" (Stephens & Greer, 1995, p. 46).

In the case of joint ventures, Stephens and Greer (1995) indicate that Mexican partners may not admit to mistakes because they are uncertain about how U.S. partners will react. Power distance may be another deterrent: "(t)he authoritarian style of many Mexican managers does not encourage upward communication of subordinate's misgivings about a course of action" (Stephens & Greer, 1995, p. 46).

The preceding discussion presents a dilemma for managers from a collectivistic culture. Their tendency is to put the interests of the collective (their company) ahead of their own self-interests. Overall, this should result in an increased propensity for these managers to discontinue an unprofitable project when compared to managers from an individualistic culture. However at the same time, there is a greater countervailing tendency in a collectivistic culture to save face, which would result in a greater tendency to continue an unprofitable project when compared to mangers from an individualistic culture. The results of Harrison et al. (1999) has shed some light on this dilemma. Both Chinese nationals from Taiwan and U.S. subjects participated in an experiment where private information (both a private information and a public information condition) and an incentive to shirk (both an incentive to shirk and a no incentive to shirk condition) were experimentally manipulated in a 2×2 factorial design. Their results indicated that: (1) overall there was a greater tendency to discontinue the unprofitable project by the Chinese nationals when compared to their U.S. Counterparts, and (2) both groups had a tendency to continue the unprofitable project in the private information, incentive to shirk condition. Interestingly, the private information, incentive to shirk condition is the only experimental condition where subjects could save face by continuing the unprofitable project.

The results of Harrison et al. (1999) indicate that the concern for saving face will more than offset the desire to act in the best interests of the company when both private information and an incentive to shirk exists in a collectivistic society. Hence, our first proposition makes the following prediction:

> **Proposition 1.** Mexican nationals who possess both private information and an incentive to shirk will have a greater propensity to continue a failing project than will Mexican nationals who experience neither of these conditions.

The results of Harrison et al. (1999) indicated that when private information and an incentive to shirk exists, both U.S. (an individualistic society) and Chinese nationals from Taiwan (a collectivistic society) subjects made similar decisions, and tended to act in their own self-interests at the expense of the company's best interests. Our second proposition makes the following prediction:

> **Proposition 2.** In the presence of private information and an incentive to shirk, Mexican and U.S. nationals have the same propensity to continue a failing project.

METHOD

Experimental Design

An experiment was used for its advantages of control and replicability. The experiment consisted of two treatment groups. The first group had private information and an incentive to shirk from continuing the failing project. The second group had public information and no incentive to shirk. These two treatment groups corresponded to groups four and one, respectively, of Harrell and Harrison (1994). They were selected because previous studies (Harrell & Harrison, 1994; Harrison et al., 1999; Harrison & Harrell, 1993) have indicated that an incentive to shirk must be present for there to be a potential conflict between self and collective interests, while private information has to be present for the individual to gain at the organization's expense.

Sample

The subjects were 66 MBA students at two Mexican universities. These subjects all worked full time and took their MBA courses at night. All participated voluntarily as an in-class exercise and were not paid. The Mexican sample was comprised of

27 females and 39 males. The typical subject was 29 years old, with seven years of business experience. The same person administered the instrument at both locations. A corresponding set of U.S. subjects for comparison to the Mexican sample was available from Harrell and Harrison's (1998) corresponding treatment cell. These were professional MBA students enrolled at a large southeastern university. The typical participant was 30 years old, had eight years of business experience, and earned an annual salary of $38,000.

Decision Task

The participants assumed the role of a project manager. Each was asked to make a decision regarding continuing or discontinuing a project which he/she had initiated and currently managed. This evaluation was placed at the end of the fourth year of the project's seven-year lifetime. To overcome the limitations of prior research, both explicit historical performance information and explicit prospective performance information were provided to the participants (Conlon & Leatherwood, 1989). For example, the participants were told that the project's net cash inflows were originally expected to be $270,000 each year. During the initial four years of the project's life, the actual net cash inflows had been $330,000 each year. But past the fourth year (the participant's decision point) the project's future performance was expected to decline. The net present value of the forecast net cash inflows for the remaining three years of the project's life was indicated to be $144,327. If the project was discontinued, its current salvage value (with three years remaining in the project's lifetime) was indicated to be $177,500.[1] since the project's current salvage value exceeded the net present value of its future net cash inflows, the best decision from the firm's perspective would be to discontinue the project. All of the subjects had been exposed to time value of money concepts in their course of study, and to expedite the data gathering process, they were instructed to accept the validity of all the computations themselves.

The participants were randomly assigned between the two treatment groups. Participants in the experimental group were told that they had initiated the project three years ago, and that they would be held responsible for the success or failure of the project. Their instructions further indicated that as the manager of this project, they possessed private information about the project's projected future unfavorable economic performance which was not available to others. These participants also were told that they were currently being recruited for a more important position with a substantially higher salary. A decision to discontinue the project would communicate that the project was a failure, which would cause the recruiting firm to withdraw from the current negotiations (thus providing an incentive to shirk).

The Appendix contains the case scenario given to the subjects in the experimental group.

Participants in the control group were also told that they had initiated the project, and that they would be held responsible for the project's success or failure. These participants also were given information about the project's expected unfavorable economic performance, except that this information was already widely known to others in the firm and industry. Furthermore, these participants were projected into the role of a senior project manager with a very solid industry-wide reputation for initiating and managing profitable projects and for being able to contain losses. This reputation had been gained over a period of years and a single unprofitable project was not expected to damage this reputation (no incentive to shirk).

In summary, the subjects in the experimental group had both private information and an incentive to shirk from continuing the failing project. In contrast, the subjects in the control group had neither private information nor an incentive to shirk.

The participants were asked to indicate their decisions on a 10-point response scale used in previous research (Harrell & Harrison, 1994, 1998; Harrison et al., 1999; Harrison & Harrell, 1993). The scale was divided at its mid-point (5.5) and labeled so that a choice on the left side (a low numerical value) indicated a decision to continue and a choice on the right side (a high numerical value) indicated a decision to discontinue. The end-points were labeled "definitely," so that proximity to the end points indicated the participants' strength of commitment to their choices.

The instrument was translated into Spanish by an employee of the Center for International Business research (CIBER). It was then translated back into English by another CIBER employee, and minor changes were made. As a final check, the back-translated English instrument was again translated into Spanish. Minor changes were made in finalizing the instrument.

RESULTS

The following demographic information was requested from the subjects: gender, age, supervisory experience, years of business experience, and salary (in U.S. dollars). No relationship was found between any of these demographic variables and the project continuation decision.

Our first proposition was that among Mexican nationals, those with both private information and an incentive to shirk would have a greater propensity to continue a failing project than those with public information and no incentive to shirk. Table 1 indicates that the mean decision of the experimental group was 4.57 (a decision to continue), and that of the control group was 8.13 (a decision to discontinue). The

Table 1. Mean Response of Mexican Subjects.[a]

Experimental Group[b]	Control Group[c]
4.57	8.13
$n = 35$	$n = 31$

[a] A response of 5 or less is indicative of a decision to continue the project.
[b] The experimental group subjects had both private information and an incentive to shirk.
[c] The control group subjects had public information and no incentive to shirk.

two sample *t*-test between them was highly significant ($t\,1{,}64 = 4.97, p < 0.0001$). These results provide support for our first proposition.

Our second proposition related to Mexican-U.S. differences in the private information, incentive to shirk condition with regards to their propensity to continue a failing project. To conduct this analysis, the responses were dichotomized as continue or discontinue (at the midpoint of our scale, which had a line down it). The first two rows of Table 2 provide the proportion of subjects who continued the failing project projected to become unprofitable in the private information, incentive to shirk condition for both the U.S. and Mexican sample. Within our Mexican sample, the proportion of subjects who continued the project was 69%. The corresponding figure from Harrell and Harrison (1998) for their U.S. subjects was 56%. A chi-square test indicated that these proportions were not significantly different (chi-square = 0.77). Thus, despite their cultural differences, the two national samples had similar propensities to take advantage of their private information and an incentive to shirk and make decisions in their own self-interests at the expense of the firm, providing support for our second proposition.

Table 2. Mean Response and Percentage of Continue Decisions Across Different Subject Groups.[a]

Subject Group	Mean Response	Percentage Who Continued
MBA students, Mexico[b]	4.57	69%
Professional MBA students, U.S.[c]	5.50	56%
MBA students, U.S.[d]	3.89	74%
MBA students, Taiwan[e]	4.77	66%

[a] These are the subjects in the private information, incentive to shirk group in each of these studies.
[b] These are the subjects in the current study.
[c] These are the subjects in the Harrell and Harrison (1998) study.
[d] These are the subjects in the Harrell and Harrison (1994) study.
[e] These are the Taiwanese subjects in the Harrison et al. (1999) study.

DISCUSSION AND SUMMARY

Some limitations and strengths of this study should be considered before discussing the implications of the results. One limitation is that the participants were not randomly selected from the overall populations of managers to which the results should be generalized. Also, a specialized decision task was used to gather the data. Furthermore, the interaction among personal values, corporate culture and national culture was not examined. Thus, caution should be used in extending these results to other groups and settings. A strength of this study is that the experimental design provided us with the internal validity needed to investigate the issues which were examined. In addition, the MBA students were well qualified for the decision task.

The results of our experimental study indicated that when they had both private information and an incentive to shirk, Mexican subjects had a tendency to continue a project expected to become unprofitable in the future. This finding is consistent with those reported by Harrell and Harrison (1994, 1998) for U.S. nationals, and Harrison et al. (1999) for Chinese nationals in Taiwan (Table 2). When the responses were dichotomized as either continue or discontinue (at the midpoint of the scale), a majority of the subjects in each of the past studies had decided to continue the unprofitable project (Harrell & Harrison, 1994, 74%; Harrell & Harrison, 1998, 56%; Harrison et al., 1999, Chinese nationals in Taiwan, 66%). In this study, 69% of the Mexican subjects opted to continue the unprofitable project. Thus, it appears that this finding is fairly robust across U.S., Chinese, and Mexican subjects. As such, the current study has extended the cross-national dimension of escalation research, and found that self interests also motivated Mexican nationals towards the continuation of unprofitable projects. This result is important because it provides an indication that this effect may be robust across cultures characterized by Hofstede's taxonomy as relatively collectivistic in nature. The empirical evidence indicates that the desire to save face in a collectivistic culture outweighs the desire to act in the collective's interest when both private information and an incentive to shirk exists.

What can be done to avert the adverse consequences associated with the tendency to continue unprofitable projects in the presence of private information and an incentive to shirk? In general, Harrison and Harrell (1993) and Harrell and Harrison (1994) suggest two things that can be done. One way is to provide the principal with the same information as their agents have. This may be very difficult to do in a decentralized operation. Harrell and Harrison (1994) suggested the use of "no-notice" management audits of project manager's activities. The results of these audits would be forwarded to senior management. The potential of having one of these audits may prove to be an effective deterrent to agent behavior inconsistent with the profit maximization goals of the principal. Another way to curb opportunism by an agent is to use outcome-based contracts that will align the interests of the principal and agent, thus reducing the potential for shirking behavior on the part of the agent (Eisenhardt, 1989).

Stephens and Greer (1995) discuss other remedies to the escalation of commitment problem which may exist in Mexico. First, Mexican employees must be allowed to reveal failure or error without losing face. "Procedures that support this process will prove important when American technological advantages must be brought to bear on a problem. Using preventive and remedial approaches to the issue, U.S. firms may be able to ward off escalating commitment to a losing course of action" (Stephens & Greer, p. 51).

Furthermore, at the organizational level Stephens and Greer (1995) make several suggestions to curb this problem: (1) rotate administrators out of projects at regular intervals; (2) separate decision making processes from decision outcomes; (3) allow for occasional failures in evaluations systems; (4) implement better information systems for tracking projects; and (5) reward candid descriptions of project progress (p. 54). They go on to say that "Mexicans must feel free to speak up, admit error, or challenge authority with the knowledge that they will not be punished" (Stephens & Greer, p. 54). These suggestions are consistent with other research on de-escalation (i.e. Ghosh, 1997), and represent avenues for further research on escalation of commitment in other cultures.

Agency theory is well suited for studying the escalation problem because it applies to relationships in which "one party (the principal) delegates work to another party (the agent) who performs the work" (Eisenhardt, 1989, p. 58). The theory assumes that the agent will act in his/her own self-interest, even when goal congruence does not exist between the principal and agent. At the macro-level, Noreen (1988) termed this opportunism as a dead-weight loss. Jones (1995) proposes that this opportunism be studied within the context of stakeholder theory. Jones puts forth an instrumental stakeholder theory, which, in essence, proposes that ethical firms which have a reputation for trustworthiness and mutual cooperation will more efficiently solve the problems of opportunism than firms which do not have this reputation. This, in turn, should give them a competitive advantage in the marketplace.

In each of the studies listed in Table 2, there was a significant number of subjects who did not act in an opportunistic matter, they instead acted in the principal's best interests, even when this was not in their (the agent's) own self-interest. Stakeholder theory provides an alternative perspective from which to view the escalation problem, and may be useful for explaining the non-opportunistic behavior of the significant minority of subjects in these studies. A topic of future research interest would be to investigate whether or not more ethical (characterized by trustworthiness and mutual cooperation) firms have less escalation behavior than those firms who don't have a reputation for being ethical.

NOTE

1. The method used for computing the net present value of the projected cash flows follows the procedures described in Dopuch, Birnberg and Demski (1982, pp. 556–561).

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APPENDIX

Private Information, Incentive to Shirk Case

You are a junior project manager with the Williams Company. Project managers gain a reputation as being highly talented when the projects they initiate and manage are successful. Highly talented project managers receive substantial economic and other benefits, for the Williams Company is aware that an active market for highly talented project managers exists in your industry. When a project which is managed by a junior project manger fails, this damages the individual's reputation, job security, and marketability. So far, the projects which you have initiated and managed have been successful. About a month ago, *your growing reputation as a highly talented project manager stimulated another firm, the Jones Corporation, to initiate informal discussions about recruiting you to a more important position with a substantially higher salary*.

Four years ago, *you initiated Project B, which you still manage*, with a machinery investment of $1,000,000. With a discount rate of 16%, projected annual net cash inflows of $270,000, and an expected salvage value of $50,000, Project B was predicted to have a net present value of $108,100 over its seven year life. Performance has been above expectations during the first four years, with annual net cash inflows of $320,000. As project manager, you possess information which indicates Project B's net cash inflows will sharply decline and be only $50,000 each year for the remaining three years of its lifetime. *This information, which is known only to you as project manager, is not available to others in your firm and industry*. You have two options available to you.

Option 1: Continue Project B. The present value of its net annual future cash inflows is $144,327. (Project B's unprofitable performance will not be known to others in your firm or industry, including the Jones Corporation, for the three years remaining until its completion. Option 1 will, therefore, *delay until long* *after negotiations with the Jones Corporation are completed any possible damage to your reputation, job security, and marketability resulting from Project B's performance*.)

Option 2: Discontinue Project B. The present value of its machinery, which will be sold for cash, is $177,500. (Option 2 will quickly communicate to others that Project B is a failure, which will immediately damage your reputation, job security, and marketability and cause the Jones Corporation to withdraw from the informal negotiations in progress.)

Will you continue (*Option 1*) *or discontinue* (*Option 2*) *Project B*? (Please circle one of the numbers on the scale below)

	Option 1						Option 2			
	1	2	3	4	5	6	7	8	9	10
Definitely Continue										Definitely Discontinue

MANAGERS' ADVERSE SELECTION IN RESOURCE ALLOCATION: A LABORATORY EXPERIMENT

Mohamad Goedono and Heibatollah Sami

ABSTRACT

Using a laboratory experiment, this study investigates agency theory determinants of managers' adverse selection in resource allocation and an approach to solve agency problems. The results suggest that agents who experience an incentive to shirk, have private information, and/or face less risky sunk costs exhibit a greater tendency to either choose less profitable projects or continue losing projects. Consistent with agency theory predictions, we also found that the tendency to choose less profitable projects and continue losing projects declined when agents were compensated based on a variable (outcome-based) compensation scheme.

1. INTRODUCTION

We investigate agency theory determinants of managers' adverse selection in resource allocation and an approach to solve agency problems by extending Harrell and Harrison (1994). Agency theory variables such as rational choice, opportunism, information asymmetries, and costly contracting dominated accounting literature during the last decade (Baiman, 1990; Demski & Kreps, 1982; Watts & Zimmerman, 1990). Despite wide acceptance of agency theory in capital market accounting research (e.g. Healy, 1985; Sami & Welsh, 1992) and behavioral

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accounting research (e.g. Harrell & Harrison, 1994), there are problems. First, as the result of the use of ex post factor design in most capital market research, many behavioral factors of agency theory (e.g. rationality and opportunistic behavior) cannot be tested directly. Capital market accounting research generally assumes that these behavioral aspects of agency theory are always present in the real world.[1] In addition, as Baiman (1990) argues, capital market research tests agency theory's predictions indirectly and does not establish causality. Second, behavioral accounting research that investigates agency problems uses negatively framed stimuli, which may cause escalation. Since the agency theory assumes that both agent and principal are rational and escalation can cause irrational decisions (Brown & Solomon, 1993; Schaubroeck & Davis, 1994), findings of these studies may be confounded (Rutledge & Karim, 1999). Third, previous studies limit their investigation only to one or two variables of the agency model (e.g. compensation in Stroh et al., 1996).

These problems raise the question of whether the agency model (e.g. Holmstrom, 1979) can be tested directly by researchers in general and behavioral researchers in particular, especially using variables that separate the effects of irrational biases. Further, there is a question of whether agency theory predictions can be confirmed when a more complete set of variables are used in a study.[2] Answers to these questions may reveal important information for further development of the agency theory model.

In this study, we use a laboratory experiment to test variables used in the agency model directly and provide evidence relative to the above questions. Particularly, this study investigates the effect of shirking, information asymmetry, and risk aversion on managers' adverse selection. In addition, we test a solution of agency problems (i.e. compensation schemes). Prior studies show that variable compensation may be used to reduce agency problems (Stroh et al., 1996). However, these studies were not conducted in a situation where all of the above three agency theory determinants were present.

The results suggest that when subjects experience an incentive to shirk, possess private information, and/or face a less risky project, they exhibit a greater tendency to choose a less profitable project and continue a losing project. Further, in losing situations, subjects exhibit greater preference to continue their projects when they face less risky projects. This indicates that subjects may be able to stop escalation if they are given more information about the projects. The results also show that variable (output-based) compensation schemes can reduce agents' adverse selection (choosing a less desirable or continuing a losing project).

The rest of this paper is organized as follows. Section 2 briefly reviews variables and behavioral assumptions of agency theory discussed in prior literature. In Section 3, hypotheses are developed based on the discussion in Section 2. In

Section 4, we discuss our methods and experimental design. Research findings are reported in Section 5. Section 6 contains a summary and a discussion of the findings, acknowledges the limitations of our study, and suggests avenues for future research.

2. LITERATURE REVIEW

2.1. Agency Theory

An agency relationship emerges when there is a contract under which one party (the principal) engages another party (the agent) to perform some service on her/his behalf which involves delegating some decision making authority to the agent. Agency theory literature (e.g. Holmstrom, 1979; Varian, 1992) indicates that when an agent possesses more information than the principal, is risk and effort averse, and faces imperfect monitoring from the principal, then the agent shirks when s/he has a chance to do so. The assumptions of agency theory are: (1) the payment schedule can depend only upon variables which both parties can observe; (2) the agent can observe her/his own effort, utility function, and outputs; (3) the principal can observe outputs as well as her/his own utility function; and (4) both agent and principal are rational.

Results of market accounting research (e.g. Healy, 1985; Larcker, 1983; Sami & Welsh, 1992; Tehranian et al., 1987) are consistent with agency theory predictions. However, as Baiman (1990) argues, these tests are indirect and do not establish causality. Thus, it is not certain, for example, whether observed compensation plans are adopted to overcome agency problems or for other reasons, such as taxes and signaling.

A more direct investigation of agency theory has been conducted in the behavioral area (e.g. Chow & Haddad, 1991; Frederickson, 1992; Harrell & Harrison, 1994). However, many of these studies either applied one or two of the theory's determinants, did not test agents' adverse selection, or used stimuli (i.e. negative framing), which may cause escalation. A large body of research indicates that firms' losses could also be caused by escalation, an irrational economic behavior (Arkes & Blumer, 1985), where managers continue projects that logically should be discontinued. Researchers usually attribute this illogical decision to some types of cognitive biases (irrationality), such as self-justification and framing. Different from dysfunctional behavior, which refers to an intentional (deliberate) act of violating an established control system, escalation refers to a situation where individuals do not fully comprehend the mistake (Bowen, 1987). This suggests that testing agency theory's prediction (which assumes individual rationality) may become confounded if possibility of escalation is present. Rutledge and Karim (1999) indicate that only under very special circumstances (low moral reasoning) the managers are likely to continue a loosing project if the adverse selection conditions are present.

Chow and Haddad (1991) tested the effect of performance evaluation on agents' risk aversion. Despite the importance of agents' risk aversion, without other required conditions (e.g. shirk and private information) there is a question whether risk aversion alone will result in adverse selection. Frederickson's (1992) study investigated the direct effects of the degree of common uncertainty and contract type (relative performance information-based compensation schemes) on effort. The study did not directly test the effect of different levels of incentive to shirk and, thus, from an agent's standpoint the benefit for lowering her/his effort was not obvious. Despite testing agency problems directly, the Harrell and Harrison (1994) study confounds the agency problems with the irrationality problem caused by escalation phenomenon. Asking the subjects to evaluate projects that they originally sponsored might have induced self-justification bias.

Consequently, in this study, our motivation is to extend previous research in several ways. First, compared to prior studies, we use a more complete set of determinants of agency theory. Including a more comprehensive set of factors related to agency theory in our experiment should result in a more appropriate way of testing some of the agency theoretic determinants of agency costs and improve the generalizability of the results. Second, we attempt to separate the effects of agency theory's determinants from sunk costs (irrational decision making) in situations where the agent faces stimuli that can induce both irrational decisions and agent's adverse selection. No prior study, to our knowledge, has addressed this issue. Finally, we test the feasibility of proposed solutions of agency problems (compensation contracts) in the presence of other determinants of agency costs, another issue that has not been addressed before.

3. HYPOTHESES

3.1. Determinants of Adverse Selections

Because agency models are stated as constrained optimization problems (Harris & Raviv, 1979; Holmstrom, 1979), we argue that to investigate agency theory predictions several conditions used in the model need to be satisfied.[3] These conditions include information asymmetry, rational decision making, risk averseness, and shirking (Holmstrom, 1979). Also, as discussed in the previous section, when an agent possesses private information, is risk and effort averse, and faces imperfect monitoring from the principal, then the agent shirks when s/he has a chance to do so. Based on these discussions, we state the first hypothesis as follows.[4]

H1. Project managers who

(a) experience an incentive to shirk,
(b) possess privately held information, and/or
(c) face a less risky project

will exhibit a greater tendency to choose a less profitable project and continue a losing project.

This hypothesis makes predictions about the main effect of each of the determinants of agency costs. For example, agents who face shirking are more likely to make adverse selection decisions than those who do not. In addition, the effects of certain combinations of factors are also predicted. For instance, it is expected that agents who face shirking, possess private information, and face less risky projects are more likely to make adverse selection decisions than those who face none of the factors. However, agency theory does not provide specific predictions regarding the effect of some other variations of the determinants. For example, agency theory does not predict whether agents who face shirking, hold private information, and face high risk projects will or will not be more likely to make adverse selection decisions than those who face shirking, have no private information, and face low risk projects. Consequently, the primary interest of the present research is to test the main effect of the determinants; and a secondary interest is to test certain interactive effects for which the theory provides predictions.

While testing variables associated with agency theory, the experiment attempt to control for the framing effects. Different from Harrell and Harrison (1994), in this study we use decision situations where agents evaluate both losing and profitable projects. Since losing and profitable projects can frame and induce individuals, relative to each other, to be risk seekers and risk averse respectively (Kahneman & Tversky, 1979; Kim, 1992), the use of different types of projects allows us to control subjects' risk preference and determine the effect of framing.

3.2. Agents' Decisions in Losing Conditions

Previous escalation studies generally do not test whether escalation can actually be reduced in situations where individuals possess more complete information (Brown & Solomon, 1993; Schaubroeck & Davis, 1994; Staw, 1981). Bowen (1987) argues that tendencies to commit new resources to a losing course of action may result from a paucity of information at the time of decision. It is possible that decision makers who suffer continuous losses learn from their experience and finally may be able to stop the escalation. Experience may enable individuals to make better assessments about project risk. Since a rational person logically prefers less risky projects, everything else being equal, we conjecture that additional information about project risk enable her/him to make better decisions and to reduce the tendency to escalate. This argument leads to the second hypothesis.

H2. Agents who experience sunk cost effects and a less risky project exhibit a greater preference for that project than those who experience sunk cost effects and a more risky project.

3.3. Solution to Agency Problems

Prior literature suggests that contractual mechanisms are frequently used to reduce managers' adverse selection (Watts & Zimmerman, 1986). Agency theory suggests that when agents' effort is unobservable, compensation contracts should be based on output. Based on this discussion the third hypothesis is as follows.

H3. Managers who are compensated mainly based on their ability to manage projects exhibit a greater tendency to avoid an unprofitable project than those who are not.

4. METHODOLOGY

4.1. Subjects

This study is a laboratory experiment. A total of 71 upper-level undergraduate and 57 graduate business students at a major East Coast university participated in the experiment. To confirm subjects' understanding of the cases used in this experiment, after they finished the experiment, they were asked whether they understood the cases and whether they could distinguish the differences between each case. In addition, they were given a simple case about risk and expected value to ascertain the subjects' understanding of these concepts. The responses by those who demonstrated lack of understanding are not included in the analyses. This procedure should improve the reliability of the treatment effects.

Eight of the 71 undergraduate subjects were dropped from the study (see Table 1) because (1) they could not distinguish the differences between each case (= 8) and/or (2) answered the manipulation check questions incorrectly (= 7). Note that some of the students were included in more than one classification. Also, one graduate student was dropped from the sample because of failing the manipulation

Table 1. Subjects' Demographic and Other Relevant Information.*

	Undergrad. Subjects	Grad.** Subjects	Total
Original sample size	71	57	128
Dropped from sample***	8	1	9
1. Could not distinguish each case	8	0	8
2. Failed in the manipulation check	7	1	8
Available sample	63	56	119
Gender			
1. Female	22	31	53
2. Male	41	25	66
Age			
1. Average (year)	23	28	25
2. Standard deviation	3	4	4
Supervisory job experience	17	25	42
Courses completed*			
1. Managerial Accounting	41	41	82
2. Finance	34	46	80
3. Managerial Economics	28	37	65
Fee earned			
1. Minimum ($)	8.00	8.00	8.00
2. Maximum ($)	16.00	16.00	16.00
3. Mean ($)	11.20	10.60	10.92

* All numbers indicate sample size (*n* or number of students), except those in the categories of age and fee which indicate year and dollar value, respectively.
** Grad. = Graduate.
*** Some students were included in more than one category.

check. Thus, out of 128 subjects, nine were dropped from the sample. The final sample size was 119: 63 undergraduate and 56 graduate students. These subjects had, at least, taken either a managerial accounting, a finance or a managerial economics course. As part of the experimental treatment (i.e. compensation contract), each subject received a monetary reward between $8 and $16. Table 1 summarizes the participants' demographics.

4.2. Research Design

To test the hypotheses, a 2^5 factorial research design, shown in Table 2, was used. The five experimental treatments (factors) include shirking, compensation

Table 2. Experimental Design for Hypotheses 1, 2, and 3.

	PI				No PI			
	High RI		Low RI		High RI		Low RI	
	SC	No SC	SC	No SC	SC	No SC	SC	No SC
FC								
SHI				Group 1				
No SHI				Group 2				
VC								
SHI				Group 3				
No SHI				Group 4				

Notes: FC = Fixed compensation contract; VC = Variable compensation contract; SC = Sunk Cost/Negative framing (i.e. evaluating an old project); SHI = Incentive to shirk; RI = Risk; and PI = Private Information.

contract, information asymmetry (private information), project risk, and sunk costs. Shirking and compensation contracts are between subjects experimental treatments, while information asymmetry, project risk, and sunk costs are within subjects experimental treatments. The presentation order of the treatments was randomized to reduce the possibility of the mono-method bias (Cook & Campbell, 1979) and carry over effects. As shown in Table 2, the combinations of between-subjects experimental treatments result in four different groups of subjects. Subjects in group 1 received a combination of fixed compensation (FC) and shirking (SHI) treatments. Subjects in group 2 received a combination of fixed compensation (FC) and no shirking (No SHI) treatments. Subjects in group 3 received a combination of variable compensation (VC) and shirking (SHI) treatments. Lastly, subjects in group 4 received a combination of variable compensation (VC) and no shirking (No SHI) treatments. The first hypothesis (H1) was tested using the shirking/no shirking, the private information (PI)/no private information (No PI), and the high/low risk treatments. The second hypothesis (H2) was tested using the sunk costs and high/low risk treatments. The third hypothesis (H3) was tested using the fixed/variable compensation treatments.

4.3. Experimental Factors

In this study, we used five experimental factors, some of which were included in prior studies (e.g. Conlon & Garland, 1993; Harrell & Harrison, 1994).

These factors and the explanation about the way they were manipulated are as follows.

(1) *Shirking*. Shirking was manipulated at two-levels: shirking and no shirking. Subjects in the shirking group were induced to pursue their own interests by telling them that a competing firm was interested in hiring them. The new position was better than the current position in terms of level (managerial position) and salary and the offer was open until next year. In addition to this information, the subjects were told that their experience with certain projects in the present firm would help them in securing the new position.

(2) *Sunk cost*. In this study subjects were asked to evaluate both projects with and without sunk cost effects. Projects with the 'sunk cost' were old projects started (previously approved) by the subjects which had suffered losses in the previous two years (negatively-framed projects). On the other hand, projects with the 'no sunk cost' were new projects that were expected to be profitable (positively-framed projects).

(3) *Information asymmetry*. In this study information asymmetry means that certain information is known only by the agent. This treatment was manipulated as a two level, within-subject factor: information asymmetry and no information asymmetry. The information asymmetry was administered by telling subjects that the profitability of the projects they evaluated was known only to them. In the case of no information asymmetry, subjects were told that information regarding profitability of the projects they evaluated was also known by all other managers in their firm.

(4) *Compensation schemes*. Variable compensation (i.e. output-based compensation) contracts that variably reward an agent's behavior can motivate an agent to choose project alternatives that are in the best interest of her/his principal. To test the effects of compensation contracts, we used two types of compensation contracts as a between-subjects experimental treatment. Some participants were informed that their salary was fixed (=$10), while the others were informed that their salary varied depending on their ability to manage projects. In other words, they were told that their salary depends on the success of the project they choose. They will be paid $2 for every successful project and nothing if the project fails. Actually, the computer randomly determined each subject's compensation in this group, but the subject were not told and did not know about it.

(5) *Project Risk*. Consistent with the finance literature, ceteris paribus, less risk is reflected by a lower standard deviation of profit (Ross et al., 1990). Thus, a risk averse agent is assumed to prefer a project whose expected outcomes are less likely to deviate from the agents' expectation. In this study, project risk is a two

level, within-subject factor: high and low risk. Subjects were informed not only about the magnitude of the standard deviations, but also were given a description of whether the projects being evaluated were high risk or low risk projects.

4.4. Response Variables

In this experiment, managers' adverse selection was operationalized as the agent's tendency to choose less profitable projects or continue losing projects in investment cases. The project investment cases were used to test the hypotheses. Subjects stated their preference after they evaluated all of the experimental factor in each case.

In investment cases when subjects evaluated negatively-framed project cases, their response was to write a probability from 1% to 100% that they would continue the losing projects. In the positively-framed investment project cases, the subjects' responses were (1) to select one of two investment projects[5] and (2) to write a probability score between 1% and 100% that reflected their preference level for the project they chose.[6]

Scores for positively framed projects cannot be directly compared with scores for negatively framed projects. As explained above, scores for the negatively framed projects have been stated as a range of preference where 1% indicates very strong preference toward abandoning the losing project, while 100% suggests very strong preference toward continuing the losing project (adverse selection). On the other hand, subjects' responses in the positively-framed project investment cases needed to be converted so that the new score of 1% indicates a strong preference for the better alternative and the new score of 100% indicates a strong preference for the worse alternative. The new (converted) scores subsequently could be compared directly with those for the negatively framed projects. The following formulas were used to convert the scores in the positively-framed situations:[7]

$$\text{Preference} = 50 + 50 \times (\text{Score}/100) \text{ if subjects choose the worse alternative} \tag{1}$$

$$\text{Preference} = 50 - 50 \times (\text{Score}/100) \text{ if subjects choose the better alternative} \tag{2}$$

As a result of the conversion, the greater the score for the worse alternative (from the firm's standpoint) the closer the new preference score will be to 100. On the other hand, the greater the score for the better alternative, the closer the new preference score will be to 0. To test whether the conversion provides consistent conclusions, two analyses were performed. The first was ANOVA based on the converted scores and the second was a frequency-based comparison using the original data.

4.5. Experimental Procedure

Initially, we used faculty members and doctoral students to pretest our research instrument and made proper adjustments based on this pretesting. Then, we conducted a formal pretesting of the instrument using 16 (four in each group) graduate and upper level undergraduate business students. We did not use these students in the main experiment. We revised the instrument after this formal pretesting. Finally, the main experiment was administered at computer laboratories. Each subject who participated received: (1) an informed consent form to obtain his(her) consent for the experiment per university rules; (2) instructions; (3) a demographics questionnaire; and (4) a diskette that contained the software needed for this experiment.[8] Participants performed the following tasks. First, subjects read the informed consent form prior to conducting the experiment. Second, subjects read the instructions and subsequently ran the computer program. The computer program started with an introduction window which explained the subject's role at Sigma Corporation, a fictitious firm used in this experiment. Then, the computer program presented a demonstration that each subject needed to try. After the demonstration, the actual experimental cases were presented to the participants. Third, after all cases were completed, the computer program informed subjects about the amount of compensation they were to receive and asked them to answer the demographics questions including the questions regarding the simple case about risk and expected value. Finally, the subjects were paid and thanked.

4.6. Statistical Analysis

Since the dependent variable is metric, then to test the hypotheses a 2^5 factorial ANOVA, with compensation and shirking as between subject and information asymmetry, project risk, and sunk costs as within subject factors, is used. The model is as follows.

$$\begin{aligned}\mathrm{DEC1}_{\mathrm{klmnop}} = {} & \mu_1 + \mathrm{COM}_\mathrm{k} + \mathrm{PI}_\mathrm{l} + \mathrm{RI}_\mathrm{m} + \mathrm{SC}_\mathrm{n} + \mathrm{SHI}_\mathrm{o} \\ & + \mathrm{SL}_\mathrm{p} + \mathrm{COM}\cdot\mathrm{SHI}_{\mathrm{ko}} + \mathrm{RI}\cdot\mathrm{SC}_{\mathrm{mn}} + \mathrm{PI}\cdot\mathrm{RI}\cdot\mathrm{SHI}_{\mathrm{lmo}} \\ & + \mathrm{COM}\cdot\mathrm{PI}\cdot\mathrm{RI}\cdot\mathrm{SHI}_{\mathrm{klmo}} + \varepsilon 1_{\mathrm{klmnop}} \end{aligned} \tag{3}$$

where,

$\mathrm{DEC1}_{\mathrm{klmnop}}$ = adverse selection, i.e. the agent's tendency to choose less profitable projects or continue a losing project,
$\mu 1$ = grand mean,

COM_k = the effect of compensation contracts (fixed and variable compensation contracts),
PI_l = the effect of information asymmetry (private information/no private information),
RI_m = the effect of project risk information,
SC_n = the sunk costs effect (negative/positive information),
SHI_o = the main effect of shirking,
SL_p = the effect of study level (undergraduate versus graduate),
$COM{\cdot}SHI_{ko}$ = the interaction effect between compensation contracts and shirking,
$RI{\cdot}SC_{mn}$ = the interaction effect between risk and sunk costs,
$SHI{\cdot}PI{\cdot}RI_{lmo}$ = the interaction effect between shirking, information asymmetry, and risk,
$COM{\cdot}SHI{\cdot}PI{\cdot}RI_{klmo}$ = the interaction effect between compensation contract, shirking, information asymmetry and risk,
k, l, m, n, o, p = the level of treatments = 2, and
$\varepsilon 1_{klmnop}$ = the unit of error associated with the observation.

Only variables and interactions that are important for hypotheses testing which can be meaningfully interpreted are included. SL is included in the model as a control variable to account for the differences that may exist between undergraduate and graduate students' responses.

Agency theory predicts the main effect of each of its determinants. For example, individuals who face shirking are more likely to make an adverse selection decision than those who do not. In addition, agency theory predicts the effect of certain combination of the determinants. For instance a combination of incentive to shirk, private information, and low risk projects is expected to result in greater adverse selection than a combination of no incentive to shirk, no private information, and high risk projects. However, the effect of some other combination of the determinants is not predicted by agency theory. Consequently, testing the main effect of the determinants is our primary interest in the present research, while testing certain interactive effects is our secondary interest.

We used (η) to measure the strength of experimental effects (Howell, 1982). This measure provides information about the percentage of overall variance that is explained by each treatment or combination of treatments. To test whether the results were affected by the use of the converted score, an additional analysis was done based on the frequency data. Chi-square tests were used to investigate the frequencies. Further analysis was performed to eliminate the effect of negative framing on subjects' adverse selections by analyzing the data for positive framing only.

Table 3. Correlation between Demographic Factors and Subjects' Preference (Managers' Adverse Selection).

Variables	Correlation	*p*-value
Age	−0.02700	0.4053
Have taken course in Finance	−0.04518	0.1637
Management Accounting	−0.00919	0.7770
Managerial Economics	−0.02518	0.4377
Study Level	0.05328	0.1004
Supervisory Job Experience	−0.00373	0.9084
Time	0.04895	0.1312

Notes: Age, supervisory job experience, and time are continuous variables. Finance, management accounting, managerial economics, and study level are categorical variables. Correlation between continuous factors and subjects' responses is measured with Pearson's correlation r. Correlation between categorical factors and subjects' responses is measured with Point-Biserial correlation r_{pb}.

5. RESULTS

Table 3 presents correlation coefficients between demographic factors and the response variable (agent's adverse selection). The Point-Biserial correlation, r_{pb}, indicates that study level (two levels: graduate and undergraduate) and completion of courses in management accounting, finance, as well as managerial economics do not significantly correlate with the subjects' adverse selections.[9] Further, the Pearson correlation, r, suggests that time (length of time spent to finish each case in the experiment), age, and supervisory job experience measured as the length of time (year) do not significantly correlate with the subjects' responses. Based on these findings, these factors should not effect the results of hypotheses testing using model (3).

5.1. Analysis Related to H1

Table 4 shows significant main effects for shirking ($p = 0.0001$, $\eta = 0.373$), private information ($p = 0.0001$, $\eta = 0.258$), and risk ($p = 0.0000$, $\eta = 0.135$).[10] These results suggest that Hypothesis 1 is supported. Further, based on their experimental effect (η), shirking plays a greater role compared to the other two variables.

Table 4 indicates that these results are not affected by study level. Further investigation (i.e. mean comparisons) was done to ascertain that the effect of the

Table 4. The Analysis of Variance of the Experimental Factors for Hypotheses 1, 2, and 3 (Dependent Variable = Adverse Selection).

Source	df	MS	*F*-value	*p*-value	η
Between Subjects	118	2,757.41			
Compensation (COM)	1	29,655.86	13.58	0.0004	0.305
Shirking (SHI)	1	44,429.11	20.34	0.0001	0.373
Study Level	1	2,151.33	0.98	0.3231	0.082
COM × SHI	1	96.54	0.04	0.8339	0.017
Error Between Subjects	114	2,184.58			
Within Subjects	833	1,118.35			
Private Information (PI)	1	62,085.45	83.81	0.0000	0.258
Risk (RI)	1	17,229.52	23.26	0.0000	0.135
Sunk Cost (SC)	1	211,091.36	384.96	0.0000	0.476
RI × SC	1	14,209.75	19.18	0.0000	0.124
PI × RI × SHI	1	3,601.11	4.86	0.0278	0.062
COM × PI × RI × SHI	1	10,744.90	14.50	0.0002	0.107
Error Within Subjects	827	740.78			
Corrected Total	951				

Notes: $R^2 = 0.5098$, MS = Mean Square, and df = Degrees of freedom.

experimental treatments is in the predicted direction. The results of these mean comparisons are shown in Figs 1–3.

Figure 1 shows that subjects who received an incentive to shirk exhibited significantly higher means of adverse selection (50.51) than those who did not (36.57). Figure 2 shows that when subjects possessed private information they tended to choose worse projects (mean = 51.90) than those who did not (mean = 35.76). Figure 3 presents the effect of risks: subjects who faced low risk projects expressed significantly higher mean of adverse selection (mean = 48.09) than subjects who

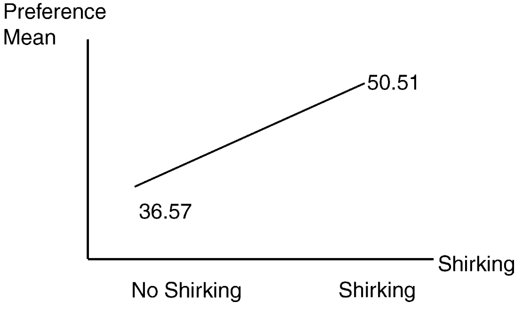

Fig. 1. The Effect of Shirking.

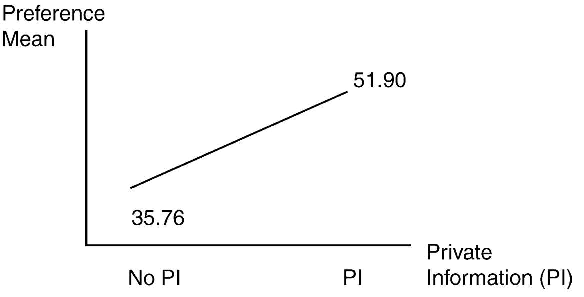

Fig. 2. The Effect of Private Information (PI).

faced high risk projects (mean = 39.58). All of these results are in the predicted direction.

Table 4 shows that the interaction effect of PI × RI × SHI is significant at $\alpha = 0.05$. This suggests that further tests of means of these factors may reveal important information (Howell, 1982). Table 5 shows a rank of these means and Student-Newman-Keuls (SNK) comparisons of these means. As predicted in Hypothesis 1, the SNK grouping shows that subjects who have an incentive to shirk (SHI), possess private information (PI), and face less risky projects (L) exhibit the largest tendency to make adverse selections (mean = 65.13). The mean which combines shirking, private information, and low risk projects is significantly different from the second largest mean (55.22) at $\alpha = 0.05$. Subjects who did not face shirking, did not have private information, and faced high risk projects exhibited the lowest adverse selection in the rank (mean = 26.18). Similar to the previous conclusions, the results in Table 5 generally support Hypothesis 1.

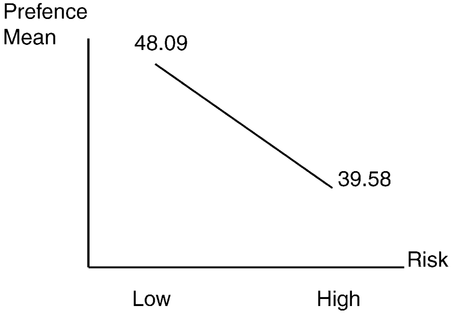

Fig. 3. The Effect of Project Risk.

Table 5. Mean Comparisons of Combined Effects of Shirking, Private Information, and Risk (Dependent Variable = Adverse Selection).

The Level of			Size of the Cell	Mean	Student-Newman-Keuls (SNK) Grouping*
SHI	PI	Risk			
SHI	PI	L	124	65.13	A
SHI	PI	H	124	55.22	B
SHI	No PI	L	124	46.08	BC
No SHI	PI	L	114	45.54	BC
No SHI	PI	H	114	40.28	C
SHI	No PI	H	124	35.59	DC
No SHI	No PI	L	114	34.27	DC
No SHI	No PI	H	114	26.18	D

Notes: H = High Risk; L = Low Risk; PI = Private Information; No PI = No Private Information; SHI = Shirking; No SHI = No Shirking; Harmonic mean of cell size = 118.79; $\alpha = 0.05$; and degrees of freedom = 941.

*Means with uncommon letters are significantly different from each other.

5.2. *Analysis Related to H2*

The ANOVA in Table 4 discloses (1) a significant main effect for sunk cost ($p = 0.0000$, $\eta = 0.476$) and (2) a significant interaction effect for risk and sunk cost (i.e. RI $\times$ SC) ($p = 0.0000$, $\eta = 0.124$). Further tests on the simple effect of risk suggests that, in losing situations, subjects expressed greater preferences for less risky projects than for riskier projects (see Fig. 4). The mean of adverse selection in low risk, losing projects is 66.84 and in high risk, losing projects is 50.61. The t-test indicates that the difference between the means is significant at $\alpha = 0.05$. In conclusion, ANOVA and mean comparisons provide strong support for Hypothesis 2.

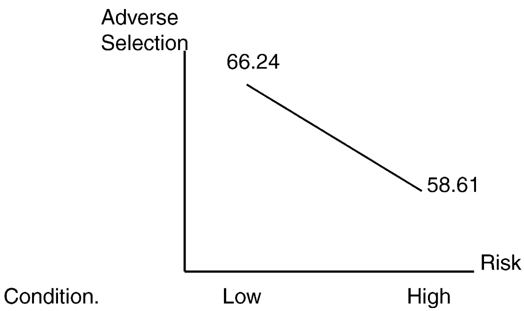

Fig. 4. The Effect of Risk in "Sunk Cost" Condition.

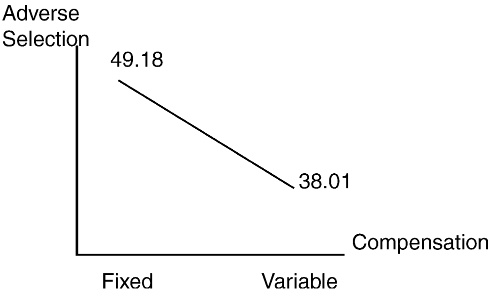

Fig. 5. The Effect of Compensation Contract.

5.3. Analysis Related to H3

Table 4 reports a significant main effect of compensation type for all subjects ($p = 0.0004$, $\eta = 0.305$). To see if the effect of compensation contracts is in the predicted direction, agents' adverse selection means of fixed and variable compensation groups are compared (see Fig. 5). The results show that subjects in the variable compensation (VC) groups exhibit a lower tendency to make adverse selections (mean = 38.01) than those in the fixed compensation (FC) groups (mean = 49.18).

Table 4 shows a significant four way interaction between COM, PI, RI, and SHI. Table 6 discloses the effects of compensation contracts on subjects who faced different levels of shirking, private information and risk. The SNK mean comparisons in Table 6 indicate that subjects who received fixed compensation (FC), shirking (SHI), private information (PI), and low risk (L) projects treatments exhibited the highest tendency to make adverse selections (mean = 69.62). The smallest mean in Table 6 is for subjects who received variable compensation (VC), no shirking (No SHI), no private information (No PI) and high risk projects (mean = 23.05). The highest and lowest means in Table 6 are different at $\alpha = 0.05$. Despite the difference between the highest and the lowest means in Table 6, it should be noted that the highest and the lowest means in the table are not different from some other means. For instance, the highest mean (69.62) in the rank does not differ from the second, the third, and the fourth highest means in the rank (see "A" alphabet). However, as mentioned previously agency theory does not make specific predictions, other than predictions for main effects of its determinants and predictions for certain combined factors (e.g. FC $\times$ SHI $\times$ PI $\times$ L versus VC $\times$ No SHI $\times$ No PI $\times$ H). For instance, agency theory predicts that adverse selection in the FC $\times$ SHI $\times$ PI $\times$ L cells should be higher than adverse selection in VC $\times$ No SHI $\times$ No PI $\times$ H (see the first and the last mean in the rank in Table 6). On the

Table 6. Mean Comparisons of Combined Effects of Compensation, Shirking, Private Information, and Risk (Dependent Variable = Adverse Selection).

Level of				Cell Size	Mean	SNK Grouping*			
Com	Shirking	PI	Risk						
FC	SHI	PI	L	66	69.62		A		
FC	SHI	PI	H	66	66.43		A		
VC	SHI	PI	L	58	60.01	B	A		
FC	No S	PI	L	58	53.87	B	A		C
FC	SHI	No PI	L	66	47.63	B	D		C
FC	No S	PI	L	58	47.18	B	D		C
VC	SHI	No PI	L	58	44.31	B	D		C
VC	SHI	PI	H	58	42.31	B	D	E	C
FC	SHI	No PI	H	66	40.00		D	E	C
VC	No SHI	PI	L	56	36.91		D	E	C
FC	No SHI	No PI	L	58	35.79		D	E	C
VC	No SHI	PI	H	56	33.16		D	E	
VC	No SHI	No PI	L	56	32.69		D	E	
VC	SHI	No PI	H	58	30.59		D	E	
FC	No SHI	No PI	H	58	29.21		D	E	
VC	No SHI	No PI	H	56	23.05			E	

Notes: Com = Compensation; FC = Fixed Compensation; VC = Variable Compensation; SHI = Shirking; No SHI = No Shirking; PI = Private Information; No PI = No Private Information; H = High Risk; L = Low Risk; SNK = Student-Newman-Keuls; Harmonic Mean of Cell = 59.26; $\alpha = 0.05$; and df = 936.

*Means with uncommon letters are significantly different from each other.

other hand, it does not predict whether adverse selection in the FC × SHI × PI × H cells should or should not be higher than adverse selection in VC × SHI × PI × L (see the second and the third means in the rank – Table 6). Therefore, despite the insignificant difference among some of the means, the results in Table 6 generally support Hypothesis 3 as shown by the number (= 5) of FCs in the eight highest means and the number (= 5) of VCs in the eight lowest means. Thus, the results in Fig. 5 and Table 6 generally indicate that variable compensation tends to induce managers to choose more profitable projects (i.e. the preferred projects from the principal's perspective).

5.4. Additional Analysis

In the previous analysis for the investment cases, the agents' adverse selection under the condition of "no sunk costs" was measured based on the converted

Table 7. A Summary of Chi-square Tests of the Experimental Factors (Dependent Variable = Adverse Selection, Measured as a Dichotomous Variable).

Variable	χ^2	p-value
Compensation Contract	22.68	0.000
Private Information	42.18	0.000
Risk	12.30	0.000
Shirking	18.00	0.000
Risk in Losing Situation	23.68	0.000

score formulated in Eqs (1) and (2). However, the use of the converted score might have affected the statistical conclusions. Therefore, an additional analysis based on frequencies of each chosen alternative (better or worse alternative) was performed. Then, the frequencies in each category of experimental treatment were analyzed using Chi-square tests.

Table 7 presents a summary of Chi-square tests on the factors. The table shows significant effect of the experimental factors on subjects' adverse selection in the predicted direction: (1) private information ($\chi^2 = 42.18$, $p = 0.000$), (2) project risk ($\chi^2 = 12.30$, $p = 0.000$), (3) shirking ($\chi^2 = 18.00$, $p = 0.000$), and (4) compensation ($\chi^2 = 22.68$, $p = 0.000$). Table 7 also shows that when analysis was limited only to the losing condition, the proportion of those who chose "low risk" worse alternative is higher than the proportion of those who chose "high risk" worse alternative ($\chi^2 = 23.68$, $p = 0.000$).

5.5. Observations Under Positive Framing

Prior studies found that sunk costs (i.e. negative framing) could induce irrational behavior (Arkes & Blumer, 1985). To eliminate the possibility of this effect, an additional test was performed by limiting observations only to the new project cases. The results in Table 8 shows that under the "no sunk cost" condition, three factors, compensation, shirking, and private information, have significant impacts on adverse selection ($p = 0.0010$, 0.0001, and 0.0000, respectively). Among the significant factors, shirking has the highest experimental effect ($\eta = 0.4485$). Further, project risk does not have significant effect.

The t-tests of mean comparisons (Table 9) show that subjects who were compensated based on a FC contract exhibited a higher tendency to make an adverse selection (mean = 35.41) than those who were compensated based on a VC contract (mean = 21.91). The FC mean is significantly higher at $\alpha = 0.05$. When subjects hold private information they are more likely to make an adverse selection

Table 8. Analysis of Variance of Compensation, Shirking, Private Information, and Risk Under the Condition of "No Sunk Cost" (Dependent Variable = Adverse Selection).

Source	df	MS	*F*-value	*p*-value	η
Between subjects	118	2,530.76			
Compensation (COM)	1	21,647.42	11.51	0.0010	0.2692
Shirking (SHI)	1	60,087.45	31.96	0.0001	0.4485
Study Level	1	1,614.08	0.86	0.3561	0.0735
COM × SHI	1	941.29	0.50	0.4807	0.0561
Error Between Subjects	114	1,880.17			
Within Subjects	357	777.94			
Private Information (PI)	1	20,059.03	29.17	0.0000	0.2687
Risk (RI)	1	72.68	0.10	0.5201	0.0161
SHI × PI × RI	1	8,657.78	12.59	0.0004	0.1765
COM × SHI × PI × RI	1	6,326.58	9.21	0.0026	0.1509
Error Within Subjects	353	687.27			
Corrected Total	475				

Notes: $R^2 = 0.5784$, MS = Mean Square, and df = Degrees of freedom.

(mean = 35.43) than those who had no private information (mean = 22.45). The difference is significant at $\alpha = 0.05$. Further, the mean of the shirking cells (39.86) is significantly higher than that of the no-shirking cells (17.06) at $\alpha = 0.05$. As mentioned previously, risk does not have a significant effect, given positive framing.

Table 9. Mean Comparisons of Different Levels of Experimental Factors Under the Condition of "No Sunk Cost."

Factors	Means		Difference
	Level 0	Level 1	
Compensation	35.41	21.91	13.50*
Private Information	22.45	35.43	12.98*
Risk	29.33	28.55	0.78
Shirking	17.06	39.86	22.80*

Notes: Level 0 of compensation is fixed compensation (FC) and level 1 is variable compensation (VC); Level 0 of private information is no private information (No PI) and level 1 is private information (PI); Level 0 of risk is low risk (L) and level 1 is high risk (H); Level 0 of shirking is no shirking (No SHI) and level 1 is shirking (SHI).

*indicates that the difference is significant at 0.05 (one tail *t*-test).

6. CONCLUSIONS AND IMPLICATIONS

Our research investigate agency theory's determinants and a solution of agency costs. We extended prior studies by: (1) separating the effect of sunk cost, (2) using a more complete set of agency theory's determinants, and (3) testing the effect of compensation schemes in situations where all of the three agency theory determinants were present. Consistent with agency theory's predictions, our results suggest that private information, incentive to shirk, and less risky projects could induce agents' adverse selection. Further, agents show that they were able to reduce their irrationality when they are more informed. This result is consistent with prior studies (Bowen, 1987; Conlon & Garland, 1993) and supports Bowen's (1987) argument that tendencies to commit new resources to a losing course of action may result from a paucity of information at the time of decision. Also, we found that compensation (monetary incentives) schemes could be used to reduce agents' adverse selection. This finding supports the agency theory's suggestion that output-based compensation can be used to reduce agents' adverse selections.

The generalizability of our research findings is limited by a modest sample size, the use of a laboratory experiment for data collection, and the use of students as the experimental subjects. The use of within-person repetition generates a greater number of observations and, thus, may reduce the effect of the modest sample size. However, within-person repetition creates subject block that should be taken into consideration. As with most laboratory experiments, the generalizability of these results to real managerial contexts is limited because of the effect of the artificiality of the contexts and the use of student subjects. Nevertheless, it should be noted that a preliminary test on student subjects who have supervisory experience indicated that experience seemed to have no significant effect on their decisions (Pearson $r = -0.00373$, $p = 0.9084$). In addition, Previous studies (Abdel-khalik, 1974; Ashton & Kramer, 1980; Slovic et al., 1972) showed support for the use of student subjects as surrogates for professionals.

One of the agency theoretic determinants of agents' adverse selection is agents' risk aversion. In our study risk preference was defined as a domain-specific risk preference (Kim, 1992) and subsequently to moderate subjects' risk preferences, different framing as well as project risk levels were used. The findings may be different if the definition of risk preference as dispositional (latent) risk preference was used. Further, there are other procedures to moderate risk preference, such as those used in Berg et al. (1986).[11] However, the use of these procedures in the present research seemed to be prohibitive, because they would only allow the use of variable incentives.

Chow and Haddad (1991) and Frederickson (1992) have investigated the multiagent environment. These studies, however, did not investigate more specifically other aspects of agency theory's determinants (e.g. incentive to shirk) that were tested in the present research. Therefore, future research should examine the effect of experimental factors of the current study in a multiagent environment.

Noreen (1988) suggest that competition in labor and product markets may reduce agency problems. The role of competition is not tested in the present study. In addition, we found that individuals who experience sunk cost effects prefer less risky projects; our study does not test whether the greater preference implies better ability of a rational person to end an escalation process when s/he has complete information. Therefore, future research can extend this study by testing the effect of competition and investigating whether the greater preference for less risky projects suggests a better ability to end an escalation process.

NOTES

1. For instance, individuals are assumed to be rational and consequently observed employment and financial contracts as well as capital markets are *assumed* to be efficient (see also Baiman, 1990).
2. Since the agency model (Harris & Raviv, 1979; Holmstrom, 1979) is essentially a mathematical programming model, a better test of agency theory needs to consider most of the variables, constraints, and assumptions of the model.
3. A study that partially adopts the model's constraints may result in the same predictions, but this may be due to other factors rather than those theorized in the model.
4. The first hypothesis is an extension of Harrell and Harrison's hypothesis. Compare this hypothesis with Harrell and Harrison's (1994) which was written as follows. H: Project managers who experience both: (1) an incentive to shirk; and (2) possess privately held information will exhibit a greater tendency to continue an unprofitable project than will those who experience only one or neither of these conditions (p. 572).
5. From the shareholders' (principal's) standpoint one of these projects is a better alternative than the other. Nevertheless, subjects might view the case in a different way. Based on agency theory, they could choose a worse alternative if by doing so they could maximize their personal objectives.
6. To avoid technical difficulties in distinguishing 0% from an empty space in the computer programming, 1% (instead of 0%) was used as the lowest probability. We assume that the use of 1% (instead of 0%) does not significantly affect the results.
7. This conversion may result in a score of 0%. But, as discussed in note 6, we assume that this substitution between 0% and 1% does not significantly affect the results.
8. There were four different versions of computer programs for each of the four groups (see Table 2). These groups contain the same information for each case except for compensation and shirking. The order of presentation of cases within each group was randomized to control for order effects. During the administration of the

experiment, the disks were arranged so that: (1) subjects received the version of the computer program in a random manner; and (2) each group cell contained the same sample size.

9. In fact we include the student level (SL) as a control variable, but the ANOVA does not yield significant results.

10. The preliminary tests indicate that the Point-Biserial correlation between study level and adverse selection is insignificant (see Table 3). In addition, a separate ANOVA for graduate and undergraduate subjects indicates similarities between the two sample groups. As a result, for testing hypotheses, graduate and undergraduate subjects' responses were combined into one analysis with a control variable for study level (see Table 4) to indicate if there is any effect of study level.

11. Berg et al. (1986) procedures have been used in Waller (1988) and Frederickson (1992). These procedures require several steps and may be more complicated. Waller (1988) suggested that the interpretation of the result of these procedures, especially for risk neutral individuals, is less clear. In addition, as Frederickson (1992, p. 667) admitted, the lack of support for economic factors in his study could be attributable to his subjects not accepting the induced utility function.

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PROCESS INNOVATION AND ADAPTIVE INSTITUTIONAL CHANGE STRATEGIES IN MANAGEMENT CONTROL SYSTEMS: ACTIVITY BASED COSTING AS ADMINISTRATIVE INNOVATION

Seleshi Sisaye

ABSTRACT

Accounting for quality and improved organizational performance has recently received attention in management control research. However, the extent to which process innovation changes have been integrated into management control research is limited. This paper contributes to that integration by drawing from institutional adaptive theory of organizational change and process innovation strategies. The paper utilizes a 2 by 2 contingency table that uses two factors: environmental conditions and organizational change/learning strategies, to build a process innovation framework. A combination of these two factors yields four process innovation strategies: mechanistic, organic, organizational development (OD) and organizational transformation (OT).

The four process innovation typologies are applied to characterize innovations in accounting such as activity based costing (ABC). ABC has been

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discussed as a multi-phased innovation process that provides an environment where both the initiation and the implementation of accounting change can occur. Technical innovation can be successfully initiated as organic innovation that unfolds in a decentralized organization and requires radical change and double loop learning. Implementation occurs best as a mechanistic innovation in a hierarchical organization and involving incremental change and single loop learning. The paper concludes that if ABC is integrated into an OD or OT intervention strategy, the technical and administrative innovation aspects of ABC can be utilized to manage the organization's operating activities.

INTRODUCTION

Management accounting techniques for reporting and control have changed over the years, notably in the 1990s. The past few years have been a period of significant changes in accounting systems for many organizations. Many organizations have adopted innovative management accounting practices such as activity based costing (ABC), benchmarking, strategic costing, balanced scorecard, use of teams/groups decisions, among others. Much of the literature in accounting has focused on the substantive benefits of these accounting innovations and the potential contributions those innovations bring to the organization (Anderson, 1995; Kaplan, 1989; Roberts & Silvester, 1996). However, there is no systematic study to date that describes the management processes that promote successful innovations in organizations.

This paper applies an institutional approach to organizational change to study the process of the diffusion of innovation, and how the process impacts successful adaptation and implementation of management accounting innovation. The research question of the paper lies in understanding the process of innovations in organizations that has contributed to changes in management accounting systems. Management accounting innovations broadly address management control systems including budgeting and performance evaluation systems. ABC has been presented as an example of a recent management accounting innovation that has significantly changed the collection, summarization, and analysis and reporting of cost accounting data in organizations. While there has been an emphasis in the technological changes in accounting control and reporting systems, there is now a realization that the diffusion process and the adaptation methods of organization influence the strategies that management utilizes for implementing innovative change in organizations. Accordingly, there has been a focus on the process that led to innovative changes in organizations.

Organizations respond to innovations in several ways depending on the source of uncertainty. The impetus for environmental change is either internally or externally induced. External environmental influences include changes in customer demands, governmental regulatory organization requirements, market competitive forces, or stockholders desire for better leadership and management styles. Internally, an organization's desire to improve current performance necessitates the need for innovations to meet or exceed the industry standards for excellent performance. Innovation is a planned change program where the extent of change can result in either single or double loop change. Single loop change represents an updating or a revision of what an organization is currently doing. Double loop change, on the other hand, represents a significant change involving benchmarks and standards. The differences between single loop and double loop learning are described in detail under the section Organizational Learning.

The institutional approach to organizational change which suggests that organizational structures, that affect an organization's learning strategy and ability to adapt to changes in the external environment, provide the context for at least two types of organizational change strategies: gradual-incremental and revolutionary-radical. The institutional framework maintains the view that organizations irrespective of their structural arrangements, can successfully change if they implement adaptive strategies of either incremental or radical change to bring about process innovation changes.

Sisaye (2001) discussed process innovation changes in management accounting, including activity based costing (ABC) and internal auditing, within the context of administrative innovations. This paper extends Sisaye's (2001) study by developing a process innovation framework to better understand the accounting innovation changes that followed the quality movement of the 1990s. Four types of process innovation typologies result from the combination of environmental factors: internal or external, and organizational change/learning strategies: single or double loop. They are identified in Table 1 as mechanistic, organic, organizational development (OD) and organizational transformation (OT) intervention strategies. ABC, as a multi-faceted management accounting

Table 1. Process Innovation Strategies For Management Accounting Systems.

		Environmental Conditions	
Organizational Change/ Learning Approaches	Incremental (Single Loop Learning)	Internal Mechanistic	External Organizational Development
	Radical (Double Loop Learning)	Organic	Organizational Transformation

innovation can take any one of the four innovation typologies described in Table 1 depending on the management accounting strategy adopted by an organization in response to environmental factors and orientation to change.

The intervention strategy the organizations are likely to choose depends on the nature of environmental factors and the organizational change/learning strategies they adopt to respond to their institutional environments. The process of change and the degree to which organizations define their problems are related to the type of learning strategy: single loop and double loop (see Argyris & Schon, 1978). Single-loop learning is limited to the correction of an error or a deviation in the organization's norms and procedures. Accordingly, incremental change has been treated as a single-loop (convergence) learning approach. It is associated with incremental changes where organizations keep the same parameters, but add emphasis to one or more of the variables that they are addressing. Double-loop learning involves the institution of new norms and procedures to correct errors in existing norms. It is categorized with radical-transformational changes where a whole new approach or paradigm is presented to solve the existing problem. Thus, radical change has been defined as a double-loop (reorientation) organizational learning strategy.

This paper adds to the behavioral accounting literature by providing a 2 by 2 contingency framework (Table 1) to allow researchers to examine process innovation strategies based on the mix of environmental conditions and organizational/change learning strategies. It is proposed that when organizations define their problems, they are implicitly choosing the form of the solution they are going to undertake. In other words, the cell into which they fall depends on the nature of the problem and the strategy that they follow to solve the problems will be dictated by the innovation strategy of the cell (i.e. typology) that they belong to.

This paper looks at the process of the diffusion of innovation and how that process impacts the successful adoption and implementation of management accounting innovations. Broadly speaking, the process of innovation addresses the introduction of new methods and techniques to change the organization activities including the management accounting reporting and control systems. Diffusion of innovation involves the flow of innovation and the process by which that innovation is spread throughout the organization (Rogers, 1971; Rogers & Shoemaker, 1971). To address these issues, the paper is divided into three sections. The first section describes the process innovation framework and the internal and external environmental conditions as well as the incremental and radical change strategies that support four organizational process innovation strategies. Section 2 examines the innovative process and the adaptive systems approach to organizational structures and innovations required for successful implementation. Section 3 illustrates with ABC the effects of organizational structures on the adoption and diffusion of process innovation in management accounting systems.

SECTION 1: THE INSTITUTIONAL APPROACH AS AN ADAPTIVE INNOVATIVE CHANGE STRATEGY

External environmental factors, including consumer demands, governmental regulation, external competition, and stockholder requirements for improved performance, affect the internal operations of organizations. These environmental changes have created increased uncertainty, intensified industry competition and have resulted in the need to change organizational systems, structures and strategies. As the firm strives to better "fit" its environment, and be more successful, sustaining and/or improving current performance have become critical for organizations that face increased environmental uncertainty and stockholder demands. Consequently, organizations are preoccupied with the adoption of new accounting innovation techniques to maintain system stability and continuity.

Innovation – Definition

Innovation refers to an introduction of new ideas, products, technologies or programs into an organization (Burns & Stalker, 1961). New programs may include operational changes such as the introduction of quality improvement programs and measurement related changes in accounting and internal control systems. In cases of process innovation, organizations introduce new approaches and methods for handling organizational tasks and activities, within existing organizational domains and boundaries. Organizations that plan process innovations may introduce technical and/or administrative innovations.

Technical vs. Administrative Innovations

The diffusion of innovation literature differentiating between technical and administrative innovations provides a basis for mapping accounting processes. Damanpour and Evan (1984) defined *technical innovation* as focusing on improving the technological performance of the organization. Examples of this include the development of a new product, equipment, service, or the introduction of new elements into the organization production process, e.g. quality control techniques to minimize waste and rejection rates (see also Damanpour, 1987, p. 677).

Damanpour and Evan (1984) described *administrative innovation* "as those that occur in the social system of an organization . . . an administrative innovation can be the implementation of a new way to recruit personnel, allocate resources, and structure tasks, authority and rewards. It comprises innovation in organizational structure and in the management of people" (p. 394). While technological innovations are self-contained, administrative innovations involve structural alignment and personnel changes and affect a wide range spectrum across all organizational levels and tasks. Accordingly, new reporting systems, recruitment and personnel policies, internal control mechanisms, resource allocation decisions, and cross-functional collaboration and coordination systems could materialize. Administrative innovations stimulate technological innovation, which affects production systems, and work arrangements. Since administrative innovations have "a clear social and applied component" that transcend "directly upon others in the work group, organization, or wider society," they are more systemic and integrative (West & Farr, 1989, p. 16). Technical innovations in comparison have limited scope targeted to certain functional areas of the organization.

Autonomous vs. Systemic Innovations

Innovations can be either autonomous (stand alone) or systemic (across units). Teece (1996) differentiated between these two types of innovations. Teece defined an *autonomous innovation* as "one that can be introduced without modifying other components or items of equipment component or device in that sense 'stands alone.' A *systemic innovation*, on the other hand, requires significant readjustment to other parts of the system" (Teece, p. 205). In systemic innovation, information flows are integrated to minimize institutional barriers to innovation. However, "the more systemic the innovation, the greater the interdependence. Exposure to re-contracting hazards is likely to be frequent" (p. 216).

Most technological innovations, including changes in manufacturing and production systems, at least begin as autonomous/stand alone changes. Autonomous changes can be implemented directly in a department, division or unit with or without minimal impact on the activities in other units or organizational processes. These improvements are considered incremental changes since they directly impact the production or manufacturing department that has initiated the change. Quality improvement programs that have been associated with total quality management (TQM) typically classified as autonomous changes.

In contrast, systemic innovations in accounting require coordination of resources – personnel, financial and material – as well as the sharing of information-technology and communication channels across units to implement a managed inventory scheduling system. According to Teece (1996), "innovations of this type require that the design of the subsystems be coordinated in order for the gains from the innovation to be realized." Systems interface and therefore "since these innovations span boundaries" and may alter "current technology, a complex coordination problem [could arise]" (p. 217). Systemic innovation raises the question of whether an organization has the adaptive structural arrangements, resources and learning capabilities for implementing such broad based innovation strategies. Business process reengineering (BPR) project that require organizational structural design and involve alignment of programs and tasks are integrated and have multidimensional changes that support systemic innovations.

An Introduction to ABC as Administrative and Systemic Innovation

Activity based costing (ABC) involves both technological and administrative innovations. ABC is a technological innovation required by an incomplete systemic change in accounting systems. When the nature of the production process changed to increased use of machines with reduced labor requirements, accounting did not respond to these changes until the 1990s. The current history of ABC dates back to this early period of the 1990s when firms adopted ABC to align management accounting information reporting systems with changing technology in manufacturing organizations. Argyris and Kaplan (1994) suggested that competitive and technological environmental changes in the 1980s contributed to the development of new products and services. Accounting systems developed new techniques to account for changes in product costs, quality and customer requirements. ABC changed accounting techniques "for assigning the indirect and support expenses of production, marketing, and selling activities" (p. 86). Accounting adopted successfully technical innovations. ABC changed accounting techniques for tracking indirect product-overhead costs. ABC altered eventually the method for calculating product costs by tracing all indirect costs commonly classified as overhead costs directly to products and services.

ABC assumes "that manufacturing is an integrated process that starts when supplies, materials, and parts arrive at the plant's loading dock and continues even after the finished product reaches the end user. Service is still a cost of the product, and as is installation, even if the customer pays" (Drucker, 1995, p. 55). ABC takes a systemic approach in analyzing and integrating "what were once several activities-value analysis, process analysis, quality management, and costing – into one analysis" (Drucker, 1995, p. 55).

However, the focus in this paper is not on the technical aspects of ABC, but rather on ABC as an administrative innovation. ABC as an administrative innovation change program requires several adaptive process stages for successful initiation and implementation. The initiation process includes data gathering, resource funding availability, cultural program of attitudinal change, education and training, and strong management support. Implementation requires the structural support of formalization, centralization and decision-making in the organization's bureaucratic structure. While organic structures support initiation, it is the mechanistic structures that implement them. The implementation of ABC and other management accounting changes, as administrative innovations will thus be influenced by the prevalence of mechanistic structures in organizations.

Administratively, ABC can be effective if the costing system is properly aligned with the production system in manufacturing organizations, or the service delivery system in organizations. It is this link between the physical and the decision-making systems in administrative innovation that makes ABC a systemic and integrative innovation.

Accordingly, ABC's cost objectives have focused on activities that affect production decisions. ABC thus gathers information on operational activities that support continuous improvement (Cooper & Kaplan, 1998, p. 110). It supports bureaucratic and mechanistic structures prevalent in manufacturing organizations. Although structural barriers have slowed the adoption of ABC, accounting innovation is being integrated into an organization's administrative process at both strategic and operational levels. ABC has become both systemic and integrative, requiring interactive work processes that can be handled through dialogue, negotiation and communication among divisions/units. The organizational learning process is being institutionalized through a step-by-step incremental approach with the objective of satisfying people, improving employee competence and organizational performance (Lukka, 1998). ABC has thus supported broader institutional changes throughout the organization.

The Institutional Approach to Process Innovations: Incremental versus Radical Change

Barnett and Carroll (1995) classified institutional theory as an adaptive change process framework, because it examines the impact of external environmental factors and market conditions on organizational change and development (pp. 217–218). The institutional approach focuses on adaptive change strategy to continuously improve existing systems, technologies, products and services (Mezias & Glynn, 1993).

The institutional framework emphasizes maintaining the status quo whether the process innovation change is either incremental or radical. While the institutional approach focuses primarily on gradual, incremental change, the approach does not rule out the need for discontinuous and radical changes if gradual changes do not meet an organization's need for survival, growth and improved performance.

According to the institutional framework, organizational change is initiated in responses to changes in either the external environment or in the internal characteristics of the organization. These responses can be either incremental-gradual or radical-revolutionary. *Incremental changes* seek solutions that help an organization adapt to the environment with minimal structural change. *Radical changes* advocate significant process innovations that require a complete transformation of the organization's mission, strategies and leadership.

Incremental Change

An incremental change is a transactional change that is usually carried out at the discretion of organizational management. The change process is gradual and initiated to improve certain organizational activities. Incremental changes impact the organization's systems, structures, management practices and climate. Changes may be required in policies and regulations, personnel procedures to match individual skills and abilities with the requirements, i.e. job-person matches, and reward systems (motivation-performance). These changes may result in reassignment of personnel to different functional areas of the organizational unit.

In incremental change, the degree of organizational change is confined to one or several units/departments and the broader structural impact is relatively low. Structurally, the focus of change is limited to operational levels that require highly specific information on a particular business or product line (Green, Garvin & Aiman-Smith, 1995; McKee, 1992). The result of incremental change thus generally ensures continued overall system maintenance and stability.

Radical Change

Radical change is a comprehensive change that recreates the organization through new organizational structures. Radical change is usually undertaken in response to forces in the external environment. It affects the organization's mission, strategy, leadership and culture (Burke & Litwin, 1992, pp. 530–531). It is a second order change that involves overhauling organization rules and regulations (Dunphy, 1988; Dunphy & Stace, 1993). The organizational-environmental inter-facing is characterized by early warning techniques causing an organization to undertake sudden organizational transformation, resulting in discontinuous change (Green, Garvin & Aiman-Smith, 1995; McKee, 1992). Thus, a radical change involves reconfiguring a significant portion of the entire system and its components to create a totally new and different system.

In the extreme, a radical change requires a paradigm shift within the entire organization (Kuhn, 1970). The development of new paradigms promotes process innovations, double loop organizational learning (reorientation) and the organizational change and transformation processes.

Organizational Learning: Single Loop versus Double Loop Learning

Organizational learning addresses the planned individual and cultural change designed to produce desired outcomes. Learning occurs when organizations use their knowledge and experience to improve employee behaviors, culture, and organizational task performance. According to Stata (1989), "organizational learning entails new insights and modified behavior. [It] occurs through shared insights, knowledge, and mental models" (p. 64). Learning involves knowing organizational rules, procedures, operating manuals, strategies, norms, behaviors, and, in general, the culture that governs the organization. Learning enables organizations to strategically align themselves with changes in their institutional environments.

The paper extends Argyris and Schon (1978) typologies of learning: single-loop and double-loop learning to describe the incremental and radical changes associated with improving organizational performance. Table 2 describes the differences between the two types of learning approaches using several dimensions. *Single-loop learning* occurs when an organization has "the ability to detect and correct deviations from a set of values and norms." *Double-loop learning* "occurs when the organization also learns how to detect and correct errors in the operating norms themselves" (Van De Ven, 1986, p. 603).

Single-loop learning has been described as involving the correction of an error or a deviation in the organization's norms and procedures. However, the correction is limited to certain functions within the organization. Double-loop learning, on the other hand, involves the institution of new norms and procedures to correct errors in existing norms. Single-loop learning is associated with incremental innovative change (convergence) whereas double-loop learning is categorized with radical-transformational innovative changes (reorientation) (Argyris & Schon, 1978; Lant & Mezias, 1992). In *convergence* learning, the focus is on better implementation of a revised innovation strategy. In *reorientation*, the organization realizes that the current system is not working and requires transformation with new structures, systems, paradigm and cognitive framework (Tushman & Romanelli, 1985). Reorientation learning accordingly promotes radical change in organizations, and is generally adopted when the impact of change from the external environment is substantial or turbulent.

Table 2. Approaches to Organizational Change: Incremental (Single Loop) versus Radical (Double Loop) Learning.

Dimensions	Incremental Change/Learning	Radical Change/Learning
Types of Learning	Single loop learning A routine incremental learning whose objective is to maintain or restructure existing rules, regulations, culture, and relationships without fundamentally changing existing organizational culture	Double loop learning An organization attempts to explore several new alternatives of technology, innovations, and rules to adapt to environmental changes. Adaptation may involve restructuring existing overall norms and behaviors instead of specific activities so that the organization develops new skills, culture, norms, and behavior
Occurrence of Learning	First order learning "An ability to detect and correct deviations from a set of values and norms"	Second order learning "Occurs when the organization also learns how to detect and correct errors in the operating norms themselves"
Implementation Strategy	Learning focuses on how to better implement the incrementally revised strategy	Learning focuses on experimentation, development of new constructs, formulation of new goals, strategies, products, and mission
Learning Outcomes	Convergence learning whereby organizations make incremental changes in strategy, structure, and systems to remain competitive	Reorientation learning occurs when the organization realizes that the current system and theory is not working and needs to be changed through the creation of new structures, systems, strategy, paradigm, and cognitive framework

Source: Adapted from Lant and Mezias (1992); Tushman and Romanelli (1985); and Van De Ven (1986).

Process Innovation Typologies

A 2 by 2 contingency table is developed to present the framework for process innovation strategies for management accounting systems. The framework presented in Table 1 indicates that a combination of environmental factors: internal and external, and organizational change/learning approaches: incremental and radical yields four types of process innovation strategies. They are: mechanistic, organic, organizational development (OD) and organizational transformation

(OT). Overall, Table 1 describes the relationships among the content of innovation: technical or administrative, organizational structures: mechanistic or organic, organizational change: incremental or radical, and learning strategies: single loop or double loop discussed throughout the paper.

On the left end of the continuum in Table 1, the internal environment: the mechanistic and organic innovations focus on implementation issues. While mechanistic and organic innovation strategies are pursued in response to internal environmental conditions to improve or maintain organizational performance, their differences are caused by their distinctive approaches to organizational change/learning. Mechanistic innovations are incremental, designed to make minor changes in administrative rules, regulations, procedures and control systems. Single loop (convergence) learning involves an organization continuously improving its current procedures to detect and correct errors that deviate from normal operating activities. Single loop changes may involve changes in standard costing related to prices and/or quantity usage related to inventory purchases, production scheduling, or labor force utilization. In organic innovation, the learning mode is double loop, where the organization radically alters current norms and behaviors to institute new norms and procedures to reorient employees into a new direction. Reorientation supports the organization's plan to introduce radical technical innovations such as process reengineering to develop new products and processes in response to internal environmental changes.

On the right end of the continuum of Table 1, the OD and OT intervention strategies are pursued by organizations that face external environmental uncertainty that requires adaptation, but experience differences in their change management and organizational learning strategies. The OD approach is pursued when the organizational change and learning strategy is single loop, convergence and incremental. OT is employed when the organization has developed the ability to undertake a radical change involving double loop and reorientation learning. An example of an OD process innovation strategy is TQM whereas business process reengineering (BPR) is equivalent to a radical change strategy that requires reorientation learning and completely new organizational structures and management control systems.

SECTION 2: PROCESS INNOVATIONS, ORGANIZATIONAL STRUCTURES AND LEARNING STRATEGIES

Managing process innovation change is a core competency of successful organizations. Process innovations take place in events as either in response to external environmental pressures or generated internally to improve current operating performance. Organizations can become proactive and pursue innovations in anticipation of changes as well as take reactive strategies in response to perceived changes in their external environment. The implicit if not explicit intent of innovation can be either single or double loop. While a single loop change represents a minor modification or update of what the organization is currently doing, a double loop, on the other hand represents a significant change from current operations. Single loop learning entails incremental changes where organizations keep the same parameter, but add emphasis in one or more of the variables. In double loop learning, there is a reorientation whereby a new approach is used to redefine the problems parameter. A good example is a standard cost variance analysis described by Dopuch, Birnberg and Demski (1967), whereby the critical decision variables that are used to estimate standard cost variances and monitor performance depend on the nature of the variance or deviation from performance. The deviation can arise from a random process that is being controlled (incremental deviation) or it could involve a temporary or permanent change in the process (radical deviation). Whether the deviation results in a modified or a new standard cost system, the organization has instituted process innovation strategies that either modifies or changes significantly the organization's course of action. It is important for management accountant researchers to understand the forces that lead to innovation, as well as the nature of the change: incremental or radical. While the events, internal or external environmental factors as well as single loop (incremental) and double loop (radical) learning approaches determine the type of innovation strategies, the diffusion processes: mechanistic, organic, OD and OT affect organizational innovation and adaptation change strategies.

Organizational Structures and Innovations

Organizational structures address the organization of work activities, including both personnel and production systems. These structures can be described along either functional or divisional dimensions. Management control, levels of hierarchy, decentralization, complexity of job tasks, degree of functional specialization, and extent of departmentalization/divisionalization vary according to an organization's size. The size, work structure and task complexity of an organization determine the form and orientation of structural innovations, e.g. *mechanistic* vs. *organic*, that prevails in an organization. The successes of technical and administrative innovations have been influenced by the prevalence of either mechanistic or organic organizational structures.

Mechanistic Structures

Mechanistic organizations exhibit hierarchical differentiation with several chain-of-command levels, concentration of power in top management and centralized decision-making. Mechanistic structures are commonly found in traditional hierarchical and bureaucratic organizations, for example manufacturing, that are relatively large in size. Mechanistic structures adhere to single loop learning that support the processing of non-complex, routine and repetitive large-scale tasks that do not require specialized technical experts. As these hierarchies separate workflow, face-to-face communication becomes difficult (Hull & Hage, 1982, p. 572). Differentiation minimizes frequency of contact and exchange of information flow among employees and divisions.

When organizations undertake mechanistic innovations, a highly developed formal planning and control system specifies the importance of rules and roles in superior-subordinate relationships, performance evaluation and reward systems. The innovation process becomes single loop, one way, top-down to reinforce the predominance of formal rule based relationships in managing organizational activities, which in turn creates coordination problems among departments and divisions (Burns & Stalker, 1961; Dirsmith & McAllister, 1982). There is a strong reliance on accounting control systems, which reinforce mechanistic innovations that adhere to existing bureaucratic structures and restrict the use of personal feedback and inter-personal relationships in management control systems.

Organic Structures

Organizations with organic structures have flexible organizational arrangements that are amenable and adaptable to changes in their institutional environments. Organic organizations have a horizontal hierarchy with less differentiation and limited chain-of-command and minimal bureaucratic features. When there is decentralized decision-making, double loop learning prevails which facilitates the flow of information and dissemination of new innovative ideas and knowledge (Argyris & Schon, 1978; Burns & Stalker, 1961). Because organic organizations are usually small or medium in size, they can carry out complex tasks that require specialists to handle these relatively complex tasks in small-scale batches.

In organizations that promote organic innovations, a command power structure is relatively absent. Instead, power is widely dispersed among divisions and team based management control prevails. Birnberg (1998) referred to such organic innovation as team based control, a cognitive approach to control where teams have the autonomy to establish and enforce their own performance goals. Under organic innovations, formal control and single loop learning is substituted with double loop learning and cognitive control where management employs frequent use of personal/flexible feedback, interpersonal relationships, face-to-face contact and communication, cooperation, and easy coordination among divisions to monitor employee performance and organization activities.

Mechanistic versus Organic Innovations

Organizational structures are instrumental for change, particularly in mechanistic and organic innovations. The process innovation framework illustrated in Table 1 identifies that organizations are more likely to undertake mechanistic or organic innovations when the environmental constraints internally create preconditions for change. The difference between mechanistic and organic innovation strategies underlie in their approaches to organizational change/learning strategies. Incremental (single loop) learning occurs under mechanistic innovation while radical (double loop) happens in organic innovations.

The organization behavior literature has substantiated that mechanistic structures are more suited to administrative innovation while organic structures support technical innovation (Damanpour, 1987). Success of administrative procedural changes occurs under mechanistic innovations in bureaucratized and centralized structures. In situations where the environment is predictable and there is less uncertainty, a formal control system can be designed to address the critical decision variables for estimating variances and monitoring performance (Dopuch, Birnberg & Demski, 1967). This is because a formal control system encourages a structured administrative mechanistic innovation. However, centralized control systems do not support organic technical innovation without promoting changes in the hierarchical structures and chain-of-command. Formalization of work arrangements and control systems support incremental single-loop learning of mechanistic innovation where the formality of control systems and work arrangements of mechanistic structures make them less suited to double loop learning and organic innovation.

The organization management literature suggests that organic structures enhance double loop radical change by deploying their resources and utilizing their human resources capabilities for implementing process innovation programs to manage change. For example, Hull and Hage (1982) indicated that the relationship between the size of the organization and responsiveness to innovation is more applicable to high technology firms than to other types of organizations. They "argue[d] that the organic model is not the only appropriate model [for innovations]. For example, organizations having mixed structures for performing large scale and complex work can achieve a medium level of innovation" (p. 566). This suggests that large-scale organizations with decentralized structures may also have attributes that support organic innovation. In other words, whether an organization is large or small, the existence of decentralized structures support double loop higher order learning and radical change in programs, strategies, policies and management visions. When these decentralized organizations pursue radical change and process reengineering to change either the production or service component of their operating activities, they are instituting process changes consistent with double loop learning and organic innovations.

In response to management change initiatives, decentralized organizations create small-scale autonomous units or teams to handle complex tasks that facilitate organic innovation. Since decentralization promotes autonomy in decision-making, managers are empowered to use cognitive control, a higher order double loop control system, to make innovative decisions that will improve their division's performance.

In addition to structural arrangements and organizational change learning characteristics, the successful implementation of process innovation changes in organizations also depends on the extent to which external environmental characteristics necessitate change. Table 1 describes that the difference between OD and OT arise in their approaches to organizational change and learning strategies. OD adopts a single-loop (convergence) learning associated with incremental change while OT utilizes a radical change strategy and double-loop (reorientation) learning. The OD and OT innovations advocate contrasting approaches for the implementation of administrative and technical innovations. While the OD's gradual approach reinforces administrative innovations, the OT's radical approach are considered necessary preconditions for technical innovations that set the stage for the broad changes in process reengineering.

Organizational Development and Transformation Innovations

Organizational development (OD) and organizational transformation (OT) are undertaken in response to external environmental influences. Table 1 describes that the differences between OD and OT is in their approach to organizational change/learning strategies. OD undertakes incremental (single loop) learning while OD utilizes radical (double loop) learning innovation. In general, both approaches advocate different, but complementary, strategies for the adoption and implementation of process innovation.

Organizational Development

Organizational development (OD) has been defined by Porras and Silvers (1991) as a change program designed to create a "better fit between the organization's capabilities and its current environmental demands, or promoting changes that help the organization to better fit predicted future environments . . . OD concentrates on work-setting changes that help an organization adapt to its external environments." It focuses on "planned change" that emphasizes "change in individual employees' cognitions as well as behaviors" (p. 54). Planned change programs reinforce single loop learning as quick remedies for the immediate problems. These remedial strategies in behaviors and work activities are not expected to bring long-term solutions.

Porras and Silvers (1991) listed organizational components associated with OD interventions: organizational arrangements (goals, strategies, formal structures, administrative systems); social factors (culture, roles, individual attributes, management style, individual and group interaction); technology (tools, expertise, job design, technical systems and work flow design); and physical setting (space configuration, architectural design, physical ambiance and interior design) (p. 56). Accordingly, the OD intervention strategy has focused on individual and group processes as well as interventions on structural arrangements and reward systems (p. 73).

The single loop incremental approach of OD has been popular in process innovation programs that advocate continuous improvement strategies in organizational products and services. The most notable of these programs in the 1990s has been TQM, where bottom-up participation and the use of change leaders (quality circles) have been advocated to improve production and quality (Sisaye & Bodnar, 1995). However, as Brynjolfsson, Renshaw and Alstyne (1997) noted, TQM's targeted changes in a single system can be counter-productive. "It may be that no single isolated change can improve a process, but that a coordinated change can" (p. 38). This approach calls for an OT strategy such as BPR that requires simultaneous change in all organizational systems encompassing both behavioral and structural changes.

Organizational Transformation

Organizational transformation (OT) proposes radical innovations of double loop learning that promote a new, different organizational paradigm. Organizations undertake OT strategy in response to volatile environmental changes or turbulence. Porras and Silvers (1991) view OT as "promoting paradigmatic change that helps the organization better fit or create desirable future environments." It focuses on double loop – reorientation organizational learning that call for "a new vision for the organization" (p. 54). The paradigm shift in OT affects the entire organizational behavior, and thereby "creates new behavior, and gives individual employees a totally new way of viewing their work" (p. 58).

Barnett and Carroll (1995) indicated that OT involves either a change in content or process. When an organization changes its content, the change dramatically alters an element or all parts of the organizational structure, including mission, strategy, authority structure and technology (see also Hannan & Freeman, 1984). A process change, on the other hand, affects "the way the transformation occurs-the speed, the sequence of activities, the decision-making and communication system, [and] the resistance encountered" (p. 219). OT thus utilizes a double loop learning strategy to bring both process and structural content changes in organizations.

An OT intervention strategy approaches accounting systems as a central component of the administrative structures in the organizations. Accordingly, administrative process innovation in accounting becomes multidimensional requiring both process and structural changes in organizations. Accounting as an administrative tool involves planning, budgeting, internal control, and reporting systems, which impact managerial communication, reward systems and decision-making at all levels of the organization. Consequently, the organizational culture shapes the accounting system and the degree to which planned administrative innovative changes can be implemented. Unlike TQM and most technical innovations in manufacturing and production systems, management accounting innovations become double loop, and are not limited to a single task, but rather affect an array of tasks and functions in organizations. When the successful implementation of process innovation involves several functions, double loop organizational learning and radical change orientation become key factors in promoting cognition change among employees to enhance mutual collaboration among various units in an organization.

Organizational Learning and Adaptive Change Strategies

Two types of organizational learning: single loop and double loop, have been described to be associated with the process innovation strategies summarized in Table 1. The differences between the two types of learning approaches are described in Table 2. Single loop learning is limited to convergence or incremental learning. Double loop learning occurs with reorientation learning, where the organization realizes that the current system is not functional and requires a new paradigmatic framework.

Organizational learning that promotes incremental change focuses on single loop (convergence) learning. Incremental learning entails mechanistic and OD interventions for restructuring existing rules, procedures, operating activities and cultures. The strategy allows an organization to retain its competitive edge by improving performance level and thereby maintaining its existing system. A radical organizational learning strategy involves double loop (reorientation) learning to pursue organizational transformation strategy to change the organization's strategy and mission as well as its structures. An organization explores new technological innovation to change existing operations, cultures, behaviors, and norms to adapt to external environmental changes (Lant & Mezias, 1992; Van De Ven, 1986). Whether an organization undertakes incremental-convergence or radical-reorientation learning, organizational learning is necessary for innovation and change, particularly when organizational innovation requires cultural and leadership changes.

In this section, single loop and double loop learning are elaborated further to describe the organizational adaptation strategies of OD and OT, and to show that the learning strategies of OD single loop approach and the OT double loop approach are present in ABC. ABC is both an administrative and technical innovation. As an administrative innovation, ABC has OD's feature of single loop learning. As a technical innovation, ABC takes OT's double loop radical learning to revolutionize the accounting reporting and control systems.

Organizational Development and Single Loop – Incremental Innovation Learning

Organizational Development (OD) learning promotes incremental changes that focus on single-loop learning. Incremental changes are characterized primarily as routine in nature and involve minor adjustments to correct errors from existing rules and regulations. Incremental changes maintain or restructure existing rules, regulations, and culture so that systems remain in balance (Lant & Mezias, 1992; Tushman & Romanelli, 1985).

Organizations are more likely to approach incremental changes as their preferred strategy if they consider their level of performance to be unsatisfactory in relation to their desired/targeted goals. Lant and Mezias (1992) indicated that "satisfactory performance will tend to result in reinforcement of the lessons drawn from the organization's past experiences; the status quo will be maintained and justified, resulting in first-order learning and convergence. By contrast, this tendency toward convergence will be mitigated when unsatisfactory performance calls existing routines and practices into question" (p. 49).

Incremental change approaches to learning are commonly associated with organizational development (OD) change strategy. Porras et al. (1982) use the term social-learning theory to describe the OD learning approach, which is directed towards changing the behavioral and attitudinal characteristics of organization individuals and groups. They described earlier OD interventions that focused on improving interpersonal relationships through team building thereby "producing permanent behavior change in the actual work setting" (p. 435). Job restructuring, changes in work environment and improvement of employees' personal skills and work qualifications are part of OD's single loop incremental changes.

In OD, decision-making is a short term, specific, one-dimensional change that focuses on single loop orientation of rational behaviors associated with individual and cultural change. However, most corporate incremental changes that utilize rationality in behavioral decision-making emphasize the economic performance of the organization (Marshall, 1994, p. 44). A single loop approach to change has short-term focus and orientation. In the long run, the planning process incorporates uncertainty beyond single loop focus of the current period that may require continuous changes in existing process innovation strategies to meet performance goals. In the short term, successful organizations that utilize single loop incremental process innovation rely on OD based continuous improvement programs like TQM to manage short-term performance issues by controlling costs, making continuous improvement in products, services, and quality to achieve goal congruence with the organization's strategy, structure, people, and technology.

However, if incremental change fails to promote process innovations consistent with a satisfactory level of organizational performance, it is possible that an "organization is more likely to undertake major changes in an effort to raise performance above aspiration level. Thus, the equivocal experience associated with failure may produce a level of organizational change consistent with reorientation and double loop learning. It is important to keep in mind, however, that aspiration levels adapt to performance, providing a moving target which implicates the dynamics of stability and change" (Lant & Mezias, 1992, pp. 49–50).

In other words, organizations, which attempt to maintain their competitiveness through incremental changes – single loop and double loop learning may contribute to structural and cultural inertia. Tushman and O'Reilly III (1996) defined structural inertia as "resistance to change rooted in size, complexity, and interdependence in the organization's structures, systems, procedures, and processes" where as cultural inertia "comes from age and success. As organizations get older, part of their learning is embedded in the shared expectations about how things are to be done. These are sometimes seen in the informal norms, values, social networks, and in myths, stories, and heroes that have evolved over time" (p. 18). Cultural inertia cannot be solved through incremental change of convergence and single loop learning. Inertia can create obstacles to radical changes that require organizational transformation, unless organizational learning programs that require second-order double loop learning and reorientation are put in place.

Organizational Transformation and Double Loop – Radical Innovation Learning

Organizational transformation (OT) has been defined in Table 1 as a process innovation strategy that an organization adopts when the environmental condition that necessitated innovation is external and the organizational change/learning strategy is radical. OT intervention changes involve double-loop learning. An organization's innovation strategy is to alter and change existing rules and procedures and replace them with new goals, strategy, structure, and mission, resulting in new cultures, norms and behavior to adapt to changes in its institutional environment (Lant & Mezias, 1992; Van De Ven, 1986). An organization will adopt a transformational change strategy if its performance is below the industry average. The change is either continuous as a result of double loop learning or discontinuous, requiring major, sometimes discontinuous, leaps in the development of new products and services.

When an organization introduces discontinuous change involving major technological changes, new products, or new services, double loop learning is required to assist in work coordination, program integration, building new technological skills, and information sharing. But once the reorientation and structural changes are over, "adjustments in organizational structures and activities will prove beneficial to short-run financial performance and long-run survival chances" (Haveman, 1992, p. 71).

In summary, as described in Table 1, organizational learning, whether incremental and/or transformational-radical, is a key factor in innovation and change. Learning allows an organization to position itself strategically ahead of environmental changes. The success of organizational learning largely depends on top leadership and strong management support. If an organization is successful in planning and implementing the learning process, either single loop or double loop, the institutionalization of innovation could be the outcome of the innovation process (McKee, 1992, pp. 233–241).

The Role of Organizational Learning in ABC

Stata (1989) viewed organizational learning as a competitive advantage for organizations able to adapt to changes in their institutional environments. The objective in organizational learning is to find new ways and methods to speed up organizational learning and improvement. "Quality improvement, or total quality control as it is often called, is a management methodology for achieving improvement and change" (Stata, 1989, p. 68).

Both single loop and double loop organizational learning are instrumental for the successful implementation of process innovation changes in management accounting and control systems, including ABC. However, which learning strategy is the preferred approach depends whether the change in the accounting system has a process – TQM or a structural – process reengineering focus. Process changes in accounting have usually followed TQM's incremental change strategy of single-loop convergence learning through communication and education. Accordingly, ABC can be classified as an OD based process innovation change in accounting systems. However, process innovations in ABC have involved multi-dimensional changes involving both technical and administrative innovations. Process innovations in ABC have been noted as an exception since ABC required the utilization of both single loop (convergence) and double loop (reorientation) learning in the design and implementation of management accounting reporting and control systems. ABC as an administrative innovation change has a single loop learning orientation that has been largely supported by mechanistic organizational structures that are hierarchical and require management coordination. ABC as a technical innovation has OT's features, which require double loop learning and is an administrative innovation, it follows OD's strategy of single loop learning. If ABC's implementation is accompanied by overall changes in both the technical and administrative components of management control and reporting systems, ABC has followed an OT innovation strategy.

However, operating procedure constraints in mechanistic structures and unrealized tangible benefits from administrative improvements have contributed to administrative innovation lags (Damanpour, 1987). Compared to technical innovations, administrative innovations generally have a lower acceptance rate and gain minimal support by senior level management. Administrative innovations have thus lagged behind technical innovations in manufacturing systems. These lags have been attributed to the slow pace in innovations, and the relative lack of establishing cost-benefit relationships in administrative innovation systems. Structural constraints in organizational, personnel and hierarchical structures have slowed the pace of administrative innovations contributing to accounting innovation lag (Dunk, 1989).

Effect of OD and OT on Management Accounting Adoption and Innovation Lag

Individual, group and organizational differences in process intervention strategies contribute to innovation lag. Organizational lag refers to the relative differences in the degree to which organizations adopt technical and/or administrative innovations (Damanpour & Evan, 1984, p. 394). Individual factors deal with personality, behavioral and attitudinal constraints. Organizational factors are more general and address institutional and environmental factors. Organizations with centralized and bureaucratic structures associated with mechanistic and OD innovations have created obstacles to adoption and diffusion that contribute to innovation lag. Divisionalized and autonomous structures, on the other hand, support organic and OT innovations that are necessary for information sharing and diffusion of innovation throughout the organization. Organic and OT interventions reduce individual and structural barriers that create innovation lag in organizations. Divisional structures and work arrangements also influence innovation behavior and the degree to which innovation can impact organizational performance. Accordingly, information and communication are key factors both in the dissemination of innovation and in the creation of adoption lag.

Innovations in information technology (IT) directly affect accounting and internal control systems by improving the speed and accuracy with which accountants can gather, process and report data on organizational performance. IT contributes to increases in job complexity, cross-departmental/divisional coordination, and the requirements for a cost-effective comprehensive plan to implement the new system (Krovi, 1993). These innovations create uncertainties among employees because of changes in jobs, skills and training requirements, leading to employee resistance to information systems (IS) implementation. The resistance is mainly behavioral, related to lack of employee commitment to the IS and/or the threat to their job security. Employee concerns about jobs, performance and normative influences affect an organization's ability to adopt and implement organization wide accounting innovations.

When systemic innovations are introduced as part of an overall organizational learning strategy, they are disseminated within existing organizational procedures, domains and boundaries. However, the progress of systemic administrative innovation in accounting has been constrained by management hierarchy and coordination problems associated with large-scale organizations. Organizational learning of systemic administrative innovation has been confounded with mechanistic bureaucratic structures, internal employee and management problems, and complicated by external constraints. As a result, advances in management accounting and internal control innovations have fallen behind recent educational and technological innovations in manufacturing processes, creating an accounting innovation lag. One of the reasons for this lag is that the potential benefits of administrative control innovations, including accounting, are generally less observable, less quantifiable, and require a longer time horizon for the benefits to be realized (Damanpour, 1987; Dunk, 1989). As a result, organizations have selectively focused on technical innovations, and have made minimal investments in administrative innovations in accounting systems (Davenport, 1993).

Organizational characteristics constrain administrative innovations. Bureaucratic procedures characteristic of mechanistic operating systems and difficulties in establishing cost-benefit linkages in administrative innovations have contributed to innovation lag. Management accounting systems have experienced innovation lag over the years (Dunk, 1989). However, while a formal control system encourages a structured mechanistic administrative innovation, it does not continue to support the innovation without changing the organization hierarchical structure and chain of command. Nevertheless, recent developments in information technology and ABC have contributed to incremental change in accounting, recording and reporting of production and quality cost data in business and manufacturing organizations. When an organization undertakes OT to change the structure from mechanistic to organic, new policies, strategies, administrative procedures, and accounting control systems such as ABC are instituted to support the change.

SECTION 3: ORGANIZATIONAL STRUCTURES AND ADMINISTRATIVE INNOVATION CHANGES: ACTIVITY BASED COSTING AS AN ADMINISTRATIVE INNOVATION

Process innovations occur because organizations are aware of the need to change their course of actions. The demand for innovations can vary by degree of structural complexity. While mechanistic and organic structures are associated with organizational complexity, it has been argued in this paper that organizational structures can either facilitate or inhibit change depending on the type of innovation. When management accounting innovations involve both technical and administrative innovations, the existence of either mechanistic or organic organizational structures affects the type of innovation. It has been documented that organic structures are best suited for technical innovations, while mechanistic structures are appropriate for administrative innovations. Because organic structures have loose, decentralized and flexible structures, they promote autonomy, lateral communication, and network structures that support specialization and technical innovations in new technologies, production processes, product development and services. Mechanistic structures, on the other hand, have centralized and differentiated structures, hierarchical authority, command and control management systems, and top down vertical communication systems that support administrative innovation (Burns & Stalker, 1961; Daft, 1978; Damanpour, 1987).

Accounting can play a role in promoting change in organizations if it is directed to reporting those activities of the organization that improve performance and productivity. Improving the activities of the organization not only requires an administrative infrastructure that is systemic and integrative, but also one that supports continuous improvement. As described in Section 2, ABC provides accounting information on the cost of activities associated with production and delivery of products to customers, along with services required after product delivery. ABC supports mechanistic organizations by reporting on those activities that affect production decisions. Accordingly, ABC is a technique used "to generate improved cost data for use in managing a company's activities" (Roberts & Silvester, 1996, p. 24). ABC thus gathers information on operational activities that support continuous improvements (Cooper & Kaplan, 1998, p. 110). As ABC has been implemented, accounting has been increasingly integrated in organization administrative processes at both strategic and operational levels. ABC has thus become an important "administrative innovation because its implementation may lead to new administrative procedures, policies and organizational structures" (Gosselin, 1997, p. 109). While ABC innovations address both the technical and administrative aspects of management accounting systems, it is the administrative innovation aspect of ABC that has received attention in the management accounting literature.

Administrative Innovations in Management Accounting Systems

Administrative innovation is designed to improve accounting control, organizational structures and systems, administrative processes, management systems, and departmental coordination as well as recruitment and personnel policies, control and motivation systems and structuring of organizational activities (Damanpour, 1987, p. 677). According to Daft (1978), the success of administrative innovation depends on organizational structural arrangements supporting the innovation. Structural arrangements refer to the level and ratio of management groups in the organization hierarchy. The more management groups, the greater the management hierarchy and intensity within the organization.

Damanpour (1987) suggested that administrative intensity, related to high managerial ratio and increases in management hierarchy, facilitates the adoption of administrative innovation. These centralized structures support single loop learning that is unidirectional from top to bottom of the management hierarchy. Since administrative innovations including changes in management accounting control and reporting systems are initiated at the top of the management hierarchy, administrative intensity affects the adoption process of accounting innovations the most (p. 679). Damanpour (1987) noted that as the management group ratio increases, the chances for integration and successful adoption are greater (p. 682). Managers at hierarchical levels higher than the technical core can only introduce administrative innovations that affect more than a single unit or department. When senior management initiates administrative innovations, the innovations are more likely to affect the organization at large compared to technical innovations limited to a single unit. Successful adoption of administrative innovation in turn facilitates technological innovation (Damanpour, 1987, p. 685). Administrative intensity also increases the capability of organizations "to resolve conflict and integrate units," thereby facilitating the adoption and diffusion of innovation (p. 686). Consistent with single loop learning, the conflicts tend to be resolved through command and compliance at the higher level of management.

Mechanistic organizations have higher levels of administrative intensity than organic organizations and have the infrastructure to resolve conflict created by administrative innovations. A centralized decision-making process and the concentration of power within top management are required to facilitate the adoption and diffusion of administrative innovation, including accounting information systems.

Changes in information systems cause organizations to modify how they assign individuals to specific positions to conduct organization business (Krovi, 1993). Information system innovation serves as an agent of social, technological and economic development because it leads to greater specialization and diversification, especially in mechanistic organizations (Laszlo, 1992). Accounting as an economic information system has broader implications managing organizational activities. When organizations decide to adopt management accounting innovations including ABC, bureaucratic structures play an important role in the adoption decision. According to Gosselin (1997), "centralized and formal organizations that adopt ABC are more likely to implement ABC than decentralized and informal organizations . . . Decentralized and less formal organizations may have greater flexibility to stop the ABC implementation process. . .if they feel it would be relevant to do so . . . Vertical differentiation may have more impact on the adoption decision than on the implementation process" (p. 117).

Mechanistic organizations adopt ABC because it is a formal accounting system designed to meet internal environmental demands for improved performance. Since these organizations have higher levels of vertical differentiation appropriate for single loop learning, they are able to implement administrative innovation throughout all levels of the organization. Centralization and formalization become the appropriate organizational structures to commit resources needed for ABC implementation (Gosselin, 1997, p. 117). Organizational contextual factors affect the diffusion innovation process and either "encourages or discourages the implementation of innovation" (p. 105).

The Diffusion of Administrative Innovation: Activity Based Costing and Accounting Change Implementation Issues

ABC is a formal accounting system more likely to be adopted by complex organizations with centralized structures. Complex organizations feature formalized structures with hierarchical and interdependent cross-functional arrangements that incur high transaction costs (Williamson, 1987). Mechanistic innovations that are based on single loop learning and incremental changes necessitated by internal environmental structures adopt ABC. ABC benefits organizations with such bureaucratic structures, because top management for performance evaluation and control purposes can use the information. Key to understanding

ABC is the analysis of transaction costs, activities and intra-organizational relationships (Roberts & Silvester, 1996, p. 32). The economies of scale that centralized organizations enjoyed as low cost producers created barriers for ABC implementation. They include "too many or too few identified activities and cost drivers; overly complex system design; reciprocal cost allocation; and lack of technical expertise on the identification and analysis of activities" (p. 26).

Structural Issues Associated with Implementation of ABC

Structural issues that arise from implementation of ABC are largely organizational problems associated with the socio-technical settings of ABC. As a technical and organic innovation, ABC requires the commitment of resources for full implementation. As administrative mechanistic innovation, ABC is a systemic innovation that affects most organizational functions and systems. If senior managers mandate ABC as a single loop incremental change process without generating commitment from lower level personnel and support from divisions and departments affected by ABC, it will have little or no impact. In most situations, ABC met the least resistance "where senior operating executives had sponsored the project and were actively involved in its early phase" (Argyris & Kaplan, 1994, p. 89). In other words, senior management relied on a double loop learning strategy that involved lower level management in the adoption and diffusion of ABC.

Senior management involvement in ABC provides legitimacy for ABC as a serious and important undertaking among functional and divisional managers. If senior managers can provide job security and offer reassignment for employees affected by ABC, they can receive support for ABC at lower personnel levels. Argyris and Kaplan (1994) stressed that ABC would promote change in organizations when management adopts ABC and aligns incentives with support programs. Their view of ABC is in line with the OD process innovation strategy. They suggest organizations develop "systems or structures that facilitate, reward, and reinforce collective change. Examples of such organizational enablers include employees empowered to act at the local level, reduced managerial layering, financial and non-financial rewards for successful implementation, and information systems that produce relevant information in a timely and user friendly manner" (pp. 89–90). OD intervention strategy in improving organizational structural arrangements, technology, personnel policies and reward systems corroborates the socio-technical focus of ABC in organizational change.

The OT intervention strategy, on the other hand suggests that external environmental factors influence the adoption and diffusion of innovation in organizations. Competition is an important institutional environmental factor that affects innovation at the organization level. For example, Anderson's (1995) study of ABC implementation at General Motors Corporation (GM) revealed that external competition brought with it an awareness of the importance of cost and the need to design new cost systems that better reflected the organization's cost structure. GM adopted ABC because GM's competitors had adopted ABC. It corroborated the assertion that "the identity of voluntary adopters of ABC is consistent with the claim that competition and environmental uncertainty promote ABC adoption" (p. 42). Anderson's (1995) GM study supported the idea that external communication through publicity and competition from outsiders provided internal support and external validity to ABC implementation. It helped ABC to "overcome internal resistance by management" and "reinforced management's commitment to ABC" (p. 42). As an OT innovation strategy, ABC will face the least resistance by management when ABC is adopted in response to external environmental conditions and supported by radical organizational learning strategies.

Administrative Innovation Issues in Management Accounting Systems

In the previous sections, potential problems and barriers – organizational structures, management support, competition and external environmental factors and resources – to administrative innovations were discussed. These bottlenecks have slowed the progress of administrative innovation, creating an administrative innovation process that lags behind technical innovation. Nevertheless, recent technological advances in computer information systems, e.g. on-line networking, telecommunication, and the Internet, have minimized the innovation gap between technical organic systems and administrative mechanistic accounting control systems. These advances have highlighted the increased importance of accounting in the post-industrial information society of advanced capitalist economic systems.

Accounting systems are administrative structures, and changing them requires a phased OD or OT innovation approach. Dixon et al. (1994) suggests a two-stage radical approach that involves "initiation and implementation. A decentralized organization best supports generation and innovation of ideas, while a centralized organization is best able to implement the innovations, implying that leadership roles and project structure might need to vary significantly in the two phases" (p. 101). Accounting functions are mostly centralized at the corporate headquarters level, tend to be micro-oriented, and can be implemented more easily than large-scale innovations that involve macro-radical OT interventions. Process analysis is used in accounting change because the procedure utilizes OD's innovation approach of continuous improvements that focus on optimization of resource mix and allocation strategies designed to minimize waste and reduce non-value added organization activities.

In a centralized mechanistic organization, administrative innovation is a bureaucratic top-down approach coming from senior management (Daft, 1978; Damanpour, 1987). Managerial accounting, as an administrative innovation process allows higher management levels to utilize a single loop learning strategy to influence the planning process. However, since administrative innovations are not easily identifiable and cannot be championed like technical innovations, senior managers are less likely to be committed to administrative innovations. Accordingly, the process of championing administrative innovation may be delegated to lower level management. When lower level staffs carry out innovation implementation, there is skepticism as to whether or not the innovation will succeed.

Most often, process innovation in administrative systems addresses routine OD practices, strategies or reporting systems that are less subject to objective measures of evaluation than technical innovation. Mezias and Glynn (1993) refer to this subjectivity of administrative process innovation as experiential learning systems (p. 78). As experiments, administrative innovations follow single loop learning practices that follow an OD based continuous process strategy, designed to bring about structural operational changes in management accounting systems, including ABC. For example, Roberts and Silvester (1996) suggested "the preexistence of an ongoing process-oriented improvement program supports ABC" (p. 33). Such incremental single loop learning change programs may include "computer integrated manufacturing, just-in-time manufacturing, or statistical process control." As an experimental change, ABC is likely to succeed in the presence of a "tested and proven interdependent infrastructure, along with a climate that supported continuous improvement and change . . . The use of cross-functional teams in activity analysis recognizes the need to dissolve structural barriers. However, actually implementing the changes often requires strong leadership from both inside and outside the team to overcome any remaining structural barriers to change" (p. 33).

A single loop learning approach has incrementally changed the mechanistic role of accounting in performance measurement. Coupled by the OD intervention strategy's of continuous improvement in administrative and technical innovations in accounting information systems, computers and information technology has changed the accounting function from that of producing financial reports to that of providing service (Dixon et al., 1994, p. 100). The information technology has enhanced accounting role from a staff function to a line function where an accountant now serves as an expert in information management, rather than as a custodian of company resources. These changes in reporting relationships have enabled accountants to act as OD technical experts and participate in decision making on cost, quality, downtime, maintenance, inspection, delivery, and related factors that indicate improved performance. Accounting systems are eventually being transformed to meet information requirements of global competitive economic systems as well as requirements of increased management accountability.

Recently, process innovation has now become a tool used by management accountants to adapt to current information needs of the competitive business environment. Moore (1997) suggests that accountants can manage process change, if they use process skills like TQM (which is referred in this paper as OD based strategy) and Business Process Reengineering (BPR) (which has been described as OT oriented intervention approach) in place of traditional (labeled as mechanistic) audit skills of flow charting and internal control assessment (see also Davidson, 1993; Vittorio, Coughlan & Voss, 1996, p. 126). This intervention can be augmented by the technical innovation process skills to introduce OD and OT innovation into management control systems (Sisaye, 1996).

Process based innovation has contributed to an organic view of the firm's management accounting function. It can contribute to technical innovations that would enable organizations to internally audit and monitor their accounting innovation capability and performance. Process innovation accounting audits are instrumental to identify the technical and administrative phases of innovation that are required to develop performance measures for each process of innovation and to assess the overall impact of innovation on competitiveness. A process based evaluation system selects processes and practices that support innovation programs and defines corrective actions that can improve organizational performance.

There is no question that accounting is an enabler of process innovation in organizations. Organizations can use accounting process to assess their performance, technological capability, human and financial resources, and competitive strategies. Accounting not only identifies quality processes in organizations; it identifies gaps between current and desired performance. It locates problems, needs, and delivers information to develop action plans for better results.

From an OD intervention strategy perspective, process innovation changes in accounting are generally considered technical micro-reengineering projects that are discrete, stand-alone solutions, technologies, and systems executed by local management. Micro engineering projects can be completed with relatively small investments, in a short time period with defined payback periods (Davidson, 1993, p. 71). In accounting, OD oriented micro-reengineering projects focus on improved reporting systems for quality improvement, cost-reduction techniques, better response time, quick delivery cycle time, faster variance reporting time and customer service and satisfaction. If these changes in accounting control systems are integrated throughout the organization, the diffusion of innovation takes a broader scope consistent with the OT intervention strategy. The OT approach promotes that process innovation in accounting such as ABC can contribute to improved organizational performance if they are implemented as part of the overall organizational change strategy.

CONCLUSION: EFFECTS OF INSTITUTIONAL CHANGE AND ADMINISTRATIVE INNOVATION ON ACTIVITY BASED COSTING

In this paper, process innovation strategies in management accounting systems are defined as contingency approaches that depend on the relationship between two factors: environmental conditions: internal and external, and organizational change/learning strategies: incremental (single loop) and radical (double loop). A 2 by 2 contingency table (Table 1) yielded four types of process innovation strategies: mechanistic, organic, OD and OT. Nevertheless, it has been argued that these innovations adapt best depending on the environmental characteristics and learning innovation strategies. It is also true that these innovations do not fit into the same cell. The efficacy of these intervention strategies depends on the nature of the accounting innovation: technical, or administrative, and systemic, or autonomous. ABC has been described as a multi-phased management accounting innovation that is best initiated as a technical, stand-alone innovation in organic structures but best implemented as an administrative systemic innovation in a mechanistic organization. ABC has OD and OT intervention aspects that can be utilized to facilitate the successful initiation and implementation of both technical and administrative innovations in an organization's operating activities.

External environmental influences, including competition, requires organizations to adapt, change, and renew their business conditions (Beatty & Ulrich, 1991; Duck, 1993). The institutional approach suggests that crisis brought about by internal and external environmental conditions creates an organizational setting that can be responsive to innovative technological and administrative innovation. Many industrial organizations have adopted either the mechanistic, organic, OD or OT process innovation strategy to align their accounting information reporting requirements with changes in technological developments in their manufacturing and production systems. The multi-dimensional aspects of ABC as both a technical and an administrative process innovation have been supported by bureaucratic centralized as well as divisionalized decentralized organizational structures.

However, there are potential barriers to the diffusion of ABC as an administrative innovation programs in an organization, particularly in the design of internal control and auditing systems (Johns, 1993, pp. 576–583). Organizational impediments arising from mechanistic structures, management hierarchy, and lack of functional coordination create bottlenecks in the design and implementation of ABC and other accounting innovation changes. The OD intervention strategy if followed by an incremental step-by-step single loop learning strategy minimizes process issues of behavioral and cultural change that affect the design and implementation issues associated with ABC. However, management accounting innovation, particularly ABC, still experiences innovation lags. Nevertheless, recent technological advancements in computerized information systems have quickened the pace of innovation in accounting and internal control systems. However, there remains substantial disparity among organizations in the adoption and diffusion of accounting innovation, including ABC. Despite those differences, the institutional adaptation approach for management control systems suggests that ABC can be successfully implemented if it is systematically integrated within the framework of OD as an administrative or OT as a technical intervention strategy.

In conclusion, it is suggested that the process innovation typologies: mechanistic, organic, OD and OT, described in Table 1, present an organizational framework for the study of management accounting innovations, particularly ABC. Section 3 of the paper substantiated the utility of OD and OT intervention approaches with management accounting innovation experiences with ABC. Research in management control can benefit from the application of these four types of process innovation strategies for studying the relationships among organizational change: incremental and radical strategies, learning approaches: single and double loop, and environmental issues: internal and external factors. Behavioral accounting researchers can selectively choose the process innovation typology depending on the mix of environmental conditions and organizational change/learning approaches best suited for an organization to initiate and implement process innovation strategies in their management control systems.

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EDI ADOPTION: CONTROLS IN A CHANGING ENVIRONMENT

TerryAnn Glandon

ABSTRACT

This study investigates the critical factors that influence decisions regarding a change in management accounting controls after implementation of electronic data interchange (EDI). A field study of 235 small businesses was conducted, using hierarchical regression to test Ajzen's (1991) theory of planned behavior. The results indicate that attitude and stakeholder perceptions influenced decisions, although management had no immediate plans to modify controls. Firm size and accounting system complexity also affected decisions. Surprisingly, limited financial and human resources were not influential.

Small business executives may be unwilling to modify controls because they may not fully understand the risks when accounting systems and/or business practices are changed. This situation may have a serious impact on businesses and their trading partners. It is cause for concern because of the predicted growth of electronic commerce. By demonstrating the link between emerging control issues and system design, owners and managers may be more likely to respond to third party concerns.

INTRODUCTION

Electronic commerce (e-commerce) concerns represent almost one third of the top ten technology issues affecting businesses today, according to The American

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Institute of Certified Public Accountants (AICPA, 2001). This is not surprising because electronic business processes are replacing traditional paper-based accounting information systems in most enterprises, regardless of size. As businesses adopt these new technologies, management accounting controls should be evaluated to determine whether they continue to meet the needs of the organization.

Prior management accounting research has addressed organizational changes such as adoption of just-in-time inventory (JIT) and electronic data interchange (EDI). These studies are limited to large, publicly traded companies (Nicolaou, 2001), are experimental (Evans et al., 1994), or utilize a specific methodology to determine the best choice for an internal control system (Lee & Winch, 1998). There has been little or no research in the small business environment. The current study addresses this with a field study of small business executives after the company has adopted EDI.

The remainder of the paper is organized as follows: The next two sections provide motivation and an analysis of prior research. The subsequent section explains the theory tested in the study, followed by a section describing the survey method. The next section presents the results. The final section includes the conclusion and implications, as well as limitations of the study and suggestions for future research.

MOTIVATION

Back-office operations required to support e-commerce processes must be understood by managers, internal auditors, and accountants. Integration of new technology goes beyond simply learning new system menus or commands to obtain desired output. For example, Microsoft's Net e-application lets computer systems talk to one another: A mouse click by the purchasing agent to buy inventory automatically updates the accounting and inventory systems. In the past, that has been handled manually, with a human review of the transaction at various phases.

The form of e-commerce discussed in this paper is electronic data interchange (EDI). As with all forms of e-commerce, EDI introduces new complexities in initiating, recording and executing business transactions. This creates a control risk that cannot be effectively managed by traditional control structures and procedures. At the same time, the electronic audit trail virtually eliminates the supporting documents and authorizing signatures provided by traditional documents. Furthermore, the increased speed with which individual transactions are processed makes it more difficult to identify and correct errors in a timely manner (Aggarwal & Rezaee, 1994; Hansen & Hill, 1989; Weiner, 1995).

In their study of control changes after EDI adoption, Sriram et al. (2000) found that management employed a relatively basic control structure, focusing on prompt recording and reporting or resolution of irregularities. There was very little emphasis on segregation of duties, matching header/trailer content, or batch processing controls. They recommend further research in the area of management's support for EDI control enhancements.

LITERATURE ANALYSIS

Research on control modifications after organizational changes has received some attention in information systems research (c.f. Hansen & Hill, 1989; Norris & Waples, 1989; Paulson, 1993). Nevertheless, in spite of the fact that accounting professionals typically are responsible for allocating resources to implement control changes, the topic is relatively new in management accounting research.

There are a few exceptions: For example, Lee and Winch (1998) demonstrated the feasibility of using value engineering methodology to determine optimal changes in the control system after an organization adopts JIT. This may prove to be a valuable tool to determine appropriate control changes for larger organizations that have the necessary resources.

Nicolaou (2001) conducted an empirical study of publicly traded companies that used JIT and EDI. He examined the effect of the interaction between a firm's cost management system and its strategic system on a financial manager's performance in carrying out cost management tasks. Nicolaou (and others) postulate that the "use of EDI systems helps coordinate the procurement of resources and delivery of finished products with internal production activities, as well as promoting . . . the control of costs throughout the supply, production and delivery processes" (p. 208). This argument holds as long as the cost management system is reliable – which would require that existing management accounting controls be modified for the new electronic environment. The results of the current study illustrate that it is not always possible to have this assurance.

Evans et al. (1994) concluded that owners are concerned about the reliability of their company's financial information. While owners valued wealth (as expected), they also were concerned about accountability by managers and other employees. In their experimental study, owner-subjects were willing to forego increased profits by selecting an accounting system where manager-subjects had no opportunity to manipulate earnings.

Although an interesting experiment, it is possible that these results do not always hold outside the laboratory setting. The current study found that small business executives had little intention to change controls after EDI implementation.

Existing management accounting research on control changes has not addressed small businesses, despite the fact that there are almost six million companies in the U.S. that fall in that category[1] (SBA, 2001). Strong controls are as important in small organizations as they are in larger ones, although it is acknowledged that the controls may differ substantially (*The COSO Report* – Coopers & Lybrand, 1992). It is generally believed that direct involvement by the top executive is adequate compensation for less sophisticated control systems. Nonetheless, supervision by top executives who do not fully understand the technological implications of EDI may not be able to provide such compensating controls. This is one of the research questions examined in the current study.

THEORY OF PLANNED BEHAVIOR

The theory of planned behavior (TPB) developed by Ajzen (1987, 1989, 1991) is an extension of the theory of reasoned action (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975). The two theories share three common variables and underlying behavioral constructs. The same methodologies are employed in both theories: a small sample group is used to complete an elicitation study to ascertain specific elements of a questionnaire. The final questionnaire is administered to a larger group to examine correlations between underlying beliefs and measures of the common variables. Hierarchical regression and correlation analysis are the statistical techniques usually employed on both theories in order to predict and understand behavioral intentions. The TPB is considered to have three separate levels of analysis. These levels of analyses are illustrated in Fig. 1.

Starting with the right side of the model, behavioral action is shown to be the first level. It is a function of behavioral intention, which mediates all other variables that influence behavioral action. The second level is behavioral intention, which is determined by the motivational factors attitude, subjective norm, and perceived control. They, in turn, are determined by behavioral beliefs, normative beliefs, and control beliefs. The TPB is based on the supposition that individuals use information that is available to them. Rather than acting automatically without forethought, they consider the intentions of their actions before they decide to engage or not engage in a given behavior. In other words they *reason out* their actions (Ajzen & Fishbein, 1980).

One of the assumptions of the TPB is that the immediate determinant of behavioral actions is the behavioral intention to act. This makes it relatively easy to predict a behavioral action once behavioral intention has been determined, often by simply asking the individual what he or she plans to do (Ajzen & Fishbein, 1980). The assumption holds as long as the individual has substantial influence on the behavior in question, which Ajzen (1987, 1989, 1991) defines as being under the volitional control of the individual. The relation among behavior, intention,

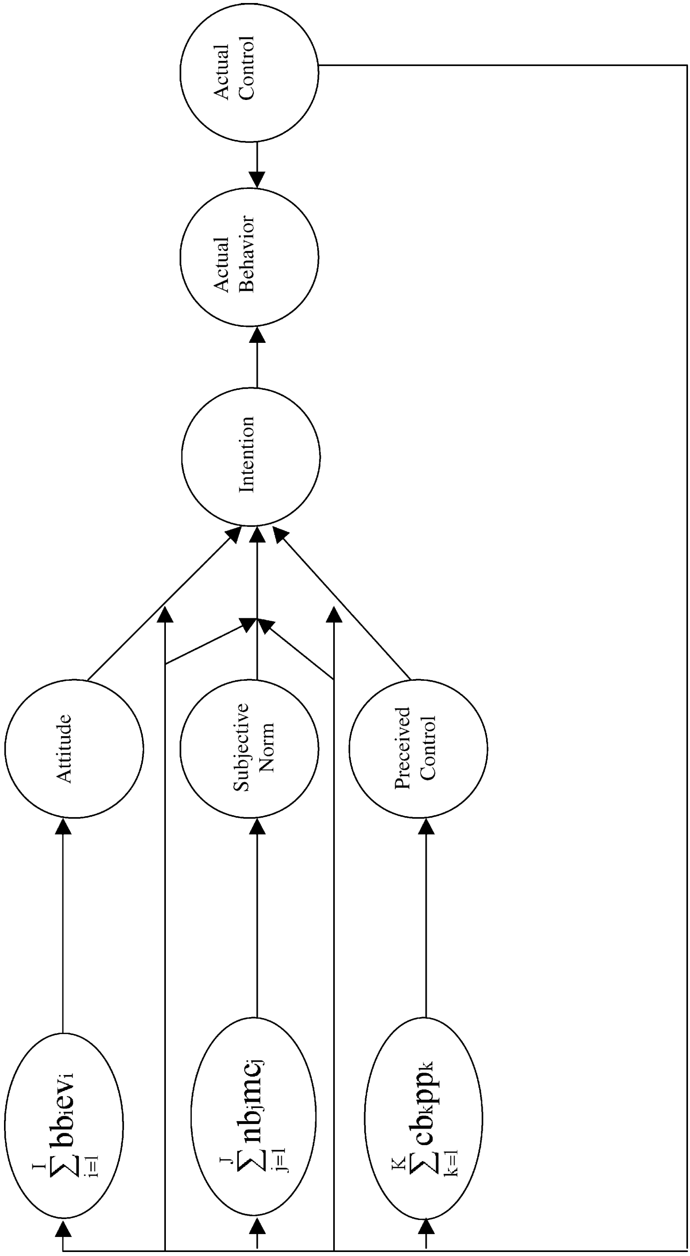

Fig. 1. Theory of Planned Behavior.

attitude, subjective norm, and perceived control is presented in Eq. (1):

$$\text{Behavior} = \text{Intention}_\text{B} = w_1(A_\text{B}) + w_2(\text{SN}_\text{B}) + w_3(\text{PC}_\text{B}) \tag{1}$$

where:

A_B = individual's attitude toward the behavior;
SN_B = individual's subjective norm regarding the behavior;
PC_B = individual's perceived control regarding the behavior;
w_B = relative weights assigned to attitude and subjective norm.

The linear combination of weighted measures of attitude, subjective norm, and perceived control are expected to predict behavioral intention. Furthermore, significant correlations between behavioral intention and attitude, behavioral intention and subjective norm, and behavioral intention and perceived control are expected.

Researchers should be able to predict certain behaviors using the TPB. However, it goes beyond merely predicting behavior – it also attempts to *understand* the behavior. To accomplish that understanding requires identification of the determinants of the behavioral intention. Those determinants are *attitude toward the behavior*, *subjective norm*, and *perceived control toward the behavior*. Attitude is defined as the individual's positive and negative evaluation of performing the behavior; subjective norm as the individual's perception of the social pressures to perform or not perform the behavior; and perceived control as the individual's perception of available resources/opportunities and obstacles/impediments to performing the behavior.

All three factors are determinants of behavioral intention; however, they are not necessarily equally influential. Ajzen and Fishbein (1980) suggest that each factor has a relative weight. The weight varies, depending on the individual, circumstances or behavior. They assert that the assignment of relative weights to each determinant improves the explanatory value of the theory.

The third level of the TPB provides a more complete understanding of behavioral intention because it goes beyond simple prediction of behavioral intention and behavioral action to determine *why* individuals hold certain attitudes and perceptions about social pressures and controls. Underlying an individual's attitude are *behavioral beliefs*. Behavioral beliefs are comprised of two constructs: the consequence of the behavioral action and the evaluation of the behavioral action. To obtain an estimate of attitude, the subjective probability (belief) that performing the behavior will result in a particular outcome is multiplied by the evaluation of that outcome and summed over *I* behavioral beliefs. This relationship is presented in Eq. (2):

$$A_{\mathrm{B}} = \sum_{i=1}^{I} bb_i ev_i \tag{2}$$

where:

A_{B} = attitude toward the behavior;
bb_i = belief or subjective probability;
ev_i = evaluation of outcome subjective norm.

For the current research, attitude is defined as follows: A manager who believes that modification of management accounting controls is necessary to be assured of accurate financial information is more likely to evaluate positively the behavioral action of changing those controls. On the other hand, a manager who believes that modifying management accounting controls is an unnecessary expense would be more likely to hold a negative attitude toward that behavior, and is therefore less likely to authorize such changes.

Underlying subjective norm are beliefs that are comprised of two constructs, termed *normative beliefs*. These are important others (also known as social referents), and the degree of motivation that the individual possesses to comply with them. To obtain an estimate of the subjective norm, the normative belief is multiplied by the motivation to comply with the salient social referent. The sum is over the J normative beliefs; Eq. (3) depicts this relation.

$$\mathrm{SN} = \sum_{j=1}^{J} nb_j mc_j \tag{3}$$

where:

SN = subjective norm;
nb_j = normative belief concerning referent j;
mc_j = motivation to comply with referent j.

For the current study, subjective norm can be described as the manager's level of motivation to comply with: (1) the accountant who approves of control changes; or (2) the employees who disapprove of the changes because their job responsibilities will change.

Actual behavioral control has not yet been defined or assessed at a global level (Ajzen, 1987) so an individual's *perceptions* of the control he or she has over events has been used in its place. Perceived control is defined as the individual's "perception of the ease or difficulty of performing the behavior of interest" (Ajzen, 1991, p. 183). He proposes that perceived control is appropriate as a surrogate for a measure of actual control – that actual control often is very difficult to measure and as long as the individual's perceptions are accurate, perceived control is an appropriate substitute. The accuracy of the perception a decision-maker has about the actual control over a behavior can be affected by several factors. Some are internal (skills, abilities, knowledge), and others are external, such as timing, because requirements or available resources may change over time; the opportunity to achieve the behavior in question; and cooperation of others.

Control beliefs underlie perceived control. They are beliefs about resources, opportunities and potential barriers to behavioral action. To obtain an estimate of perceived control, each control belief is multiplied by the perceived power of the particular control factor to facilitate (or obstruct) the performance of the behavior. The sum is over the K control beliefs. The relation is depicted in Eq. (4):

$$\mathrm{PBC} = \sum_{k=1}^{K} cb_k pp_k \tag{4}$$

where:

PBC = perceived control toward the behavior;
cb_k = control belief of k;
pp_k = perceived power of k.

For the current research, perceived control can be described as the manager's lack of understanding of the appropriate controls, available financial resources, and the skills and cooperation of employees.

Hypotheses Development

Attitude, subjective norm and perceived control have been reliable predictors in prior business research. For example, attitude has been found to be an important predictor in microcomputer software usage (Davis et al., 1989; Mathieson, 1991); employees' preference between e-mail and voice mail (Adams et al., 1992); and decisions of senior executives regarding adoption of a specific information technology (Harrison et al., 1997). Subjective norm had predictive qualities in Liker and Sindi's (1997) study of whether accountants would use an expert system, and in Hartwick and Barki's (1994) study of required/voluntary users of a particular information technology. Finally, perceived control added explanatory power to the model when an individual does not have complete volitional control, such as the small business executive's decision to adopt a particular information technology (Harrison et al., 1997). Also, Mathieson (1991) and Taylor and Todd (1995) found that adding perceived control improved predictive ability of their studies. Hypothesis 1 is stated in the alternative form:

H_1. In the small business environment the manager's decision (intention) to support modification of controls is a positive linear function of: (a) his or her attitude toward; (b) the subjective norm regarding modification of; and (c) his or her perceived control over achieving modification of those controls.

Ajzen (1987, 1989, 1991) considers the three determinants to be *sufficient* to explain and predict intentions. In other words, all "external" variables are mediated by attitude, subjective norm and perceived control. Hypothesis 2 tests whether attitude, subjective norm, and perceived control are sufficient, or whether external variables have a direct effect on behavioral intention. It is stated in the alternative form as follows:

H_2. Attitude, subjective norm, and perceived control are the only variables that directly affect intention and are sufficient to predict and explain executive decisions (intentions) to change controls.

The third level of research questions is comprised of three hypotheses that represent the underlying beliefs (behavioral beliefs, normative beliefs, and control beliefs) discussed earlier. Measures of attitude, subjective norm and perceived control were broken into their constituent elements and tested to determine whether their multiplicative form provided a better explanation than their additive form. A high, positive correlation is expected between global measures of attitude, subjective norm, and perceived control, and the belief-based components of each one (Ajzen & Fishbein, 1980). Nevertheless, such correlations do not provide adequate evidence that the constructs arise from multiplicative composites (Harrison et al., 1997). Hypotheses 3a–c test this premise:

H_{3a}. Attitude toward the modification of the control system is an additive function of beliefs about the likelihood of anticipated consequences, with each belief multiplied (weighted) by a judgment of the value of that consequence.

H_{3b}. Subjective norm with respect to changing the control system is an additive function of beliefs about expectations of salient social referents, with each belief multiplied (weighted) by a judgment about the firm's motivation to comply with that referent.

H_{3c}. Perceived control over the modification of the control system is an additive function of beliefs about the likelihood of anticipated obstacles or barriers to modification, with each belief moderated by a judgment about the adequacy of the firm's resources for overcoming the obstacles.

External Variables

Ajzen (1991) asserts that the TPB is sufficient to explain and predict behavioral intentions (tested in Hypothesis 2). Prior research has found that this is not always the case – that certain external variables affect intentions. In this study, it was expected that two external variables may moderate (interact with) managers' decision about changing controls.

Size

Large organizations have stronger controls than smaller businesses (Icerman & Hillison, 1990; Kreutzfeldt & Wallace, 1986; Wallace & Kreutzfeldt, 1995). The current research is limited to businesses with fewer than 500 employees. Of interest in this study is whether the size of the organization (within the SBA's definition of a small business) affects the manager's intention to modify management accounting controls, beyond the effects of the theoretical variables.

Harrison et al. (1997) found that larger firms relied more on subjective norm to make decisions and that firm size had a neutralizing effect on both the attitude ⇔ intention relation, and the perceived control ⇔ intention relation. Hypothesis 4 tests for interaction between firm size and the three main constructs. It is stated in the alternative form as:

H_4. The size of the firm will moderate the effects of attitude, subjective norm and perceived control on the manager's decision (intention) to support modification of controls.

Complexity

The number of accounting modules available in the accounting software influences the complexity of the system. Companies that utilize multiple modules probably would have a more complex system than those that use only one or two modules. Eight modules were listed in the questionnaire with the request that the respondent indicate the modules being used. A variable (COMPLEX) was created to count the number of modules respondents marked on the survey form.

Magal and Lewis (1995) assert that small businesses do not have the resources for sophisticated and complex information systems, suggesting that it may not be possible to untangle the size of the firm from the type of information system it possesses. However, this was not an issue in the current study. The majority of firms were very small, with 78% employing fewer than 50 employees; yet, most firms (59%) reported their information systems contained at least five (out of eight) modules.[2] Stated in the alternative form, Hypothesis 5 tests whether system complexity has an interaction effect on attitude, subjective norm, and perceived control:

> **H_5.** The complexity of the firm's accounting information system will moderate the effects of attitude, subjective norm and perceived control on the manager's decision (intention) to support modification of controls.

The next section will describe the survey method used in the study.

RESEARCH METHODOLOGY

An elicitation survey was created and administered to a sample group of business executives. Twenty-four responses were received and content analyzed. Two raters individually coded the responses, then met to discuss and reach a consensus on the final categories. A final survey was created using the most salient responses. The survey was pilot-tested and additional examples of controls were added for clarity. The survey was administered to business executives who were not involved in the elicitation survey. A copy of the final survey is included in the Appendix.

Sample Identification

The Small Business Administration (SBA) was the source of business contacts for this research. Businesses registered with the SBA typically employ between 1–500 employees, allowing comparison with prior studies that have been conducted in the small business environment. (e.g. Chen & Williams, 1998; Cragg & King, 1993; Iacovou et al., 1995; Tucker, 1997; Udo & Pickett, 1994). The SBA database consists of more than 171,000 small businesses located throughout the United States. A series of steps was taken to ensure that the highest quality responses would be obtained. Firms that had not updated their information within a year and those not registered as EDI users were eliminated. Over five thousand (5,096) businesses remained.

The questionnaire was sent to a random selection of over 1,000 SBA members in southern states. Nine firms were eliminated because of incomplete addresses. Also, branch offices ($n = 3$) were removed because organizational decisions such as management accounting controls usually are developed at the firm's headquarters, rather than at a branch office. The number of firms from each state is reported in Table 1.

Table 1. Descriptive Data – Target Sample.

Firms Selected from Each State		Average Annual Revenue	
State	Number of Firms	Revenue	Number of Firms
Arkansas	42	Less than $500,000	261
Arizona	56	$500,000–$1 million	166
Colorado	125	$1–$2.5 million	178
Kansas	106	$2.5–$5 million	151
Louisiana	95	$5–$10 million	176
Missouri	124	$10–$25 million	63
New Mexico	44	$25–$50 million	21
Nevada	41	$50–$100 million	5
Oklahoma	49	Blank	49
Texas	358		
Utah	30		
Total	1,070	Total	1,070

Surveys were sent with a personally signed cover letter and postage-paid return envelope. A reminder postcard was mailed to the entire sample three weeks after the initial mailing. Shortly thereafter, all firms that had not yet responded were mailed another personally signed cover letter, survey form and postage-paid envelope. To reassure the participants of confidentiality, they were asked to *not* write their name or the company's name on the survey form. As an incentive to complete and return the survey, the cover letter stated that each participant who returned a business card would be eligible for a drawing for a free copy of *Microsoft Office 2000*.[3] Four addresses were incorrect with no forwarding address information available, resulting in a total of 1,066 surveys that are assumed to have reached their destination. A total of 235 questionnaires were returned, or a response rate of 22% (235/1,066).

DATA ANALYSES

The target sample contains many very small businesses, with over half (57%) reporting average annual revenue of less than $2.5 million. Only 8% reported earning more than $10 million. Table 1 provides an analysis of the target businesses by average annual revenue.

The sample (1,066 firms) was compared to the comparable regional SBA database ($n = 5{,}096$) to ensure it represented SBA businesses. The SBA database does not provide firm size as measured by number of employees; consequently, a direct comparison was not possible. Firm revenue from the database was used as a substitute. The majority (80%) reported annual revenue of less than $10 million, 18% reported revenue of $10–50 million and 2% reported revenue of more than $50 million. This stratification by firm size is comparable to that of the sample, as reported in Table 1.

The majority of respondents owned or managed very small firms, with 78% reporting that they employ fewer than 50 workers. The median firm size was 150 employees. The distribution of firm size was positively skewed; therefore, the median is reported and the data were transformed for the purpose of analyzing any possible effect on intention. Table 2 reports the categories of firm size and industry classification.

Demographic data on the respondents revealed that 44% of the respondents were less than 45 years of age, with 31% between the ages of 46 and 55. Sixty-seven percent (157) were male, 32% (74) were female, and 1% (4) did not answer this question. Almost half (49%) listed their title as owner, president, or vice president (115); managers made up 19% (46); accountants and controllers represented 14% (34). The complete listing of respondents' positions is reported in Table 2.

Refining the Sample

The cover letter that accompanied the questionnaire requested that the respondent have some responsibility for the organization's control system. To help ensure that the form would be completed by the appropriate person, the following question was asked: "How much does your firm's decision to modify accounting controls depend on your personal opinion?" If the respondent indicated that he or she had no say in the control structure of the firm, that observation was dropped from the analysis. Seven questionnaires were completed by individuals who had no

Table 2. Descriptive Data – Sample.

Number of Employees		Industry Type		Respondents' Positions	
1–50	78%	Manufacturing	34%	President/Owner	90
51–100	14%	Service	21%	Vice President	25
101–200	4%	Retail/Whsl	16%	Manager	46
201–300	1%	Distribution	15%	Accountant/Controller	34
301–400	1%	Construction	8%	Director/Other	12
401–500	1%	Other	6%	Blank	28
Blank	1%				
Total	100%	Total	100%	Total	235

responsibility for the control system; responses from those forms are not included in the analysis.

Management accounting controls may be modified over a relatively short period of time, rather than immediately upon a change in the AIS. While a gradual change is not optimal with respect to safeguarding the company's assets, expecting an immediate change is problematic. It was anticipated that most of the firms would be somewhere in the *process* of modifying controls and it was likely that some would have made all necessary changes. To determine this, the following question was asked: "Approximately how many accounting control changes already have been made?" The executive was asked to mark on a scale ranging from "None" to "All Planned Changes." Nineteen firms had made all changes. Because the TPB is concerned with *intention* to perform a specific behavior, these observations were dropped from further analysis.

Survey Results

Table 3 presents the results of the survey in summary form. With the exception of subjective norm, each construct included at least three items. The underlying beliefs for subjective norm and perceived control each contained six items; attitude contained ten. The table presents the number of items used to measure each construct or underlying belief, the mean response and standard deviation.

Reliability of Measures

Cronbach's alpha was used to measure the internal consistency of the questionnaire items for each construct. The reliability estimates (alpha) for measures of behavioral intention was 0.82, attitude was 0.95, subjective norm was 0.85, and

Table 3. Summary of Measurements.

Measure	Number of Items	Mean	Standard Deviation
Behavioral Intention (BI)	3	−0.50	1.69
Attitude (ATT)	4	0.56	1.33
Subjective Norm (SN)	2	0.13	1.62
Perceived Control (PBC)	3	0.45	1.22
$\sum bbev$	10 bb, 10 ev	5.20	14.75
$\sum nbmc$	6 nb, 6 mc	10.44	34.52
$\sum cbpp$	6 cb, 6 pp	5.80	17.56

perceived control was 0.69. The first three values shown are considered highly reliable. The reliability for PBC, however, warranted further investigation.

Business executives had been asked to indicate: (1) whether modifying controls would be easy/difficult; (2) whether modifying controls is under/out of the firm's control; and (3) whether modifying controls is simple/complicated to accomplish. These three items represent the overall PBC measure. Executives were almost neutral in their responses about the difficulty (mean $= -0.30$) and possible complications (mean $= -0.08$) in modifying controls, but they considered it to be within their control (mean $= 1.72$). It is possible that they interpreted the statement to mean that it was *their* decision (rather than a trading partner's decision) of whether or not to make any changes. This is an area that needs to be studied more closely in future research.

Hypothesis Testing

Multiple regression was used to test each of the previously stated hypotheses. Previous research has demonstrated that multiple regression is the most appropriate method for this research model (Harrison et al., 1997; Mathieson, 1991). Two of the independent variables had a skewed distribution. Firm size (SIZE) was positively skewed, with the majority of the firms employing fewer than 50 workers. The variable was log-transformed to reduce the inflated leverage of firms at the upper end. System complexity was negatively skewed, with the majority of respondents reporting that all eight accounting modules were computerized. Because system complexity (COMPLEX) was negatively skewed, the observations were inverted and the log was taken of the inverted data.

Residual diagnostics were analyzed for departures from the assumptions of normality, equal variance, independence and linearity. There were no severe departures from these assumptions.

Results of Hypotheses Tests

The first hypothesis predicts that the manager's decision (intention) to support modification of controls is a positive linear function of (a) attitude toward controls, (b) subjective norm regarding modifying controls and (c) perceived control over modifying controls. Table 4 presents the values for the standardized coefficients and the change in R^2 for each successive stage in the modeling process.

Attitude and subjective norm each explained a unique portion of the variance in intention, partially supporting Hypothesis 1. Perceived control was not significant.

Table 4. Results of Hypotheses 1 and 2.

Hypothesis 1 Using Multiple Regression			Hypothesis 2 Using Hierarchical Regression		
Standardized Variable	Change in R^2	Coefficient	Standardized Variable	Change in R^{2}[a]	Coefficient
ATT	0.35	0.29*	$\sum bbev$	0.00	
SN	0.17	0.51*	$\sum nbmc$	0.00	
PBC	0.00	−0.01	$\sum cbpp$	0.00	
			Lsize	0.02	−0.06*
			Lcomplex	0.03	0.06**
Adj. R^2 = 0.51; $F_{3,165}$ = 58.2; * $p < 0.0001$			* $p < 0.05$; ** $p < 0.001$; Adj. R^2 = 0.56		

[a] At successive stages of the modeling process.

Two issues may have had an impact on the lack of influence of perceived control. First, it is possible that the respondents may consider themselves "in control" of most or all aspects of their business without analyzing particular aspects that may prevent them from having complete control. Ajzen (1991) addresses this when he suggests that it is "possible that the global measures evoke a relatively automatic reaction whereas the belief-related items evoke a relatively reasoned response." (p. 197) The second issue relates to the unique characteristics of owners and managers of small businesses. The data suggest that they fail to incorporate control-related information into their decisions about modifying accounting controls. Implications of this result will be discussed in the conclusion.

Hypothesis 2 tested whether the TPB is sufficient to explain and predict the manager's decision to modify controls. External variables of interest (firm size and complexity of the accounting information system) and the underlying behavioral, normative, and control beliefs were each tested using hierarchical regression. The results are presented in Table 4.

Only part of Hypothesis 2 was supported. The results indicate that the (log of) firm size and (log of) complexity *directly* affected managers' decisions on whether or not to modify controls. Previous research has found that: (1) firm size had a moderating effect on the theoretical variables; and (2) smaller firms had weaker controls. Therefore, it is logical to suggest that firm size may influence the small business owner's decision about changing controls. Fewer of the smallest firms had made substantial control changes – 77% reported they had made no changes, only 43% of the larger firms had made no changes. Therefore, the negative coefficient for LSIZE is not unexpected. Hypothesis 4 predicted a moderating effect of firm size on the constructs of behavioral intention. This hypothesis was not supported by the data.

Table 5. Results of Hypotheses 3a–c and 5.

Hypotheses 3a–c			Hypothesis 5		
Variable	Coefficient		Standardized Variable	Change in R^{2a}	Coefficient
3a ATT					
$\sum bb$	0.015	$F_{3,175} = 25.8^*$	Complex × ATT	0.03	0.26*
$\sum ev$	0.053	Adj. $R^2 = 0.29$	Complex × SN	0.00	
$\sum bbev$	0.031		Complex × PBC	0.00	
3b SN					
$\sum nb$	0.048				
$\sum mc$	0.030	$F_{3,175} = 40.3$			
$\sum nbmc$	0.019	Adj. $R^2 = 0.40$			
3c PBC					
$\sum cb$	−0.021				
$\sum pp$	−0.027	$F_{3,175} = 4.2$			
$\sum cbpp$	−0.002	Adj. $R^2 = 0.05$			
* $p < 0.01$			Adj. $R^2 = 0.56$; $p < 0.01$		

[a] At successive stages in the modeling process.

Hypothesis 5 predicted that system complexity would moderate the constructs of behavioral intention. This hypothesis was partially supported, with respect to the interaction effect of attitude on intention. The results, presented in Table 5, indicate that attitude had a stronger effect on the decision-making process of owners/managers of firms that used more complex information systems.

Residual diagnostics were used to check for correlations between independent variables. There is a relatively weak ($r = 0.14$) positive correlation between (log of) firm size and (log of) system complexity that is considered to be statistically significant ($p = 0.05$). The weak correlation does not indicate serious multicollinearity.

Correlation Analysis

Correlations among attitude, subjective norm and perceived control with their underlying beliefs were as follows: attitude ($r = 0.45$, $p < 0.001$) and subjective norm ($r = 0.62$, $p < 0.001$) were significant and in the expected direction. Perceived control ($r = -0.18$, $p < 0.007$) was significant but not in the expected direction. As discussed previously, this may be a result of managers' unique responses to the question regarding whether they considered changing controls to be under their control.

According to the theory of planned behavior, simple correlations do not provide unequivocal evidence that attitude, subjective norm and perceived control arise from their multiplicative composites. Hypotheses 3a–c tested whether the multiplicative form of beliefs provides unique prediction of each construct beyond that of the additive form. As reported in Table 5, only Hypothesis 3a (attitude) was supported.

CONCLUSIONS AND IMPLICATIONS

With reduced software and hardware costs, organizations of all sizes are adopting e-commerce technologies to streamline their operations. Some adopters will consider electronic data interchange simply a means of reducing the exchange of paper documents and will fail to conduct a thorough analysis of their accounting information systems and business practices. Organizational changes without control changes could contribute to undetected errors or fraud, affecting the reliability of the financial and management accounting reporting systems. The viability of the entire organization may be at stake.

Changing controls was not considered to be a high priority by the owners or managers who completed the survey. One of the questions on the survey form asked "Prior to receiving this survey, how often have you thought of changing accounting controls after EDI adoption?" The question was scaled from "never" to "frequently" (1 to 7). The mean response was 2.5, indicating that few business executives had considered changing controls. This is disturbing because 194 executives (82%) reported that they had 50% or more responsibility for the firm's control structure. Ninety-two executives (39%) reported the control system was solely their responsibility. It is possible that they are more concerned about competition, production and/or operations, and less sensitive to control issues.

Anecdotal information regarding small business executives and their disregard for accounting controls has existed for some time. This study provides empirical evidence of the phenomenon by measuring the constructs of the theory of planned behavior. Fishbein and Ajzen (1975) suggest that the attitude toward a behavior can be influenced by changing salient beliefs about the behavior or by changing evaluations associated with those beliefs. They assert that the first step in *changing* a behavior is to predict and understand the intention to perform the behavior. By determining which aspects of the theory influence executives' decisions, it may be possible to increase their sensitivity to the risks associated with the lack of adequate controls and appreciation for a secure control environment. The findings of this study may help to clarify and emphasize the importance of adequate controls, especially in a changing control environment.

Implications of the Study

Subjective norm and attitude were found to have an impact on executives' decisions about modifying controls. As important social referents, accountants are in a position of influence. They should continue to emphasize the importance of strong controls.

This study contributes to management accounting research by investigating control changes in the small business environment, which could include a large segment of U.S. businesses. It identifies potential weaknesses in the ability of trading partners to implement controls in the electronic environment. Smaller trading partners may be at risk and, without realizing it, may be placing all of their trading partners at risk. Further research is necessary to determine if this phenomenon is limited to this particular sample. It is possible that it is indicative of behavior exhibited by the majority of executives of small businesses, which could have serious implications for any firm considering an electronic trading-partner relationship.

Limitations of the Research

The data for this study were collected from self-reports of owners and managers. This data collection method increases the potential for inflated correlations between dependent and independent variables due to common method variance, a limitation of the theory of planned behavior (Ajzen, 1991).

Another limitation is that the data in this study were correlational. The patterns observed are not sufficient to infer that attitude, subjective norm and perceived control all have causal influence on the decision to modify controls. However, Ajzen (1988) reports many lab experiments and field experiments of the TPB support the causal impact of these components on decisions.

A third limitation is that the study was restricted to a geographical region. Mail surveys have proliferated in the last decade and business executives can be overwhelmed with requests for information. Many of these surveys are discarded, with response rates diminishing over the years; response rates in the low teens are not uncommon. To increase the reliability of this study by obtaining the highest response rate possible, a regional survey was conducted. A national survey is suggested for future research to determine whether the results are comparable.

Future Research

The majority of businesses in this study were very small firms with fewer than 50 employees. Firm size had a direct effect on the manager's decision. It would be instructive to discover whether the results would be comparable when the sample contained a greater percentage of larger firms.

In the elicitation survey a small representative sample listed salient obstacles that might prevent executives from changing controls. Nonetheless, respondents who completed the final survey form may have misinterpreted the questions, leading to the unexpected result with respect to perceived control. Potential obstacles and control perceptions should be clarified to obtain more precise measurement.

Finally, it is suspected that small businesses engaging in e-business on the Internet (B2B) have even less regard for strong controls than those using the more structured EDI format. Research on companies conducting this type of activity would be beneficial because of the projected growth of B2B.

CONCLUSION

This research suggests that business executives of small enterprises are influenced by their attitude and by their perception of whether stakeholders will approve or disapprove of control changes. Two external variables, firm size and accounting system complexity, also had an impact on their decision. Executives in smaller firms were more likely to modify controls; this is probably due to the fact that they had made fewer changes to date. System complexity interacted with attitude, suggesting that the executive's attitude was more important in firms with more complex systems. Unexpectedly, limited financial and human resources did not influence their decisions.

Overall, the owners and managers who completed this survey had no strong motivation to modify controls after EDI adoption. It is possible that they are not aware of the increased business risk associated with changing accounting systems and business practices without a corresponding change in management accounting controls. An inadequate control system can have serious implications for *all* trading partners due to the interaction involved in e-business activity. This study may help executives of small enterprises develop sensitivity to reduce the business risks associated with electronic commerce.

NOTES

1. The Small Business Administration (SBA) defines a small business as an independent business (not a sub-unit of a larger organization) that employs fewer than 500 employees.
2. Modules cited most often were Accounts Payable, Accounts Receivable, EDI, General Ledger, Purchase Order and Sales Order.
3. Thirty-six respondents included their business cards to register for the drawing.

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APPENDIX

Examples of Accounting Controls

Manual or Partially Computerized System	*EDI System*
Authorization: Invoices and Purchase Orders are reviewed by a Supervisor before mailing	*Authorization:* Prices/quantities agreements are established with Trading Partners. Invoices and Purchase Orders are processed electronically without review; relying on pre-programmed computer controls

Appendix (*Continued*)

Examples of Accounting Controls	
Manual or Partially Computerized System	*EDI System*
Accounting Records: Paper audit trail of invoices, purchase orders, checks, receiving reports are available for daily operations and for review by accountant/auditor	*Accounting Records:* Very few paper documents exist. The audit trail still exists, but is in electronic format.
Access Controls: Maintain supply of invoices, purchase orders, checks, etc. in safe location. Limit access to computer terminals and use passwords	*Access Controls:* Limit access to computer terminals and use passwords
Segregation of Duties: Requiring two signatures on checks over a certain dollar amount	*Segregation of Duties:* No signatures are required for checks
Employee #1 orders inventory, Employee #2 inspects inventory upon receipt, Employee #3 issues check for payment of inventory	Inventory is ordered and paid for automatically, computer controls are based on pre-existing agreements with Trading Partners
Supervision: Review of printout of sales invoices, purchase orders or check register	*Supervision:* Review of printout of transaction sets (which do not resemble their paper counterpart)

INSTRUCTIONS

In this survey, sometimes you will use rating scales with seven places. Please put an 'X' in the place on the scale that best describes your opinion. Place your marks in the middle of the spaces, not on the boundaries.

For example, if you were asked to rate how GOOD or BAD **"the economy in the United States"** is on such a scale, and you thought the economy was EXTREMELY GOOD, then you would mark an 'X' on the scale as follows:

GOOD								BAD
	X							
	extremely	quite	slightly	neither	slightly	quite	extremely	

You will also be making ratings about how LIKELY or UNLIKELY something is. You will use the rating scale in the same way. For example, you might make a rating about the following:

If our firm adds employees, it is _______ that it will help us improve our service to customers/clients.

UNLIKELY								LIKELY
					X			
	extremely	quite	slightly	neither	slightly	quite	extremely	

In making your ratings, please remember the following points:

1. Please answer all the items - do not omit any, even if they don't seem to apply to you.
2. Never put more than one check mark on a single scale.

The purpose of this survey is to assess the impact of EDI on the accounting controls in small businesses. For your convenience, a few examples of such controls are listed on the facing page.

REMINDER - ALL OF YOUR ANSWERS ARE COMPLETELY CONFIDENTIAL. ONLY RESEARCH TEAM MEMBERS WILL EVER SEE YOUR ANSWERS.

USE OF ELECTRONIC DATA INTERCHANGE (EDI)

Does your company use EDI to exchange business documents with (check all that apply):

- ❑ CUSTOMERS
- ❑ SUPPLIERS
- ❑ OTHERS ___________________________(please describe)
- ❑ EDI IS NOT USED

If you marked “EDI IS NOT USED” do plans exist to adopt EDI (check one):

- ❑ WITHIN 6 MONTHS
- ❑ MORE THAN 6 MONTHS BUT LESS THAN 1 YEAR
- ❑ MORE THAN 1 YEAR
- ❑ NO PLANS TO ADOPT EDI AT THIS TIME

If EDI is currently being used or adoption plans exist, please continue with the remaining questions. If you marked “NO PLANS TO ADOPT EDI AT THIS TIME” please return the survey in the postage-paid envelope. Thank you for your support with this project

OPINION

How likely is it that your firm will modify accounting controls after EDI adoption?

UNLIKELY |______|______|______|______|______|______|______| LIKELY
extremely quite slightly neither slightly quite extremely

How certain are the plans to modify accounting controls after EDI adoption?

CERTAIN WE DO HAVE PLANS |______|______|______|______|______|______|______| CERTAIN WE DO NOT HAVE PLANS
extremely quite slightly neither slightly quite extremely

Our firm’s commitment to modifying accounting controls after EDI adoption is …

WEAK |______|______|______|______|______|______|______| STRONG
extremely quite slightly neither slightly quite extremely

How likely is it that most people or groups who are important to your firm would strongly approve of your firm modifying accounting controls after EDI adoption?

UNLIKELY |______|______|______|______|______|______|______| LIKELY
extremely quite slightly neither slightly quite extremely

Most people or groups who are important to your firm would …

DISAPPROVE |______|______|______|______|______|______|______| APPROVE
strongly somewhat slightly neither slightly somewhat strongly

It would be ________ for your firm to modify the accounting controls after EDI adoption. (Please mark each of the following four scales.)

GOOD |______|______|______|______|______|______|______| BAD
extremely quite slightly neither slightly quite extremely

HARMFUL |______|______|______|______|______|______|______| HELPFUL
extremely quite slightly neither slightly quite extremely

POSITIVE |______|______|______|______|______|______|______| NEGATIVE
extremely quite slightly neither slightly quite extremely

FOOLISH |______|______|______|______|______|______|______| WISE
extremely quite slightly neither slightly quite extremely

To your firm, modifying the accounting controls after EDI adoption would be…
(Please mark each of the following three scales.)

EASY |_______|_______|_______|_______|_______|_______|_______| DIFFICULT
extremely quite slightly neither slightly quite extremely

UNDER YOUR |_______|_______|_______|_______|_______|_______|_______| OUT OF YOUR
FIRM'S CONTROL FIRM'S CONTROL
extremely quite slightly neither slightly quite extremely
3

SIMPLE TO |_______|_______|_______|_______|_______|_______|_______| COMPLICATED
ACCOMPLISH TO ACCOMPLISH
extremely quite slightly neither slightly quite extremely

<u>Prior to receiving this survey</u>, …

how often have you thought of changing accounting controls after EDI adoption?

|_______|_______|_______|_______|_______|_______|_______|
never sometimes frequently

how many (approximately) accounting control changes already had been made?

|_______|_______|_______|_______|_______|_______|_______|
none approximately half all planned changes

How much does your firm's decision to modify accounting controls depend on your personal opinion? ___________%

FUTURE CONSEQUENCES

The items listed below have to do with the possible consequences you might associate with changing accounting controls in your firm after EDI adoption. (Mark the scale so that it completes the statement in a way that best expresses your opinion.)

If changes are made to the accounting controls in our firm after EDI adoption, it is …

UNLIKELY						LIKELY	
extremely	quite	slightly	neither	slightly	quite	extremely	that it will improve the accuracy of the accounting records.
extremely	quite	slightly	neither	slightly	quite	extremely	that it will improve the reliability of the firm's financial information.
extremely	quite	slightly	neither	slightly	quite	extremely	that it will decrease fraud or errors.
extremely	quite	slightly	neither	slightly	quite	extremely	that it will improve existing accounting controls.
extremely	quite	slightly	neither	slightly	quite	extremely	that it will improve the firm's recordkeeping efficiency.
extremely	quite	slightly	neither	slightly	quite	extremely	that it will improve the firm's recordkeeping consistency.
extremely	quite	slightly	neither	slightly	quite	extremely	that additional costs will be incurred.
extremely	quite	slightly	neither	slightly	quite	extremely	that training of employees will be required.
extremely	quite	slightly	neither	slightly	quite	extremely	that additional personnel will be required.
extremely	quite	slightly	neither	slightly	quite	extremely	that daily operations will be less efficient.

ASSESSMENT

In the previous section, you indicated your opinion on possible consequences associated with changing accounting controls. Please mark the scale that best expresses how positive (good) or negative (bad) you feel about those future consequences, in general.

GOOD						**BAD**	
extremely	quite	slightly	neither	slightly	quite	extremely	accuracy of the accounting records.
extremely	quite	slightly	neither	slightly	quite	extremely	reliability of the firm's financial information.
extremely	quite	slightly	neither	slightly	quite	extremely	decrease in fraud or errors.
extremely	quite	slightly	neither	slightly	quite	extremely	improvement in existing accounting controls
extremely	quite	slightly	neither	slightly	quite	extremely	improvement in recordkeeping efficiency
extremely	quite	slightly	neither	slightly	quite	extremely	improvement in recordkeeping consistency
extremely	quite	slightly	neither	slightly	quite	extremely	additional costs will be incurred
extremely	quite	slightly	neither	slightly	quite	extremely	training of employees will be required
extremely	quite	slightly	neither	slightly	quite	extremely	additional personnel will be required
extremely	quite	slightly	neither	slightly	quite	extremely	daily operations will be less efficient

POSSIBLE OBSTACLES AND BARRIERS

How likely is it that each of the following factors would affect your firm's ability to change the accounting controls after EDI adoption? (Mark the scale so that it best expresses your opinion.)

UNLIKELY						LIKELY	
extremely	quite	slightly	neither	slightly	quite	extremely	financial resources
extremely	quite	slightly	neither	slightly	quite	extremely	employee resistance to change
extremely	quite	slightly	neither	slightly	quite	extremely	unfamiliarity with new accounting controls
extremely	quite	slightly	neither	slightly	quite	extremely	sufficient time to implement new controls
extremely	quite	slightly	neither	slightly	quite	extremely	necessity of two accounting controls systems (one for EDI, one for existing system)
extremely	quite	slightly	neither	slightly	quite	extremely	training of employees

How <u>IMPORTANT</u> is each of the following factors for your firm regarding changing the accounting controls after EDI adoption? (Mark the scale so that it best expresses your opinion.)

IMPORTANT						UNIMPORTANT	
extremely	quite	slightly	neither	slightly	quite	extremely	financial resources
extremely	quite	slightly	neither	slightly	quite	extremely	employee resistance to change
extremely	quite	slightly	neither	slightly	quite	extremely	unfamiliarity with new accounting controls
extremely	quite	slightly	neither	slightly	quite	extremely	sufficient time to implement new controls
extremely	quite	slightly	neither	slightly	quite	extremely	necessity of two accounting controls systems (one for EDI, one for existing system)
extremely	quite	slightly	neither	slightly	quite	extremely	training of employees

SOCIAL FACTORS

How much would each of the following people or groups DISAPPROVE or APPROVE of your firm changing the accounting controls? (Mark the scale so that it completes the statement in a way that best expresses your opinion.)

	DISAPPROVE						APPROVE
employees would	strongly	somewhat	slightly	neither	slightly	somewhat	strongly
accountants or auditors would	strongly	somewhat	slightly	neither	slightly	somewhat	strongly
customers would	strongly	somewhat	slightly	neither	slightly	somewhat	strongly
suppliers would	strongly	somewhat	slightly	neither	slightly	somewhat	strongly
department managers would	strongly	somewhat	slightly	neither	slightly	somewhat	strongly
upper/top management would	strongly	somewhat	slightly	neither	slightly	somewhat	strongly

Please put an "X" in a space that indicates, IN GENERAL, how much your FIRM WANTS to do what the following groups or individuals think it should do. Mark one "X" per question. For example, if your firm always wants to do what the government thinks it should, you'd mark the "Very Much" part of the scale. If a question does Not Apply, write "NA" next to it.

IN GENERAL, how much does your firm usually want to do what …

employees think the firm should do?	not at all			somewhat			very much
accountants or auditors think the firm should do?	not at all			somewhat			very much
customers think the firm should do?	not at all			somewhat			very much
suppliers think the firm should do?	not at all			somewhat			very much
department managers think the firm should do?	not at all			somewhat			very much
upper/top management thinks the firm should do?	not at all			somewhat			very much

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On the following page are a few questions about you and your firm. Please take a few minutes to complete that section.

Organizational category:
❑ Government ❑ Service ❑ Manufacturing ❑ Telecommunications
❑ Retail/Whlsl ❑ Distribution ❑ Transportation
❑ Other ________________________ (describe)

Number of employees (approximate):
❑ Fewer than 50 ❑ 50–100 ❑ 101–200 ❑ 201–300
❑ 301–400 ❑ More than 500

Following is a list of computerized Accounting Information System packages. Check all that are used in your firm.

❑ ACCPAC	❑ Peach Tree
❑ CYMA	❑ Platinum
❑ Great Plains	❑ Progression
❑ Impact Encore	❑ Quick Books
❑ MAS 90	❑ RealWorld
❑ MICA	❑ SBT Pro
❑ One Write	❑ Solomon
❑ Other _____________________ (describe)	❑ Traverse

Following is a list of accounting functions. Check all that are computerized in your firm.

❑ Accounts Payable	❑ Inventory Management
❑ Accounts Receivable	❑ Job Cost
❑ Electronic Data Interchange	❑ Purchase Order
❑ General Ledger	❑ Sales Order

How would you describe your current involvement in accounting functions? (check all that apply)
❑ I prepare source documents (example: create Sales Invoices, prepare Accounts Payable checks, prepare Payroll).
❑ I perform bookkeeping functions (example: record cash receipts or payments, record shipment or receipt of inventory items).
❑ I prepare adjusting entries (example: calculate depreciation expense, etc.).
❑ I prepare financial statements.
❑ I supervise the accounting function.
❑ I review completed financial statements.
❑ I am not involved in the accounting function.

What is your current position or title?_______________________________________

Gender: ❑ Male ❑ Female

Age: ❑ Less than 35 ❑ 36–45 ❑ 46–55 ❑ 56–65 ❑ More than 65

Please briefly describe in your own words, what the term "internal controls" or "accounting controls" means to you:

Thank you for your valuable input.
Please return the survey in the postage-paid envelope.