

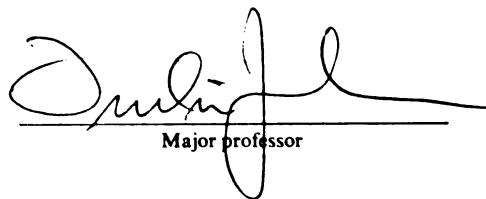


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Barbara Lamberton

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THE EFFECT OF INDUSTRY KNOWLEDGE ON COST DRIVER SELECTION

By

Barbara Lamberton

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Accounting

1998

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ABSTRACT

THE EFFECT OF INDUSTRY KNOWLEDGE ON COST DRIVER SELECTION

By

Barbara Lamberton

The purpose of this study is to examine determinants of skilled cost driver selection through a controlled laboratory experiment with objective performance criteria. Although auditing research has investigated knowledge and ability effects on audit performance, little behavioral research has been done on cost driver selection.

Two types of knowledge were examined, industry specific manufacturing knowledge and general management accounting knowledge. The sample included student volunteers and was comprised of participants with high and low levels of general management accounting knowledge. To induce industry knowledge, half of the participants were randomly assigned to a training session related to the production process of a package printing plant. The training session was derived from materials used by the industry trade association.

The results suggest that superior management accounting knowledge substitutes for low ability and lack of industry specific manufacturing knowledge. In particular, superior management accounting knowledge allowed participants to recognize highly biased cost drivers without the benefit of specialized knowledge of the manufacturing process. In contrast, for those with low levels of management accounting knowledge, both industry specific knowledge and ability had a significant effect on performance.

The study also suggests that both industry specific and management accounting knowledge affect success at selecting the driver with the lowest tracking cost out of several equally accurate alternatives.

Demonstrating a substitution effect between knowledge and ability provides a unique contribution to the accounting literature. Previous accounting research has been unable to demonstrate that one type of knowledge may be able to substitute for another type or for weaknesses in ability. Examining the effects of different types of knowledge on performance is a logical starting point for a research agenda examining the relationship between technology and individual differences in a management accounting setting.

This is dedicated to my loving husband and best friend, Donald.

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CHAPTER I INTRODUCTION

1.0 Overview

The research question is discussed in section 1, while Section 2 lays the groundwork for the study. Contributions of the study are discussed in Section 3 and the institutional setting, package printing, is discussed in Section 4.

1.1 Research Question

The purpose of this study is to test the degree to which variation in cost driver selection can be explained by individual differences in knowledge and ability. This study shows that individual differences affect the way decision makers use and process the information needed to evaluate alternative systems designs. Although auditing research has investigated knowledge and ability effects on audit performance, the effects of these variables on cost driver selection have not been examined.

1.2 Groundwork

This study starts with the assumption that the decision maker (DM) makes rational choices when evaluating alternative systems designs. The skilled DM is expected to have the knowledge and/or training required to effectively evaluate systems with alternative combinations of cost drivers using some type of cost-benefit perspective.

As a minimum, the DM needs to be able to differentiate between a system that provides accurate costs and another system that results in high cost distortion. To eliminate highly inaccurate drivers, the DM needs to have enough skill to identify which cost drivers are clearly uncorrelated with a given activity. In this study, competence at eliminating highly inaccurate drivers is called the accuracy skill.

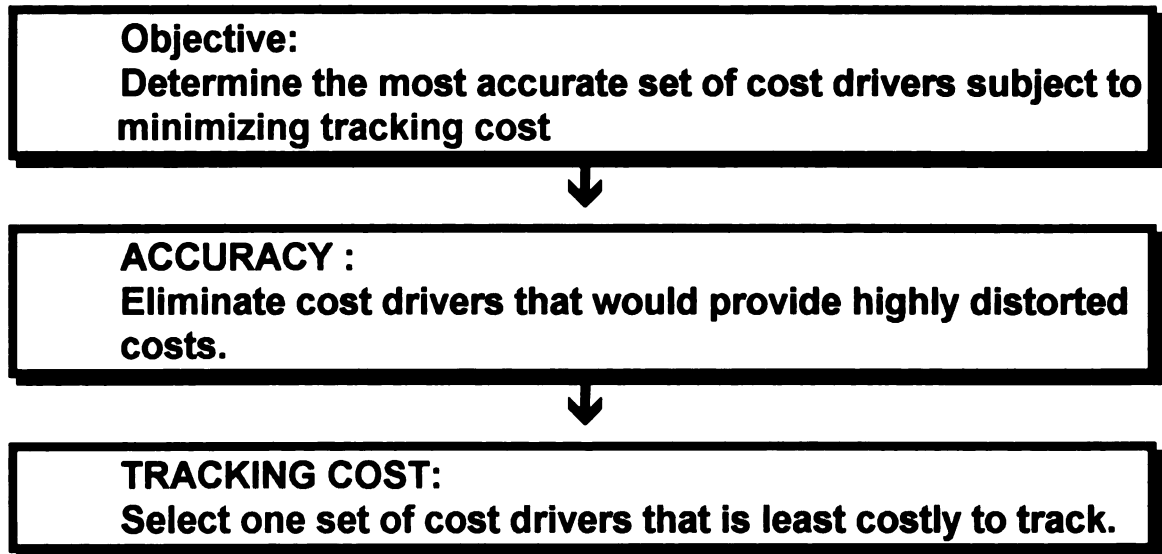
Although skill at recognizing the difference between accurate and biased cost drivers is critical, it is only one aspect of evaluating alternative systems designs. For example, it is reasonable to assume that there may be several cost drivers that provide the same benefit in terms of accuracy. If that is the case, the skilled DM would be expected to recognize a situation in which one set of cost drivers provides the same level of benefit as another but at a lower tracking cost. By considering differences in relative tracking costs, the DM reduces the chance of spending more than necessary to obtain a given level of accuracy in the cost system. In this study, competence at selecting the most accurate, least costly system is called the tracking cost skill.

A controlled laboratory experiment was employed to test the effects of knowledge and ability using an experimental stimuli with objective criteria. To that end, participants were given a series

of problems and asked to recommend a design that provides accurate information at the lowest tracking cost. The experiment was designed to distinguish between skill at accuracy and skill at tracking cost.

As shown in figure 1.1, this study seeks to demonstrate that success at identifying accurate drivers and success at noticing tracking costs represent sub-components of the cost driver selection process. This distinction is important since it is conceivable that the two sub-components correspond to separate costs associated with making sub-optimal systems implementation decisions. The first cost results from implementing a system with highly distorted costs. To the extent that accurate costs are imperative for decision making, relying on a system with distorted costs may lead to poor decisions resulting in economic loss. The second cost relates to the cost of maintaining a given system design. The economically rational DM would be expected to explicitly consider the relative cost of tracking various drivers to avoid implementing a more expensive system than necessary. In this study, skill at the accuracy part of the task proxies for skill at quantifying the opportunity cost of a bad decision. Similarly, skill at cost driver selection proxies for skill at quantifying the tracking costs of a given system design.

Figure 1.1
COST DRIVER SELECTION



The direct implication of using a cost-benefit perspective is that the DM needs to have the knowledge and/or ability to quantify both types of costs. Yet, it is not certain that the types of knowledge required to quantify both types of cost are the same, nor is it certain when and how the knowledge is acquired. In fact, very little is known about the cognitive processes and knowledge requirements associated with selecting cost drivers.

The primary message of this study is that knowledge and ability have profound and different effects on the two sub-components of the cost driver selection process. This study suggests that various types of knowledge, such as industry specific knowledge and general management accounting knowledge, affect components of cost driver selection differently. In addition, it is not clear how knowledge and ability relate to task performance. According to Libby, "superior ability may allow inferences to be made which may substitute for incomplete knowledge."(1994, p. 13).

Intuitively, an individual with industry specific experience would be expected to have substantive knowledge about the production process in a particular institutional setting. It is conceivable that such knowledge would make correlation among competing cost drivers salient. In turn, this salience may reduce

the complexity of cost driver selection by reducing the number of competing cost drivers that need to be evaluated.

Prior research has not provided much insight on effects of different types of knowledge on performance of a management accounting task. Nor has research indicated whether one type of knowledge can substitute for another. A well-trained accountant familiar with general management accounting concepts may be able to perform at the same or better level than the industry trained individual.

1.3 Why this question is important

Management accounting systems have been criticized as being irrelevant and out of step with the information needs of an advanced manufacturing environment. The implication is that the information needed to develop cost savings' strategies, investment justifications, and pricing decisions is simply not available. Activity based accounting (ABC) has been proposed as the solution to this problem. The focus of ABC is on collecting and storing more detailed information, called a cost driver, about manufacturing overhead costs. Proponents of ABC suggest that a system with multiple cost drivers will enhance understanding of costs and lead to better decisions.

Not all researchers agree that more is better than less when

it comes to cost drivers. The research of Datar and Gupta (1994), Gupta (1993) and Banker and Potter (1993) suggest that caution be used when deciding whether or not to increase the amount of detailed information being tracked by a management accounting system. Gupta (1993) demonstrates that increasing the number of cost drivers does not always increase product cost accuracy. Datar and Gupta (1994) show that careless selection of drivers may lead to implementing a system that provides less accurate costs. Banker and Potter (1993) identified specific situations in which a firm would be better off economically with a single cost driver system. The implication is that cost driver selection is a critical decision in the design of management accounting systems. Economic benefits would seem to be associated with careful selection of cost drivers.

In terms of previous work on cost driver selection, analytical research suggests that knowledge about the correlation among cost drivers is crucial to efficient evaluation of alternative systems designs (Dewan and Magee, 1992; Babad and Balachandran, 1993). Specifically, researchers have demonstrated that efficient cost driver selection exploits correlations among cost drivers to reduce the complexity of the task. In the current study it is shown that some participants are better than others at identifying

meaningful resource consumption patterns about potential cost drivers. In particular, it is shown that individual differences affect success at recognizing patterns of high correlation among competing cost drivers.

By increasing our understanding of the cost driver selection process, this study has both practical and theoretical value. The results are relevant to firms planning to implement changes in their cost accounting system, such as ABC. Although researchers have begun to investigate ABC empirically (Foster and Gupta, 1990; Banker and Johnston, 1993) and analytically (Datar, et al. 1993; Hwang, et al. 1993; Gupta, 1993), little or no research has been done examining the effect that individual differences have on evaluation of alternative systems designs.

In the systems design area, the results should help in the construction of more effective systems, decision aids, and development teams. Demonstrating the effect of different types of knowledge on performance is considered a logical starting point for a research agenda examining the relationship between technology, knowledge and ability in a manufacturing setting.

The results of this study should also be helpful in the design of learning experiences that allow efficient acquisition of knowledge for individuals of varying ability levels. This study is

expected to provide some evidence of the benefit of instructional strategies that use real world manufacturing examples in the classroom.

1.4 The Institutional Setting: Package Printing

The institutional setting used in the study reflects cost behavior patterns of a package printer experiencing a change in product mix. Prior to the mix change, the printer's single cost driver system was considered adequate for decision making purposes. The current problem facing the printer is to determine if and how the system needs to be upgraded.

The package printing industry was chosen due to the inherent complexity of the manufacturing process and the potential for diversity in product mix. Analytical research demonstrates (Hwang, Evans, and Hedge, 1993) that the demand for multiple cost drivers is a function of the heterogeneity of the production process and the diversity of the product mix. Similarly, Gupta (1993) found a positive effect between complexity and the magnitude of cost distortions caused by using fewer cost drivers. The package printing industry was also chosen due to the availability of an industry expert and industry training materials. The package printing industry is a major industry with whole-wide sales of \$120 billion.

Because of the inherent complexity of the production process in package printing, the performance task focuses on determining the best cost driver(s) to use in one major activity, press setup. Press setup is a complex and costly activity for the package printing industry. Just-in-time demands, changing mix and other forces in the market have made press setup a strategically critical activity in package printing.

1.5 Summary

This chapter introduced the research question in this study and presented some contributions expected from this research. There are four chapters that follow. Chapter II is a literature review and Chapter III presents the methodology used in this study. Chapter IV describes the data analysis. Limitations, contributions and implications are summarized in Chapter V.

CHAPTER II LITERATURE REVIEW

2.0 Overview

The theoretical background for this study utilizes literature about cost aggregation and skilled performance. The issues related to cost aggregation are addressed in the first section. The determinants of skilled performance are addressed in the second section. Development of the hypotheses is found in section 3.

2.1 Cost Aggregation

A critical decision in designing a management accounting system is determining the number and type of cost drivers to include in the information system. Since measuring all potential cost drivers and activities may be impractical, management usually needs to limit the number and type of cost drivers to be tracked by the information system. Some aggregation of activities and cost drivers is typically part of design of the system upgrade.

Historically, issues related to the cost aggregation problem (CAP) have interested accounting researchers. In terms of activity based costing, the CAP refers to the need to limit the number of cost drivers being tracked by a company's system.

The CAP has received considerable amount of attention in the analytical literature (Demski, 1980; Feltham, 1977; Demski and Feltham, 1976; Demski and Feltham, 1972; Feltham and Demski, 1970). The information economics model with its emphasis on an optimum solution and cost-benefit criterion has been viewed as the theoretical standard for evaluating accounting choice problems regarding aggregation.

Superficially, it would appear the information economics model would provide a reasonable theoretical framework for understanding cost driver selection. The task of selecting a cost driver could be considered a sub-component of the cost aggregation problem (CAP). Several authors (Dopuch, 1993; Dewan and Magee, 1992), however, have suggested that the information economics model may not be an appropriate and practical reference point to guide research about the cost aggregation decision. As a consequence research has shifted to exploring heuristics used to solve the CAP (Dewan and Magee, 1992; Babad and Balachandran, 1993).

Dewan and Magee suggest that decision makers are likely to rely on heuristics to reduce the amount of time required to solve the CAP. Defining the objective function as minimizing the sum of opportunity and tracking costs, Dewan and Magee used

simulations to evaluate heuristic approaches to solving the CAP. Dewan and Magee's objective function assumes that there are two costs that need to be considered when solving CAP. The first cost is the opportunity cost of a bad decision. The second cost is the cost of tracking a given number of cost drivers. The Dewan and Magee results indicate that heuristic performance is significantly affected by the degree of correlation among the various cost drivers.

In 1993, Babad and Balachandran took a slightly different perspective from Dewan and Magee by explicitly incorporating product cost accuracy in the cost driver selection process. Unlike Dewan and Magee, the approach taken by Babad and Balachandran involved several perfectly correlated cost drivers. In addition, the objective function was less complex. The model presented by Babad and Balachandran was based on maximizing a given level of accuracy subject to minimizing tracking costs.

Like Dewan and Magee, Babad and Balachandran found that the degree of correlation among the cost drivers was a major factor affecting the process of cost driver selection. For example, Babad and Balachandran demonstrated that perfect correlation among cost drivers can be used to reduce the number of different drivers that need to be evaluated. The authors

presented a proof demonstrating that perfectly correlated drivers may be substituted for one another with no loss in product cost accuracy.

From a behavioral perspective, the work of Babad and Balachandran has some parallels to Dewan and Magee's work on the CAP. First, both papers present models with objective criteria of success. For the behavioral researcher, the availability of objective criteria for performance is potentially valuable in an area where objective criteria are difficult to find and support.

Second, both papers emphasize that characteristics of the data, namely correlations among the cost drivers, have a significant effect on cost driver selection. In that regard, both papers presume that the decision maker can quickly recognize strong versus weak correlations among the potential cost drivers. In addition, in both papers, the decision maker needs to be able to make complex computations and comparisons. The common thread throughout these works is the lack of any explicit discussion about the skill of decision makers. Both studies assume that the decision maker is adept at identifying and computing the net benefit of one system design versus another. Examination of the effect of decision makers characteristics on

performance is left to future research.

2.2 Determinants of skilled performance

Our current understanding of skilled performance has developed from over thirty years of research in cognitive psychology and auditing behavioral research. Overall, the research indicates that skilled performers, called experts, have specific characteristics that differentiate them from less skilled performers, called novices. The literature also provides support for the concept that skilled performance is a function of different types of knowledge and innate ability. Each of these issues will be discussed in the following sections.

Section 2.2.1 summarizes the key research related to the differences between experts and novices. Section 2.2.2 covers behavioral research about the effects of various types of knowledge on skilled performance. 2.2.3 presents the literature about the link between ability and skilled performance.

2.2.1 Differences between experts versus novices

Behavioral researchers in a variety of different domains have investigated the differences between experts and novices. Prior research suggests that skilled performers tend to view relevant cues in a coherent, meaningful pattern (Newell and Simon, 1972; Chase and Simon, 1973a). Researchers have also found that

experts are especially adept at classification and categorization of various problem types (Hinsely, Hayes and Simon, 1978). The consensus (Bedard and Biggs, 1991; Lesgold et al. 1988; Akin, 1980) is that experts tend to focus on salient characteristics of a problem while novices tend to look at superficial properties. Experts are thought to use knowledge about underlying principles of their given domain to differentiate between significant and superficial aspects of the problem. Novices, on the other hand, are thought to rely primarily on superficial features which may be irrelevant to the task at hand. The tendency for novices to rely on potentially irrelevant factors suggests that their performance deficiencies reflect deficiencies in knowledge.

To understand the differences in knowledge between experts and novices, Chi et al. (1982) conducted eight studies using the domain of physics. The stated objective of these studies was to provide some empirical evidence about the differences between experts and novices in a context which requires command of a complex knowledge domain.

The particular area of physics chosen for the Chi et al. studies was mechanics. The expert participants ranged from physics professors to graduate students in physics. The novices were students who had taken a mechanics course. A variety of

tasks were used in the studies including sorting problems, writing assignments and protocol analysis. The results indicate that experts categorize and represent problems in terms of specific laws of physics, such as Newton's Second Law or the Conservation of Energy Law. In contrast, the protocols of the novices tend to be dominated by statements about the physical aspects of the problem. For example, physics novices tend to focus on the fact that the problem involves a spring or a pulley rather than the law of physics involved.

Based on the results of a hierarchical sorting task and a writing assignment, Chi et al. found evidence that classification schemes used by expert physicists are more extensive, organized and interrelated than those of novices. The experts used the laws of physics as the primary classification category and considered the surface features as subordinate categories. The experts classification schemes took into consideration both underlying principles of physics and superficial properties. Novices, on the other hand, focused on superficial, physical aspects of the problem. The implication of the Chi et al studies is that the knowledge of experts and novices was different and the difference in knowledge affected performance.

According to Bonner and Pennington (1991) the organized

and extensive knowledge of the expert translates to two distinct advantages in performance. First, the expert's knowledge provides a reference point that aids in interpreting the facts of a given problem. Knowledge assists the expert in matching the pattern of the facts and features of the problem at hand to known underlying principles of the given domain. Thus, this skill may be a reflection of the tendency of experts to rely on knowledge to represent a problem that requires combination of multiple cues. Bonner and Pennington used the term "global interpretation of the situation" to describe problem representation, skill at establishing a framework for problem solving.

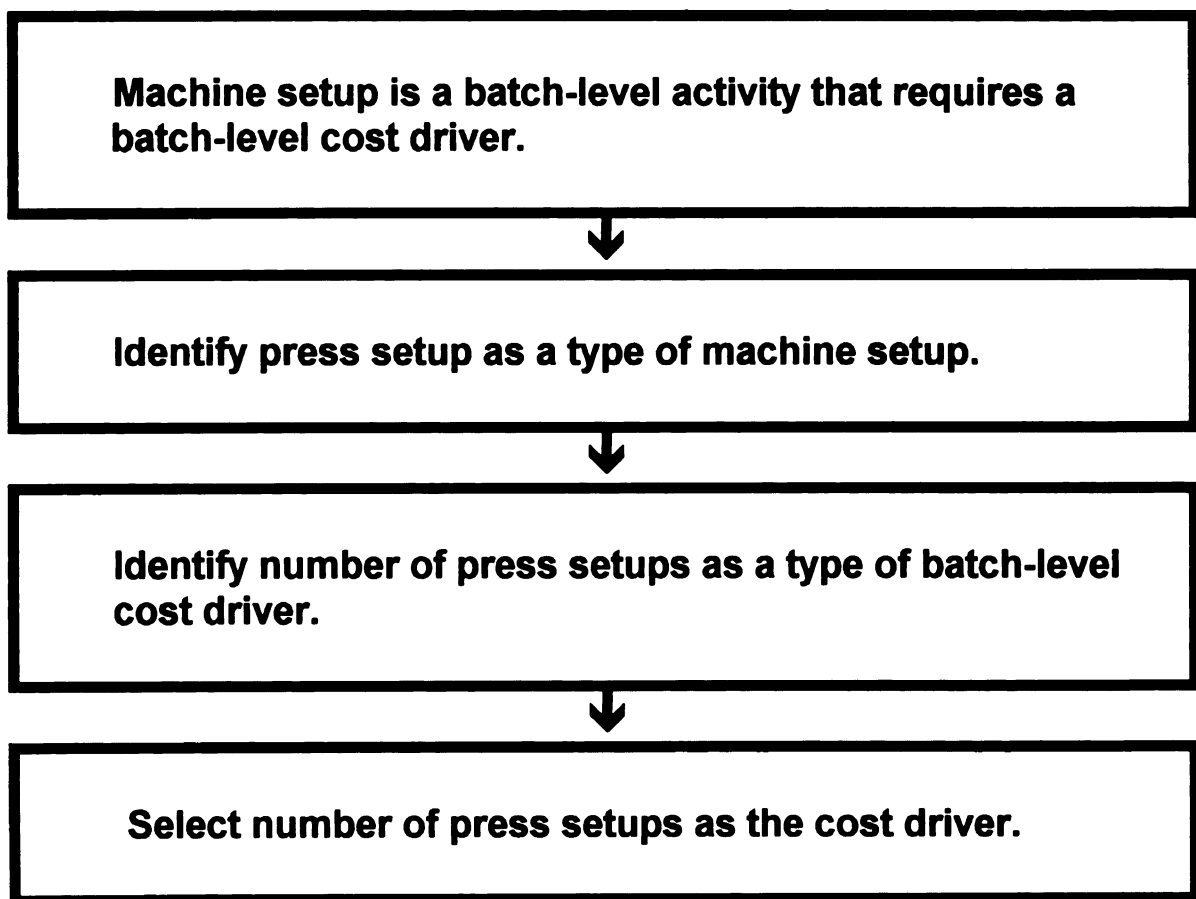
Second, the expert's knowledge may include the actions and procedures relevant to the problem at hand. According to Chi et al. "experts' schemata contain much more knowledge about the explicit conditions of applicability of the major principles underlying a problem" (1982,p.62). Two examples include the chess masters command of defense and attack strategies (Chase and Simon, 1973) and procedural knowledge demonstrated by expert physicists (Chi et al., 1982).

Consistent with other domains, the auditing behavioral research also suggests that novices tend to represent a problem on a more superficial level than experts. Bedard and Biggs

(1991) imply that auditors that make errors may be focusing on the surface features of the task rather than relying on their knowledge of the underlying accounting principles.

Research from other domains would suggest that differences in knowledge would have a profound effect on performance for management accounting tasks, such as cost driver selection. In presenting the topic of cost driver selection, many managerial texts (Anderson and Sollenberger, 1994; Noreen and Garrison, 1996, Zimmerman, 1993) employ a heuristic that classifies activities into mutually exclusive categories and uses these categories to simplify cost driver selection. Using the heuristic, activities such as assembly and fabrication are classified as volume driven and a volume driver is selected. Similarly, machine setup would be classified as batch-level and the use of number of setups would be suggested. Once the classifications of the activities and cost drivers have been learned, the heuristic becomes simple to use. For example, the selection of a cost driver for assembly is limited to a few volume-driver cost drivers. Similarly, a batch-level cost driver, such as number of setups, would be selected for a batch-level activity, such as machine setup. In terms of the current study, Figure 2.1 shows how the simplistic heuristic would be applied to the press setup activity in

Figure 2.1
Simple heuristic



package printing.

The concept of reviewing all possible combinations of cost drivers is not typically discussed in managerial texts. Instead, a number of problems in the text materials test the student's proficiency at classifying activities based on the heuristic just discussed. For novices, the simplicity of the heuristic may hide the underlying principle that, all else being the same, cost drivers are selected for their correlation with a given activity. Evidence from other domains would suggest that the novice decision makers, when faced with cost driver selection, may ignore the underlying principle of high correlation and focus on some "surface feature" of the problem. Novice individuals may select cost drivers based solely on the name of the activity entirely ignoring resource consumption patterns. Skilled performers would be expected to focus on the underlying principle that cost drivers and their related activities need to be highly correlated. In contrast, less knowledgeable decision makers may tend to focus on surface features of the task, such as the name of the activity.

2.2.2 Types of knowledge and skilled performance In 1990, Bonner and Lewis (BL) proposed that skilled performance is a function of different types of knowledge. To test the effect of

different types of knowledge on performance, the authors constructed a series of knowledge tests and administered them to auditors with varying amounts of experience. The types of knowledge examined by BL include the following: (1) world knowledge (2) general domain knowledge and (3) sub-specialty knowledge. The definitions of general domain knowledge and sub-specialty knowledge are most relevant to this study.

BL define general knowledge as the type of knowledge that virtually everyone in a particular domain would have the opportunity to acquire through instruction and/or experience. Knowledge of internal controls, proficiency with certain audit computations and an understanding of the basic accounting model are examples of general knowledge in the audit domain.

Sub-specialty knowledge, as defined by BL, refers to the knowledge that is acquired through experience with specific industries and/or clients. Specific knowledge about interest rate swaps and industry experience with manufacturing were two types of sub-specialty knowledge tested by BL.

The BL study examined knowledge effects related to four audit tasks that had been the subject of previous auditing behavioral research. General accounting knowledge of internal controls was positively related to performance of an internal

control task and knowledge of the analytical procedures was positively related to ratio analysis. The specialized knowledge of hedging transactions, a type of sub-specialty knowledge, was positively related to performance of an audit financial instruments task. The BL findings provide some preliminary evidence that, for auditing, general and specialized knowledge are separate constructs that have different effects on task performance.

2.2.3 The link between ability and skilled performance

Research in psychology suggests that ability is another determinant of skilled performance (Hunter, 1986; Lesgold, 1984; Simon, 1979). Hunter (1986) summarized the results of 515 studies conducted by the US Employment Service and data from nearly half a million military personnel. The results indicate that while the predictive validity of ability is highest for complex jobs, ability is nevertheless a valid predictor for virtually all jobs.

In studying the determinants of audit performance, BL argue that certain types of tasks tend to require a certain level of ability. Specifically, BL found that ability was positively correlated with performance for analytical review and an earnings manipulation task.

To increase understanding of the link between ability and performance, Libby and Tan (1992) reexamined the BL data. As

part of this reexamination, Libby and Tan presented and tested a classification scheme that categorized each of the BL tasks as either structured or unstructured. The authors suggest that unstructured tasks require problem solving ability while structured tasks do not. According to Libby and Tan (1992), an unstructured task is any task which requires, to some degree, the need to “define the problem, generate alternative solutions, search for information from disparate sources and make computations.” Using this classification scheme, Libby and Tan argued that the internal control and financial instruments tasks are fairly structured. The internal control task required the participant to: (1) list two financial statement errors that could occur in spite of the internal control system and; (2) list two audit procedures that would detect the errors. The financial instruments task required the participant read about an interest rate swap agreement, name the type of transaction involved and the accounting required. In both tasks, the problem was well-defined and there was no need to search for information from different sources. Neither task required high levels of ability for performance.

Libby and Tan(1992) classified the two other tasks studied by BL, ratio analysis and an earning manipulation task, as being

unstructured. The ratio task requires the participant to identify an accounting error that would account for unusual changes in several financial ratios. The earnings manipulation task requires the participant notice the relationship between a pattern of errors and a management compensation agreement described in a footnote. Since both tasks require computations, generation of alternative solutions and search for information from disparate sources, ability was predicted to affect performance. The results indicated that ability was significant for the ratio analysis task and marginally significant for the earning manipulation task.

BL (1990) and Libby and Tan (1992) were not the first accounting researchers to link ability and performance. In 1979, Benbasat and Dexter found an interaction between ability and level of aggregation. In 1982, Otley and Dias studied the combined effects of ability, aggregation level and information content on performance. The authors predicted that the low ability participants would have more difficulty in a management accounting task than high ability participants. For a variety of methodological reasons, the Otley and Dias experimental results did not support a significant effect related to ability.

In the behavioral literature, the term, ability, is often used to describe general intelligence. Since ability is a difficult construct

to measure, a number of different instruments have been employed by researchers. For example, Hunter's (1986) definition of ability was based on the U.S. Employment General Aptitude Test Battery (GATB). Other measures used in behavioral research include selected GRE questions (Bonner and Lewis, 1990) and various timed tests.

In accounting, behavioral researchers have frequently relied on the theory of field independence to define one kind of ability that is believed to be relevant to certain accounting tasks (Awashi & Pratt, 1990; Gul, 1984; Otley and Dias, 1982; Benbasat and Dexter, 1979; Gul & Zaid, 1981; Lusk, 1973; Doktor, 1973).

Field independence theory considers an individual's style of perception as a type of ability. The theory focuses on the individual's skill at isolating simple figures from complex diagrams. In field independence terminology, individuals who are adept at noticing simple patterns in complex diagrams are said to be field independent and thus high ability. In contrast, individuals who have difficulty isolating simple patterns are called field dependent or low ability. The theory predicts that field independent individuals tend to perform relatively well at problem solving and excel at analyzing and structuring certain tasks. In this study, the construct of field independence was used to define

ability. Therefore, throughout the remainder of this paper, the terms ability and field independence have been used interchangeably.¹

The instrument most often used to measure field independence is the embedded figures test, a visual perception test (Wilkin et al. 1971). The test consists of series of exercises that require the participant locate a simple geometric figure embedded in more complex diagram. In this study, competence at performing the embedded figures test provides a measure of ability, as defined by field independence theory.

2.3 Hypotheses Development

Prior to hypothesis testing, confirmatory factor analysis was performed confirming that the accuracy and tracking cost aspects of the stimuli form two separate scales. The hypotheses related to accuracy are discussed first followed by the hypotheses for tracking cost.

2.3.1 The determinants of success at accuracy Due to prior ABC training, all participants are expected to be very familiar with the simplistic cost driver selection heuristic described in section 2.2.1 and shown in Figure 2.1. In particular, all participants are expected to easily recognize press setup as a type of machine

¹ The Bonner & Lewis GRE questions were also administered but were not as successful as the field independence instrument in explaining performance.

setup, a batch-level activity. According to the heuristic, as long as resource usage is a flat amount per setup, a system based on number of setups would provide accurate information. Use of the heuristic is justified based on the presumption that the components of setup cost strongly correlate with number of setups. The underlying principle is that there would be little or no benefit to tracking more information if costs are always the same amount per setup.

It is the purpose of the accuracy part of the experimental task to test skill at recognizing situations in which such a simplistic approach to cost driver selection would result in an inaccurate system. Since the case materials show resource usage is not a flat amount per setup, the participant who selects number of setups as the cost driver will be recommending a highly inaccurate system. The key to success is recognizing that use of a batch-level driver, such a number of setups, would result in a system with highly distorted costs.

It should be noted that the case study materials provide all the information needed to recognize that number of setups is not the correct cost driver. The resource consumption patterns include detail information about setup labor usage, ink waste, number of colors, number of setups and number of orders. The

consumption patterns demonstrate that the number of colors printed, setup labor and ink usage are perfectly correlated. The participant needs to eliminate the system design that only tracks number of setups selecting any one of the three perfectly correlated drivers. Since colors, labor and ink usage are perfectly correlated, any one of these three drivers would provide accurate costs.

As a minimum, the participant needs to have a firm grasp on basic management accounting concepts including knowledge of generic cost behavior patterns and cost terminology. To perform well, the participant also needs to be sufficiently familiar with data analysis techniques to recognize the accounting significance of a change in production complexity on indirect costs. Higher levels of general management accounting knowledge are expected to make the participant more sensitive to the importance of a strong correlation between resource usage and cost drivers. Individuals with high levels of management accounting knowledge are less likely to view cost driver selection as narrowly defined by the simplistic heuristic.

Although all participants are trained in basic ABC, by the second management accounting class, participants are expected to have relatively high levels of general management accounting

knowledge. In this study, participants who are completing their second management accounting class are classified as high management accounting knowledge. Those participants completing their first management accounting class are classified as low management accounting knowledge.

High management accounting participants are expected to have a better understanding of the factors that cause indirect costs to change than the low management accounting participants. In addition, it is reasonable to assume that participants in the second management accounting class have had more practice with data analysis than those in the first class.² Better knowledge of data analysis techniques is expected to aid participants in interpreting the resource consumption patterns. Specifically, knowledge of data analysis techniques, such as regression, is expected to make the underlying principle of correlation among cost drivers especially salient for those in the second management accounting class.

The high management accounting knowledge group is also expected to approach the task with a broader definition of the problem than their low management accounting knowledge

² The second undergraduate management accounting class included specific lessons on techniques such as linear programming and regression. Of the 78 participants classified as high general knowledge, 75 demonstrated basic competence in regression through completion of a class project unrelated to this study.

counterparts. Unlike the low management accounting knowledge group, the high management accounting knowledge group is expected to consider comparison of the resource patterns the focal point of problem solving. For those with superior management accounting knowledge, the superficial characteristics of the task, such as names of the activities and drivers, are not expected to play a prominent role in performing this task. For virtually all of the high management accounting knowledge group, eliminating highly distorted drivers is expected to be a well-defined and straightforward task. As a consequence, neither ability nor industry training are expected to affect performance for those with superior levels of management accounting knowledge. Little or no variance is expected for the high management accounting knowledge group.

Due to the lack of variance for the high management accounting knowledge group, the hypotheses for accuracy examined determinants of performance for the low management accounting knowledge group. For those with low levels of management accounting knowledge, industry training is expected to have a positive effect on performance by providing knowledge about the activities and products involved in package printing. Specifically, industry training is expected to increase awareness

that number of colors printed is a major factor driving the complexity of the production process and that resource usage is not a flat amount per batch. Knowledge of the link between production complexity and the number of colors is expected to provide a critical reference point in reviewing the facts surrounding the case materials. Unlike the control group, the industry trained group is expected to notice changes in resource consumption patterns. Therefore:

H₁: Industry training positively affects selection of an accurate system for the low management accounting knowledge group.

Ability is also expected to have a positive effect on performance for the low management accounting knowledge group. Higher ability is expected to aid the low management accounting knowledge group in recognizing the need to broaden the definition of the problem beyond that of the simplistic heuristic. In contrast, lower ability participants are expected to ignore resource consumption patterns, focus on the superficial aspects of the task, and to continue use the simplistic heuristic.

Therefore:

H₂: Ability positively affects selection of an accurate system for the low management accounting knowledge group.

2.3.2 Tracking cost hypotheses As shown in figure 1.1, accuracy is a critical sub-component of the cost driver selection process. Failing at the accuracy sub-component is a fatal error. Hypothesis testing for the second component of the process, tracking cost, focuses on a reduced sample composed only of those participants who succeeded at the accuracy task.

To identify the lowest cost driver, the participants must make comparisons beyond those required for the accuracy task. Industry training is expected to aid both high and low management accounting knowledge participants in isolating the least costly driver, colors. Unlike the control group, the treatment group comes to the problem aware of the relationship between colors and the complexity of the production process. Essentially, prior knowledge of the significance of colors to the setup activity is expected to simplify the task for the treatment group. Therefore,

H₃: Industry training is expected to positively affect skill at identifying the least costly driver for both high and low management accounting knowledge participants.

The content of the industry training session focuses on the complexity of the manufacturing process and the diversity of the items produced. The slides and scripts contain no explicit accounting information. To succeed, the participant needs to recognize that the number of colors in the design is characteristic of the product that correlates with two components of cost, labor and ink. As a consequence, superior management accounting knowledge is also expected to affect performance. Participants with high levels of management accounting knowledge are expected to notice a pattern that shows labor and ink use are proportional to the colors printed. By helping the participant recognize the accounting significance of the redundancy between colors and resource use, more extensive management accounting knowledge is expected to reduce the complexity of the task. Such a finding would be consistent with previous research suggesting that correlations among input cues can reduce task complexity if the decision maker is aware of the redundancy.

(Bonner, 1994; Hammond, 1986, Naylor and Schenck, 1968).

Similarly, the positive effect of general knowledge would be consistent with the BL (1990) finding that general knowledge of analytical procedures was related to performance of a financial instruments task. Therefore,

H₄: Management accounting knowledge is expected to positively affect skill at identifying the least costly driver.

2.4 Summary

This chapter contained the literature review related to the study. The research surrounding cost aggregation was summarized in Section 1. Issues regarding the determinants of skilled performance were discussed in Section 2.

This chapter also presented the hypotheses testing skill at cost driver selection. The determinants of skill at accuracy were presented in section 2.3.1 and hypotheses related to the tracking cost portion of the process were presented in section 2.3.2.

The four hypotheses were subsequently examined through

an experiment described in the next chapter. Specific results are presented in Chapter IV.

CHAPTER III METHODOLOGY

3.0 Overview

The purpose of Chapter III is to discuss the hypotheses test procedures. A controlled laboratory experiment is used to investigate cost driver selection.

The first section presents an overview of the experiment and the research design employed. The second section discusses the participants. The third section is a detailed discussion of the experimental stimuli. The fourth section discusses the methods used in hypothesis testing.

3.1 Experimental Design

This study employed student participants to test the degree to which variation in cost driver selection can be explained by individual differences in knowledge and ability.

The experiment was conducted in two phases that took place approximately one week apart. In the first session, participants were given several tests including two ability measures.

After the first session, half of the participants were randomly assigned to an industry training session that provided an overview of a manufacturing process similar to the one presented in the

performance task.

The training session was based on an audio-visual presentation currently used by the industry trade association. The industry audio-visual training session lasted approximately twenty minutes and was conducted in the second session prior to the performance task. The intent of the training session was to provide an overview of the major activities involved in package printing. (See Appendix A). The content of the scripts and the slides focused only on the manufacturing process and not on accounting issues, such as costs and correlations among cost drivers. Neither the scripts nor the slides contained any explicit instruction on the accounting significance of characteristics of the production process. For example, the lesson includes the fact that the number of print stations that need to be used depends on the number of colors to be printed. The accounting implication that colors would drive press setup costs was not explicitly stated.

In the second session, just prior to the performance task, all subjects were given a training session to familiarize themselves with the requirements of the task. The training session involved a review of a sample cost driver selection problem using a non-manufacturing setting. The correct answers were given and reviewed. The sample case was provided to ensure that all

participants clearly understood the objective of the experimental stimuli was to identify the most accurate, least costly set of drivers. The training session took approximately fifteen minutes.

Next, the actual performance instrument, a case study, was administered (See Appendix B). After completing the performance instrument, participants were asked to complete exit interview questions that included demographic and other debriefing information. The case study and exit interview questionnaire were self-paced. For most participants the second session lasted less than 1 1/3 hour.

3.2 Participants

3.2.1 Sample Statistics Originally, a total of 180 undergraduate and graduate level students participated in this experiment. All students had the same instructor and were enrolled in a class that covered activity-based costing. To ensure uniform coverage of the topic, the ABC instruction included a handout that was covered in class.

All the participants were volunteers and expected to be adequately motivated and give adequate attention to the experimental tasks. To verify the assumption of adequate motivation and attention to task, the experiment included five straightforward cost computation questions. An example of this

type of question is discussed in section 3.3.1. A total of 11 participants were eliminated when they failed to correctly answer at least four out of five of these questions.³

Although ABC was covered in class, some participants may not have learned the basics due to poor attendance. To verify that all participants had a working knowledge of the cost driver heuristic described in section 2.2.1, five simple cost driver questions were included in the experimental stimuli. These questions, simplified versions of the performance instrument, are described in section 3.3.2. A total of 15 participants were eliminated when they failed to answer correctly at least four out of the five of the simple ABC questions.

Finally, 11 participants were eliminated because they failed to fully take part in the second part of the experiment making the final sample size equal to 143, as shown below in Table 3.1.

Of the 143 participants, 10 were graduate students and 133 were undergraduate cost accounting students. The 143 students remaining in the study were a fairly homogeneous group in terms of motivation, basic ABC knowledge and familiarity with basic management accounting concepts. Specifically, nearly all

³ Poor performance may have reflected factors other than low motivation, such as lack of rudimentary accounting knowledge and weak computation skills. These particular individuals tended to perform poorly on all of the tasks.

participants remaining in the study received a perfect score on the easy cost computation questions designed to test motivation and the simple cost driver questions designed to test ABC knowledge. In addition, in a self report, nearly all remaining participants indicated that they were either familiar or very familiar with general management accounting concepts and cost driver selection.⁴ Of the 143 participants, 65 were completing their first management accounting class, while 78 were completing their second. The experiment was run during the last weeks of the term in which the management accounting class was taken.

Table 3.1
Sample Statistics

Original participants	180
Lack of motivation	(11)
Lack of ABC knowledge	(15)
Lack of full participation	<u>(11)</u>
Total sample size	143

The participants were primarily composed of inexperienced individuals. Only three individuals, all graduate students, had accounting work experience of over one year. The three

⁴ A multiple choice test was also administered to measure basic competence in management accounting concepts. For the participants remaining in the study, the test scores had no explanatory value once the number of management accounting classes was considered.

experienced accountants were unfamiliar with printing prior to the experiment.

3.2.2 Task Incentive Participants were paid \$1.00 to complete the experiment. In addition, monetary incentives were used to motivate all participants. The monetary incentives were based on performance on the case study with the incentive portion of the payment ranging from zero to \$17.00. In addition, a \$25.00 lottery was held for all participants at the end of school term.

3.3 Task

Participants were presented with a case study for a package printing plant that recently had purchased another plant. The case materials clearly stated that both plants were identical in terms of the manufacturing capacity. The only salient differences between the plants related to product mix and the volume of business handled at each location. Because of the acquisition, the product mix produced at each plant was subject to change. The problem facing the printer was to determine the adequacy of the company's single cost driver system given the impending change in mix.

The participants were given 10 different problem sets and asked to compute setup costs and select a cost driver for the

setup activity. The first five problem sets were relatively easy with high correlation among all the cost drivers. Responses to the first five problem sets served to filter out participants who lacked motivation or basic ABC knowledge.

The second five problem sets were more difficult. For hypotheses testing purposes, the responses to the difficult cost driver problems provided the basis for computation of the performance variables. In this study, skilled performance is defined as selecting the most accurate, least costly system out of five alternatives.

The instructions indicated that each problem set should be answered independently of the others. The case materials were developed such that every participant received the same set of cost driver problems in the same order. The order went from a set of five problems with high correlation among the drivers to a set of five difficult ones with low correlation.⁵

Section 3.3.1 discusses the cost computation task. Section 3.3.2 covers the set of five straightforward problems used to test basic ABC knowledge. Section 3.3.3 and section 3.3.4 present detailed descriptions of the two performance variables based on

⁵ Progressing from high correlation to low correlation among the cost drivers was necessary to portray how mix realistically changes in a package printing plant. According to industry sources, product mix is likely to become more complex rather than less over time.

responses to the second set of five cost driver problems. Section 3.3.3 discusses how skill at identifying an accurate driver is measured. Section 3.3.4 discusses how skill at selecting the least costly driver is measured.

3.3.1 Cost computation task The cost computation task requires the computation of annual variable setup costs for the newly acquired plant. Information was provided about the resource usage for the typical job produced at both the original and new acquired plants. The instructions explicitly state that participant needs to follow these steps:

1. Compare the resource usage of the typical order for the original plant to the typical order for the new facility.
2. Compute an accurate setup cost per order for the new plant.
3. Compute annual variable setup costs for the new plant using the following formula:

$$\text{Annual costs} = \text{setup cost per order} * \# \text{ of orders}$$

To allow detail computation of setup costs, the narrative accompanying the case materials states that setup costs are composed of labor, ink waste and the cost of a plastic setup roll. The narrative also includes all the information needed to compute the labor rate per hour and the input prices of the two types of

indirect materials, ink and plastic. The setup labor rate in the case materials computes to \$60.00 per hour. The ink cost computes to \$3.00 per pound and the setup roll costs \$25.00 each.

The resource consumption information illustrates that the typical order produced in the original plant involves one setup, uses 1.5 hours of labor, 27 pounds of ink and 1 setup roll. Based on the input prices and the specifications of the typical order, the cost per setup computes to \$196.00, as shown below:

$$\begin{array}{rclcl}
 \text{Variable cost per setup} & = & \$60 \times 1.5 \text{ hrs} & + & \$3 \times 27 \text{ ink lbs.} & + & \$25 \times 1 \text{ setup roll} \\
 \$196.00 & & = \$90.00 & & + \$81.00 & & +25.00
 \end{array}$$

As previously discussed in section 3.2.1, the first five cost computation problem sets were designed to test motivation and attention to task. The only relevant change from one straightforward question to another was a change in the number of setups per order.

Problem set 2, reproduced in Table 3.2, is an example of one of these questions.

Table 3.2
Straightforward cost problem

Typical specifications	New Plant	Original
# of orders annually	200	500
# of setups per order	3	1
# of setup rolls per setup	1	1
# of colors in the design	3	3
# of setup labor hours per setup	1.5	1.5
# of ink lbs wasted per setup	27	27
Variable setup costs per order	?	\$196.00
Annual variable setup costs	?	\$98,000

Each participant was expected to use this information to compute annual setup costs to be \$117,600 (\$196.00 cost per setup * 3 setups * 200 orders). Of the 143 participants in the final sample, all but 4 had perfect scores on the first five cost computation questions. As noted previously, to be included in the study, the participant had to answer at least four out of five of these problems correct.

The last five cost computation problems were significantly more difficult than the first five. To compute costs correctly, the participant needed to recognize that the cost function had changed due to a change in mix. Participants who continued to compute costs based on \$196.00 per setup were scored as having failed at this task. This type of cost computation error is referred

to as the batch error in subsequent discussions. In contrast, participants who computed costs using detailed information about resource use were scored as having succeeded at the task.⁶

An example from the actual case study, Problem set 7, will be presented to illustrate the correct solution and the magnitude of the effect of the batch error on cost computation. The information presented as part of Problem set 7 is shown in Table 3.3.

Upon review of the resource data, the successful participant is expected to notice that the new plant uses more labor and ink per setup than the original plant. In this type of situation, the participant needs to apply the input prices to the quantities of labor, ink and rolls used. The simplistic rule using \$196.00 per setup needs to be abandoned.

The correct solution and the batch error are illustrated in Panels A and B respectively of Table 3.4. As shown in Panel A of Table 3.4, the correct setup cost computes to be \$253 per setup, \$1,012 per order and \$303,600 annually. In contrast, using \$196.00 per setup results in computing costs to be \$235,200 annually.

⁶ The correlation between the batch error in cost computation discussed here and selecting an inaccurate system, discussed in section 3.3.3, was close to one.

Table 3.3
Difficult Problem

Typical specifications	New Plant	Original
# of orders annually	300	500
# of setups per order	4	1
# of setup rolls per setup	1	1
# of colors in the design	4	3
# of setup labor hours per setup	2	1.5
# of ink lbs wasted per setup	36	27
Variable setup costs per order	?	\$196.00
Annual variable setup costs	?	\$98,000

Each of the other four problem sets used in measuring the cost computation variable followed the same pattern. Failure to abandon the \$196.00 per setup cost function results in significantly distorted costs. For each problem set, the magnitude of the batch error as a percent of cost is quite large.

As presented in Table 3.5, the absolute value of the batch error ranges from a low of 23% of cost for problem set 7 to a high of 139% for problem set 8. In a business dependent upon long term contracts and competitive bidding, such large errors would have serious business implications.

Table 3.4
Cost Computation: Difficult Problem

Panel A Correct Solution

2 Setup labor hours* \$60.00 =	\$120.00
36 lbs of ink * \$3.00 per pound =	\$108.00
1 setup roll * \$25.00 per roll =	\$25.00
variable cost per setup =	\$253.00
* # of setups per order =	4
Variable setup cost per order=	\$1012.00
* # of orders annually	300
Annual variable setup cost	\$303,600

where variable cost per setup is:

$$\begin{array}{rclcl}
 \text{Variable cost per setup} & = & \$60 \times 2.0 \text{ hours} & + & \$3 \times 36 \text{ ink pounds} & + & \$25 \times 1 \text{ setup roll} \\
 \$253.00 & & = & \$120.00 & + & \$108.00 & + & \$25.00
 \end{array}$$

Panel B Batch Error

variable cost per setup =	\$196.00
* # of setups per order =	4
Variable setup cost per order =	\$784.00
* # of orders annually	300
Annual variable setup cost	\$235,200

Table 3.5
Magnitude of the batch error

	Cost Computation		Magnitude of the batch error	
	Correct	Batch error	Dollar amt.	% error
Problem set 6	\$75,060	\$105,840	\$30,780	41%
Problem set 7	\$303,600	\$235,200	\$68,400	23%
Problem set 8	\$65,600	\$156,800	\$91,200	139%
Problem set 9	\$173,600	\$109,760	\$63,840	37%
Problem set 10	\$44,040	\$23,520	\$20,520	47%

3.3.2. Basic ABC knowledge To test for basic ABC knowledge, the first five driver selection questions were similar to problems covered in the management accounting classes. All participants were expected to easily recognize press setup as a type of machine setup, a batch-level activity. Due to basic ABC training, all participants were expected to know how to apply the simple heuristic discussed in Chapter II and shown in Figure 2.1.

Because the simple heuristic does not specifically deal with tracking costs, there was a concern that some participants might select number of setups as a cost driver when an equally accurate, less costly driver was available.

To determine whether participants noticed the tracking

costs, one of the five straightforward problem sets assumed that all cost drivers were perfectly correlated. This problem set was added to determine if participants would always select a system that uses a batch-level driver even when a less costly, equally accurate single cost driver system would suffice. Virtually all of the participants answered this question correctly by recommending that the company continue with its single cost driver system.

The next four problems required a batch-level cost driver, number of press setups. Problem set 2, shown in Table 3.2 in section 3.3.1, is an example of one of these problems. The tracking cost information illustrates that number of press setups is less costly to track than setup labor, ink use or number of colors. As a consequence, the participant was expected to recognize that a system that tracks data by number of setups would provide accurate information with the lowest tracking cost. Nearly all of the 143 participants received a perfect score on these questions.

3.3.3 Dependent variable one: Accuracy Whereas the first five cost driver problems were simple and meant to test basic ABC knowledge, the remaining five problems were more difficult and served as the basis for computation of the performance variables.

In the discussions that follow, the performance variables

were defined solely in terms of the difficult cost driver questions rather than incorporating the cost computation responses into the results. Since the correlation between making the batch error and selecting an inaccurate system was close to one, the results were essentially the same regardless of the definition of accuracy used.⁷

Therefore, for hypotheses testing purposes, the accuracy variable is defined solely in terms of selecting an accurate system design out of five possible alternatives. The alternatives included two highly inaccurate options and three designs that would permit accurate costs.

The five alternatives included one volume-level driver, number of orders, and one batch-level driver, number of setups. The three accurate drivers were setup labor hours, ink pounds wasted and number of colors in the design. Resource consumption patterns demonstrated that three cost drivers, labor, ink, and colors were perfectly correlated.

It is significant to note that the participant does not have to compute costs in order to selecting an accurate system design. As shown in figure 3.1, the participant only needs to focus on the

⁷ In computing costs, many participants omitted one element of cost. This omission error was unrelated to skill at selecting the least costly, most accurate system design. Although not presented here, statistical analysis of the omission error provides some evidence that use of information requires skills other than those required for system design.

resource consumption patterns. By comparing the relative resource usage between the old and new plant, the participant is expected to realize that resource usage is not a flat amount per setup.

The same resource patterns shown in Table 3.3 in section 3.3.1 will be used to illustrate skill at selecting an accurate system.

The skilled performer is expected to notice that setup labor and ink costs are not a uniform amount per setup. As shown in the shaded area in Table 3.6, the new plant uses $1\frac{1}{3}$ as much labor and ink per setup as the old plant.

Each of the other four problem sets followed the same pattern as shown above. In each of these situations, continued use of a simplistic heuristic would result in recommending a system with highly distorted costs. In scoring the accuracy variable, the participant's solution to each of the problems was examined. If the participant recommended any one of the three accurate drivers, the answer was considered correct. If number of setups was selected, the answer was scored as wrong. As expected, none of the 143 participants selected a single cost driver system as the solution to these problems.

Figure 3.1
Skilled performer: Accuracy

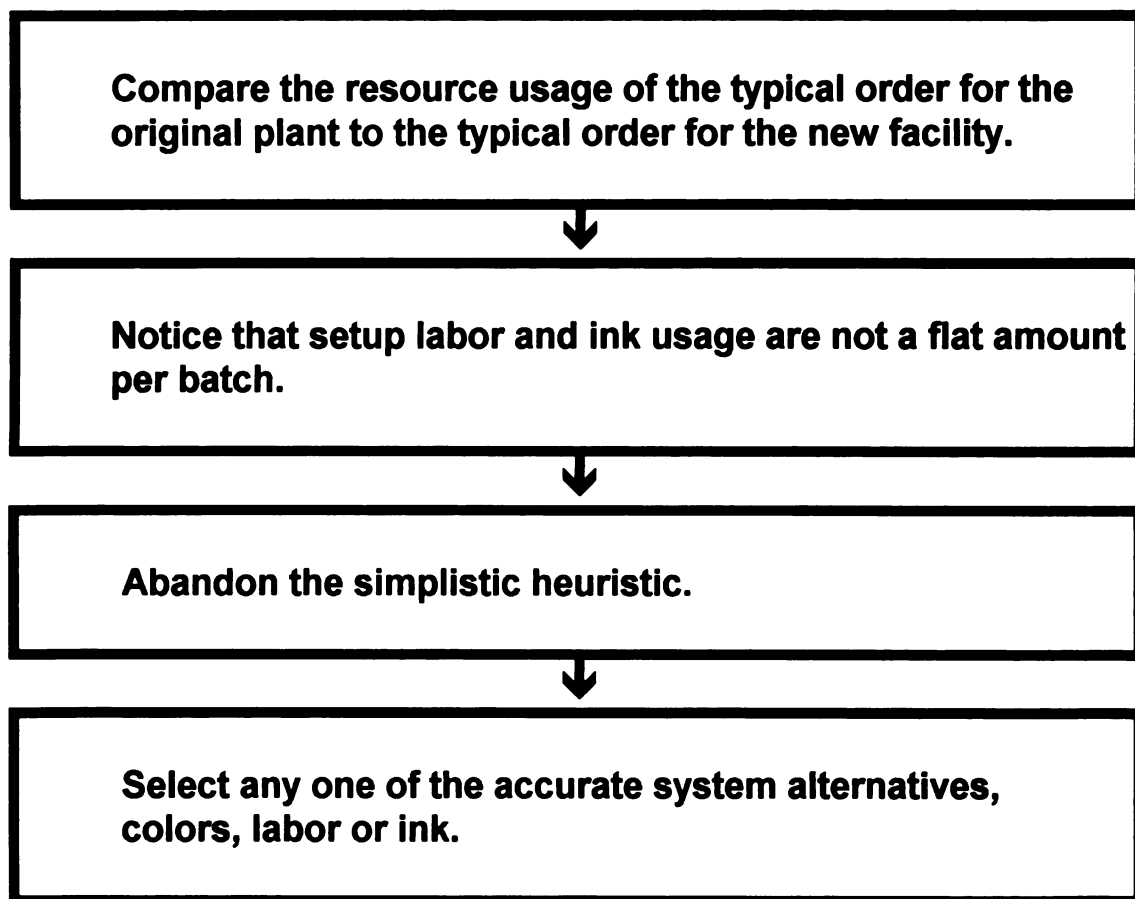


Table 3.6
Ratio of Resource Usage

Typical specifications	New Plant	Original	Ratio of resource usage
# of setup rolls per setup	1	1	1 to 1
# of colors in the design	4	3	1 1/3 to 1
# of setup labor hrs per setup	2	1.5	1 1/3 to 1
# of ink lbs wasted per setup	36	27	1 1/3 to 1

3.3.4 Dependent variable two: Tracking cost As indicated in section 2.3.2, only the responses of the participants who selected one of the three accurate cost drivers are included in the analysis of the second dependent variable, tracking cost.

In addition to the resource consumption information, the participant was given tracking cost information for each of the five cost driver alternatives. The relative tracking costs are presented in Table 3.7. The tracking costs of the five systems remained the same for all the problem sets. This was necessary to have a realistic situation portrayed in the case. Discussions with a package printing controller and an industry expert confirmed that the ranking of the tracking costs used in the study was realistic for their industry.

Table 3.7
Costs of Tracking

#	Alternative System Design	Annual Tracking Cost
1	# of orders (the current system)	\$0
2	# of setups per order	\$1,000
3	# of colors in the design & # of setups	\$2,500
4	# of setup hours and # of setups	\$3,000
5	# of ink lbs & # of setups	\$10,000

As depicted in figure 3.2, the skilled performer notices the link between colors and resource use and that the color driver is least costly. The unskilled performer, shown in figure 3.3, focuses only on the labor and ink correlation ignoring the color driver entirely. The variable, tracking cost, was scored correct if the color driver was chosen, wrong otherwise.

3.3.5 Pretests The case materials used in this study were developed with the assistance of a controller of a midwest package printing company and an industry expert. The controller was especially helpful in reviewing the reasonableness of the resource consumption patterns shown in the problem sets and the input prices used. Earlier versions of the case study were tested with both undergraduate and graduate level students.

Figure 3.2
Skilled performer: Tracking cost

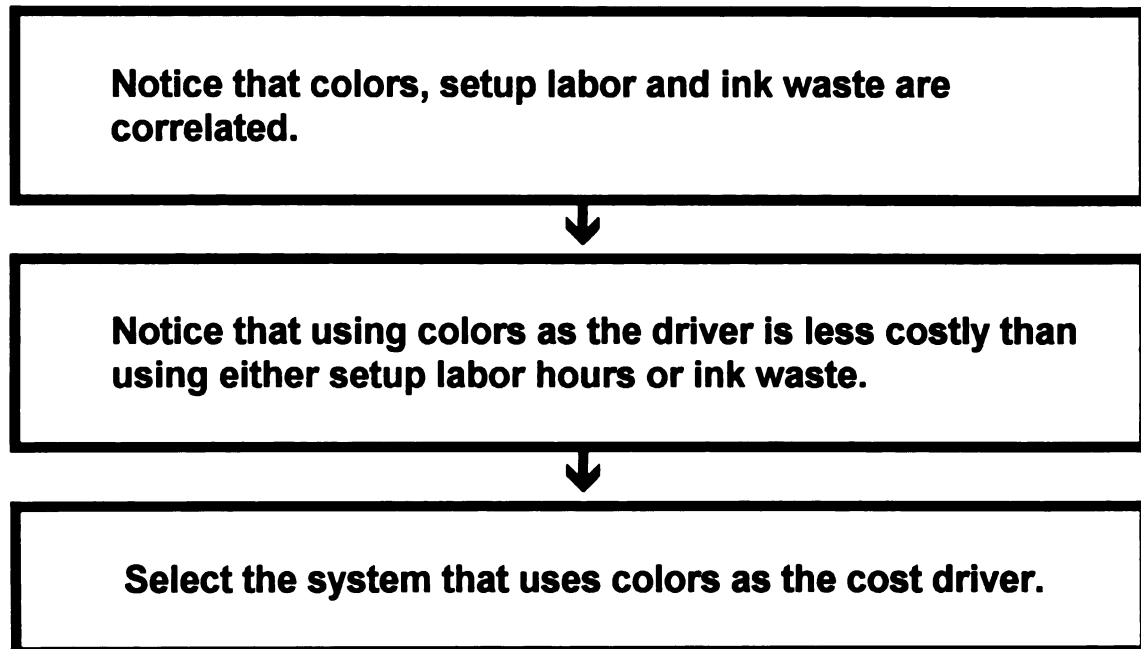
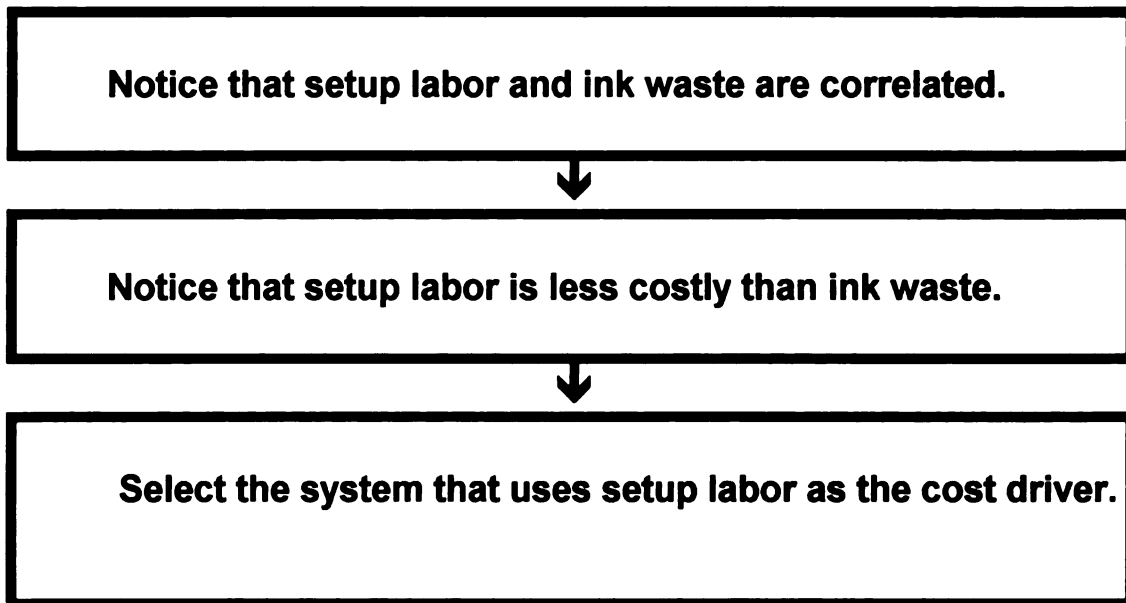


Figure 3.3
Unskilled performer: Tracking cost



In addition to 180 participants discussed in section 3.2.1, nine individuals were identified prior to the experiment as having printing industry experience. Of these nine experienced individuals, six were very familiar with multi-color printing and three were only familiar with single color printing. One individual was a consultant to the printing industry. All nine selected an accurate cost driver. All but one experienced participant selected number of colors as the least costly, most accurate driver. The one individual who failed to select colors as the cost driver was one of the three unfamiliar with multi-color printing.

Other than not being randomized to either the control or treatment condition, the nine experienced participants were treated the same as the other volunteers. Their responses, however, were not included in the statistical analyses for hypotheses testing. Instead, these participants attended the control condition and helped to further validate the case study materials. Prior to taking part in the experiment, none of the experienced individuals were aware that the project related to the printing industry.

3.3.6 Ability variable Ability is measured using the embedded figures test, an instrument which has been validated in previous research and found to have a reliability in excess of .80.

The theory of field independence, discussed in Chapter II, provides the theoretical justification for use of the embedded figures test to measure ability.

The embedded figures instrument has three timed sections, two of which are scored. The first section is unscored and has a two minute time limit. The participant's solutions to the first section are reviewed to ensure familiarity with the requirements of the test before proceeding to the scored sections. The second and third sections of the test include nine questions each and have time limits of five minutes each. Each question requires the participant isolate a simple geometric figure, such as a cube, in a more complex figure. The questions in sections two and three are significantly more difficult than those in the unscored first section. In this study, FD1 refers to the score on section two of the embedded figures test. FD2 refers to the score on section three. The responses to FD1 and FD2 were tested for reliability prior to hypothesis testing and found to be adequate. The sum of both sections, FD1 and FD2, is referred to as FDTOT in the test of hypotheses in the next chapter.

3.3.7 Manipulation checks As a manipulation check on the independent variable, industry training, participants were asked to rate their familiarity with multi-color printing on the post

experiment questionnaire. In addition, after the experiment participants were asked to list the major factors that drive changes in the complexity of the press setup activity. The individuals with industry training were expected to be more familiar with printing and mention colors more frequently than those in the control condition.

3.4 Method of Analysis

3.4.1 Confirmatory factor analysis. Prior to testing the research hypotheses, confirmatory factor analysis was conducted to ensure that the five accuracy responses would form one unidimensional performance measure while the five tracking cost responses would form another.

3.4.2 ANOVA Analysis of variance and graphing were employed to test for interactions. As shown in section 4.4.1, the only significant interaction that occurred related to the two accuracy hypotheses with the management accounting knowledge variable.

3.4.3 Regression. Logistic regression and ordinary least squares(OLS) regression were used to test the hypotheses. In OLS the objective is to find the coefficients that result in the smallest sums of squared distances between the observed and predicted values of the dependent variable. Hence, the method

is called least-squares. Ordinary least squares methods are quite useful but have certain assumptions that need to be considered prior to hypothesis testing. As a consequence, before using OLS, the distributional properties of the accuracy and cost driver selection variables were examined.

In this study, the experimental stimuli had the deliberate effect of classifying participants into one of two mutually exclusive categories, those who performed the task well and those that did not. Essentially, the performance variables are distributed in a pattern similar to a dichotomous variable. This was expected.⁸

Since the responses tended to fall into one of two categories as described above, one of the key assumptions of OLS, normally distributed errors, was violated. To deal with this problem, logistic regression was run using SPSS. Logistic regression does not require as many distributional assumptions as OLS.

Measurement error in the variables was also a concern. To deal with this type of error, linear regression was run twice. The first regression was done assuming perfect measures. A second regression was computed using the same variables but with a corrected correlation matrix. Both OLS regressions and the

⁸ In pilot studies it was found that substantially increasing the number of problem sets did not change the distributional properties of the variables.

logistic regressions are discussed in the next chapter.

3.5 Summary

This chapter contained an overview of the experimental setting, participants, decision task and methods of analysis used in the study. The experimental results follow in the next chapter.

CHAPTER IV DATA ANALYSIS

4.0 Overview

This chapter contains the experimental results of the study. As discussed previously, the experiment was conducted to examine the effects of industry knowledge on cost driver selection. To accomplish this goal, a performance instrument was developed with objective performance criterion.

Confirmatory factor analysis of the performance variables, accuracy and tracking cost, was conducted prior to hypotheses testing. A discussion of the confirmatory factor analysis is presented in section 1. Section 2 reviews the results of manipulation checks on the independent variable, industry knowledge. Section 3 presents descriptive statistics and an examination of the distributional properties of key variables. Section 4 describes the results of the statistical analysis for the accuracy variable. Section 5 discusses the results of the statistical analysis for tracking cost. The final section of this chapter is a summary of overall results.

In the discussions that follow the term, treatment group, is used to describe those subjects who took part in the industry training session. The term, control group, is used to describe all others. On the various charts and tables, Industry = 0 will

designate the control group, while Industry = 1 will designate the treatment group. Similarly, low management accounting knowledge will be depicted as Genknow = 0, and high management accounting knowledge will be referred to as Genknow = 1. For example, a label that combines Genknow = 0 and Industry = 1 will refer to low management accounting knowledge participants who took part in the industry training session.

4.1 Confirmatory Factor Analysis

The confirmatory factor analysis evaluated the accuracy items, tracking cost items and the ability scores in terms of both internal and external consistency. The concept of internal consistency indicates that all the items in a given scale measure the same underlying construct. External consistency (also called parallelism), on the other hand, requires that all the items within a scale relate to items in other scales in a similar fashion. Item by item correlations are typically examined to evaluate both internal and external consistency.

To test for the internal consistency of the accuracy responses, the correlations among the five accuracy questions were examined. Although the correlations among the five items were very high, three of the five questions had close to a perfect

correlation. As a result, the two questions with slightly lower correlations were eliminated. A high correlation among the accuracy responses was expected since participants tended to use the same strategy or heuristic in answering each of the questions. As shown in section 4.3.2, the responses for remaining questions formed a bimodal distribution. Participants tended to consistently succeed or consistently fail.

Once the internal consistency of the accuracy scale had been established, the issue of external consistency needed to be evaluated. As stated in section 3.4.1, a key expectation of this study was that the accuracy responses would form one internally consistent scale while the tracking cost responses would form another. Determining that the responses formed two separate scales was a significant goal of this research. As stated in chapter I, the accuracy part of the task and the tracking cost questions were expected to correspond to different costs associated with sub-optimal systems design decisions. The accuracy aspect of the experimental task was intended to tap into skill at differentiating between accurate and highly distorted cost systems. In contrast, the tracking cost part of the task was intended to measure another aspect of performance, skill at differentiating between systems of equal accuracy but varying

operating costs.

To evaluate external consistency, the correlations between each accuracy item, each tracking cost item and the two ability scores were examined. If externally consistent, one would expect correlations of a similar magnitude between each of the accuracy items and each of the tracking cost and ability items.

Examination of item by item correlations indicated that external consistency was strong. The correlations between each accuracy item and the items in the other two scales were of a similar magnitude. In addition, the correlation between each accuracy response and each outside item was much lower than the correlations among the accuracy items themselves. Since it appears to be both internally and externally consistent, the three item accuracy scale was used in evaluating the hypotheses.

The same approach was taken to evaluate the tracking cost responses. This evaluation resulted in the elimination of one cost driver item. Similar to the accuracy responses, the correlation among the four remaining items was close to 1. Therefore, the four item tracking cost scale was used to test the hypotheses.⁹

⁹ For the accuracy and tracking cost responses, the high correlation among the items precluded the use of standard confirmatory factor analysis programs and made their use unnecessary. Nevertheless, in the interest of completeness, the hypotheses were tested with and without the eliminated items. The results were unchanged.

Several confirmatory factor analysis programs were used to compute the reliability of the two ability items, FD1 and FD2.

According to the programs, the two item ability measure has a standard score coefficient alpha of .88. As a result, the scores on FD1 and FD2 were summed and used in the remaining evaluation of the test hypotheses. The summed ability measure will be referred to as FDTOT.

4.2 Manipulation checks

This next section includes an examination of manipulation checks on the training session.

4.2.1 Manipulation check: Familiarity with printing To check on the effectiveness of the manipulation of industry knowledge, the exit interview questionnaire included the following question about perceived familiarity with multi-color printing.

At this point, how familiar do you feel with commercial multicolor printing?

- (a) very unfamiliar
- (b) unfamiliar
- (c) familiar
- (d) very familiar

The results of this question indicate that the control and the treatment groups were quite different in terms of perceived familiarity with printing. Table 4.1 indicates that only 17 participants out of 70 in the control group felt familiar with multicolor printing. This contrasts with the treatment group who seemed to feel more familiar with multicolor printing. As noted in Table 4.1, 58 out of 73 participants in the industry trained group felt familiar or very familiar with multicolor printing.

Table 4.1
Familiarity with printing

Response	Frequency	
	Industry = 0	Industry = 1
Unfamiliar or very unfamiliar	53	15
Familiar and very familiar	17	58
Total	70	73

The means were computed to be 2.0143 for the control group and 2.8767 for the treatment group. As shown on Table 4.2, the t test indicates that the difference was significant.

Table 4.2
t test: Familiarity

t-tests for Independent Samples of INDUSTRY

Variable	Number of Cases	Mean	SD	SE of Mean

FAMILIAR				
INDUSTRY 0	70	2.0143	.732	.088
INDUSTRY 1	73	2.8767	.622	.073

Mean Difference = -.8624

Levene's Test for Equality of Variances: F= 1.251 P= .265

t-test for Equality of Means					95%
Variances	t-value	df	2-Tail Sig	SE of Diff	CI for Diff

Equal	-7.60	141	.000	.113	(-1.087, -.638)
Unequal	-7.57	135.44	.000	.114	(-1.088, -.637)

4.2.2. Manipulation check: knowledge of colors In addition to familiarity with printing, the training session was also expected to increase awareness of the causal link between colors and production complexity. In particular, it was expected that the industry training session would provide knowledge about the prominence of colors as a characteristic of product that significantly affects press setup.

To help to identify the kind of knowledge that was conveyed by the training session, after the experiment, the participants were asked to list the factors that drive the press setup activity. Industry trained participants were expected to mention colors in the design more frequently than the control group.

Review of the responses indicated that the control and treatment groups differed in their assessment of the link between colors and production complexity. As shown in Table 4.3, only 5 out of 70 participants without industry training mentioned colors in contrast to the majority of the trained participants.

The results of the t test and the Mann-Whitney U test, shown in Panel A and B respectively of Table 4.4, indicate that the treatment and the control group differed in how frequently they mentioned colors.

Table 4.3
Colors

Response	Frequency	
	Industry = 0	Industry = 1
Do not mention colors	65	10
Mention colors	5	63
Total	70	73

The study had predicted that there would be no difference between high and low management accounting knowledge groups related to *acquisition* of industry knowledge. The industry training session was expected to allow both high and low management accounting knowledge participants to easily acquire the knowledge that colors affects press setup. Any difference between high and low management accounting knowledge was expected to relate to the application rather than acquisition of industry knowledge. The t test and Mann-Whitney U test, shown in Table 4.5, suggests that there was no difference between management accounting knowledge groups in terms of knowledge of colors.

Table 4.4
t test: Colors

PANEL A: t tests for Independent Samples of INDUSTRY

Variable	Number of Cases	Mean	SD	SE of Mean
COLORS				
INDUSTRY 0	70	.0714	.259	.031
INDUSTRY 1	73	.8630	.346	.041

Mean Difference = -.7916

Levene's Test for Equality of Variances: F= 6.818 P= .010

t-test for Equality of Means					95%
Variances	t-value	df	2-Tail Sig	SE of Diff	CI for Diff
Equal	-15.42	141	.000	.051	(-.893, -.690)
Unequal	-15.51	133.30	.000	.051	(-.893, -.691)

PANEL B: - - Mann-Whitney U - Wilcoxon Rank Sum W Test

COLORS
by INDUSTRY

Mean Rank	Sum of Ranks	Cases		
43.11	3017.5	70	INDUSTRY =	0
99.71	7278.5	73	INDUSTRY =	1

		143	Total	
U	W	Z	2-Tailed P	
532.5	3017.5	-9.4421	.0000	

Table 4.5
t test: Colors by Genknow

PANEL A: t-tests for Independent Samples of GENKNOW

Variable	Number of Cases	Mean	SD	SE of Mean
COLORS				
GENKNOW 0	65	.4923	.504	.062
GENKNOW 1	78	.4615	.502	.057

Mean Difference = .0308

Levene's Test for Equality of Variances: F= .340 P= .561

t-test for Equality of Means					95%
Variances	t-value	df	2-Tail Sig	SE of Diff	CI for Diff
Equal	.36	141	.716	.084	(-.136, .198)
Unequal	.36	136.19	.716	.084	(-.136, .198)

PANEL B: Mann-Whitney U - Wilcoxon Rank Sum W Test

COLORS
by GENKNOW

Mean Rank	Sum of Ranks	Cases		
73.20	4758.0	65	GENKNOW =	0
71.00	5538.0	78	GENKNOW =	1

		143	Total	
U	W	Z	2-Tailed P	
2457.0	5538.0	-.3656	.7147	

Based on the manipulation checks, the treatment group seemed to be more familiar with the production process than the control group. In addition, industry training seemed to have made colors more salient for the treatment group. In this case, industry training, not management accounting knowledge, appears to make the difference in acquiring industry knowledge.

4.3 An analysis of the properties of the key variables.

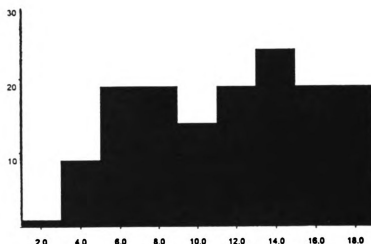
Prior to hypothesis testing, frequency information and descriptive statistics of the key variables are presented. Since the two hypotheses related to accuracy require splitting the sample into low and high management accounting knowledge groups, some of the data are presented for the sample split into applicable sub-groups.

The first section, section 4.3.1, presents descriptive statistics for the one measured independent variable, ability. After the descriptive statistics on ability are shown, a series of t tests examine the equivalence of various groups in terms of ability.

Section 4.3.2, covers the dependent variable, accuracy. The final section, section 4.3.3, covers tracking cost.

4.3.1 Ability A histogram with descriptive statistics for the ability variable is presented in Figure 4.1. The ability scores ranged from a low of 1 to a high of 18. The mean is 11.112, the median is 12 and the mode is 12.

Figure 4.1
Ability Histogram



A series of t tests were also run to test for differences between the control group and treatment groups related to ability. As depicted in table 4.6, the mean score for ability for the control group was 11.1429, while the mean score was 11.0822 for the treatment group. The t test results indicate that the means for the control and treatment groups were not significantly different.

TABLE 4.6
t test of Ability: Full sample
N=143

t-tests for Independent Samples of INDUSTRY

Variable	Number of Cases	Mean	SD	SE of Mean

FDTOT				
INDUSTRY 0	70	11.1429	4.305	.515
INDUSTRY 1	73	11.0822	4.657	.545

Mean Difference = .0607

Levene's Test for Equality of Variances: F= .486 P= .487

t-test for Equality of Means					95%
Variances	t-value	df	2-Tail Sig	SE of Diff	CI for Diff

Equal	.08	141	.936	.751	(-1.424, 1.545)
Unequal	.08	140.81	.936	.750	(-1.421, 1.542)

Since hypothesis testing of the tracking cost variable was conducted with a reduced sample, a second t test was run. The second t test, shown in Table 4.7, indicates that the treatment and control groups were not different in terms of ability.

4.3.2 Accuracy A histogram with descriptive statistics for the accuracy variable is presented in Figure 4.2. The mean is 2.4 and the standard deviation is 1.17. As expected, the distribution appears to be bimodal.

Figure 4.2
Accuracy Histogram

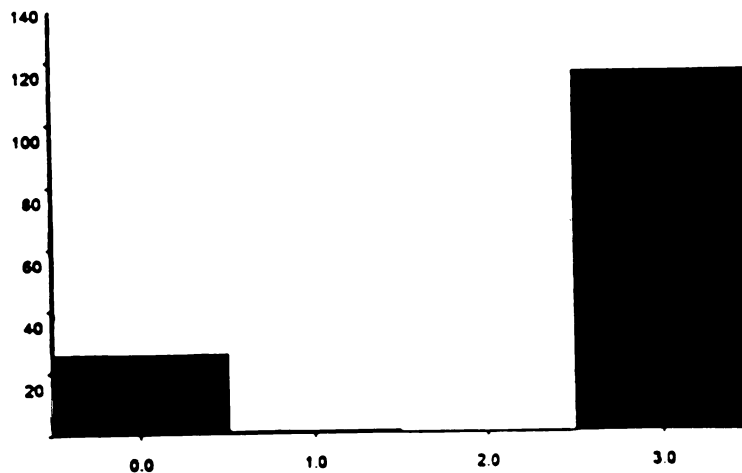


TABLE 4.7
t test of Ability: Reduced sample
N=116

t-tests for Independent Samples of INDUSTRY

Variable	Number of Cases	Mean	SD	SE of Mean

FDTOT				
INDUSTRY 0	48	12.3125	3.855	.556
INDUSTRY 1	68	11.4118	4.565	.554

Mean Difference = .9007

Levene's Test for Equality of Variances: F= 2.489 P= .117

t-test for Equality of Means					95%
Variances	t-value	df	2-Tail Sig	SE of Diff	CI for Diff

Equal	1.11	114	.267	.808	(-.700, 2.502)
Unequal	1.15	110.30	.254	.785	(-.655, 2.456)

Frequency information for the accuracy variable is presented in Table 4.8. Panel A of Table 4.8 splits the whole sample of 143 into treatment and control groups. Panel B splits the sample into management accounting knowledge groups and Panel C shows the low management accounting knowledge group split by treatment.

Panel A indicates that most of the participants were able to select an accurate cost system with 116 out 143 succeeding at the task. Of the 27 participants who failed at the task, 22 were from the control group and 5 were from the treatment group.

Panel B of Table 4.8 provides additional insight by splitting the information into management accounting knowledge categories. It is clear from this data that industry training was unnecessary for the high management accounting knowledge group. According to Panel B, 26 of the 27 low scorers were low management accounting knowledge participants (Genknow = 0).

Panel C presents the data for the low management accounting knowledge group (Genknow = 0) split by industry. The low management accounting knowledge control group (Genknow = 0; Industry = 0) had more difficulty with the accuracy task than the corresponding treatment group (Genknow = 0; Industry = 1).

Table 4.8
Frequencies: Accuracy

PANEL A: BY INDUSTRY

	WHOLE SAMPLE	INDUSTRY = 0	INDUSTRY = 1
1 or less	27	22	5
2 or more	116	48	68
TOTAL	143	70	73

PANEL B: BY MANAGEMENT ACCOUNTING KNOWLEDGE GROUP

	WHOLE SAMPLE	GENKNOW= 0	GENKNOW = 1
1 or less	27	26	1
2 or more	116	39	77
TOTAL	143	65	78

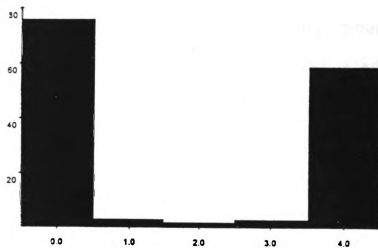
**PANEL C: LOW MANAGEMENT ACCOUNTING KNOWLEDGE BY
INDUSTRY**

	Industry = 0		Industry = 1	
	Freq	Percent	Freq	Percent
1 or less	21	66%	5	15%
2 or more	11	34%	28	85%
TOTAL	32	100%	33	100%

4.3.3 Tracking cost In the analyses that follow, the 27 participants who failed to select an accurate system were excluded. Therefore, the analyses for the tracking cost portion of the task will be based on the reduced sample size of 116.

A histogram with descriptive statistics for the tracking cost responses is presented in Figure 4.3. The mean is 2.2, and the standard deviation is 1.94. As expected, the distribution appears to be bimodal.

Figure 4.3
Tracking cost Histogram



Using a format similar to that of the accuracy variable, frequency information is presented on Table 4.9. Panel A presents the responses split by control and treatment group. The frequency data clearly shows the positive effect of industry knowledge. Of the 62 participants who succeeded at the task, 52 were from the treatment group, while only 10 were from the control group.

Panel B shows the frequencies split by management accounting category. While the results were not as dramatic as the industry training variable, management accounting knowledge also seems to positively affect performance. In particular, the results indicate that 45 out of the 62 high scoring participants were from the high management accounting knowledge group in contrast to 17 from the low management accounting knowledge group.

Panel C, the low management accounting knowledge table, shows that one member of the control group succeeded in comparison to a majority of the treatment group.

Panel D, the high management accounting knowledge group, shows that 9 out of 37 of the control group selected the least costly driver in contrast to 36 out of 40 of the treatment group.

Table 4.9
Frequencies: Tracking cost

PANEL A: BY INDUSTRY

	REDUCED SAMPLE	INDUSTRY =0	INDUSTRY = 1
2 or less	54	38	16
3 or more	62	10	52
TOTAL	116	48	68

PANEL B: BY MANAGEMENT ACCOUNTING KNOWLEDGE GROUP

	REDUCED SAMPLE	GENKNOW= 0	GENKNOW = 1
2 or less	54	22	32
3 or more	62	17	45
TOTAL	116	39	77

**PANEL C: LOW MANAGEMENT ACCOUNTING KNOWLEDGE BY
INDUSTRY**

	Industry =0	Industry =1
2 or less	10	12
3 or more	1	16
TOTAL	11	28

PANEL D: HIGH MANAGEMENT ACCOUNTING KNOWLEDGE BY INDUSTRY

	Industry =0	Industry =1
2 or less	28	4
3 or more	9	36
TOTAL	37	40

4.4 H₁ and H₂: Determinants of skill at accuracy.

H₁ predicted that, for the low management accounting group, industry training would have a positive effect on skill at selecting an accurate cost system. H₂ predicted the positive effect of ability for the same group of participants.

Before proceeding to the test of the hypotheses, two steps were taken to assess the possibility of an interaction. If an interaction occurs, the sample would need to be split. The first step involved plotting the mean values of each dependent variable by independent variable categories. ANOVA was then run to statistically test for the significance of any interaction.

Both steps, graphing and ANOVA, require separating participants into mutually exclusive categories. The categories related to the treatment and management accounting knowledge variables were straightforward. The classification of ability, however, was more complex.

To classify participants as either high or low in ability, the median score on FDTOT of 12 was used as a cut-off. All participants who scored 12 or greater on the FDTOT measure were classified as high ability. Those who scored less than 12 were classified as low ability.¹⁰ On all the figures and tables that

¹⁰ Various cut-offs were used. If there was any indication of an interaction, the applicable groups were split and separate analyses were performed for hypothesis testing purposes.

follow the dichotomized ability variable is labeled as FDDIC12 to differentiate it from the ability variable, FDTOT.

Although scores on the accuracy variable could range from zero to three, the interpretation of the results is most meaningfully viewed in terms of a binary result, success or failure at selecting an accurate system. By design, the experiment involved predicting whether success would occur given different types of knowledge and ability.

A dichotomous dependent variable creates problems for the testing of the hypotheses. The assumptions necessary for ordinary least squares regression analyses are violated. To deal with the problems associated with a binary result, a variety of statistical techniques and approaches were utilized to test the hypotheses. In particular, after ANOVA was run to test for interactions, logistic regression was run with a binary version of the dependent variable.

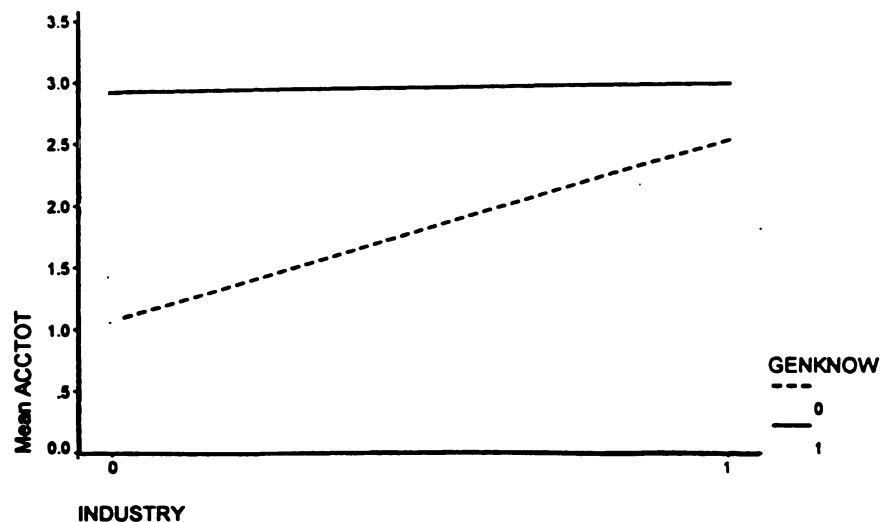
Measurement error in the ability variable is another problem that may mitigate the results. To gauge the effect of measurement error, ordinary least squares regression was run twice. The first ordinary least squares regression assumed perfect measures. The second regression was computed with the correlation matrix corrected for measurement error in the ability

variable.

Both hypotheses, industry training and ability, are tested in sections 4.4.1 through 4.4.3. The first section uses ANOVA and graphs to test for interactions. The logistics regression portion of the analysis is presented next in section 4.4.2. Ordinary least squares is covered in section 4.4.3.

4.4.1 Potential interaction effects: accuracy As Figure 4.4 indicates, industry training provides no additional benefit for the high management accounting knowledge group.

Figure 4.4
Genknow versus Industry: Accuracy



The ANOVA presented in Table 4.10 shows one significant and one marginally significant interaction. Both interactions occur with the management accounting variable. This interaction was expected due to the lack of variance for the accuracy variable with the high management accounting group. Therefore, the analyses that follow for the accuracy variable focus on participants with low levels of management accounting knowledge.

Figure 4.5 plots the means for accuracy by industry training and ability for the low management accounting group. The graph indicates that both industry training and ability effect performance. In addition, the graph makes it appear that the slope of the ability line for the control group is steeper than the slope for the treatment group. Different slopes suggest the possibility of an interaction.

To investigate the possibility of an interaction between industry training and ability for the low management accounting group, ANOVA was rerun. The ANOVA, presented in Table 4.11, shows main effects for industry training and ability. The interaction between ability and industry training is not significant.

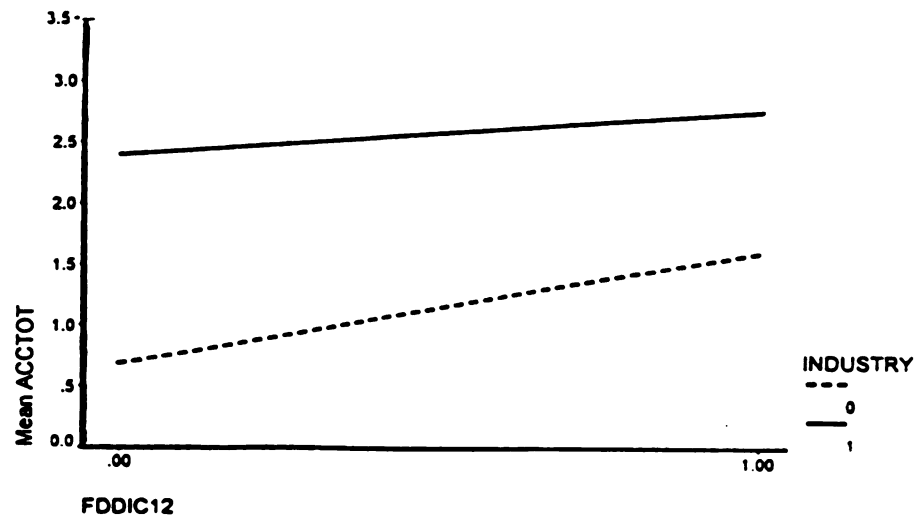
Table 4.10
ANOVA of Accuracy:Full sample

Tests of Significance for ACCURACY using UNIQUE sums of squares					
Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	102.65	135	.76		
FDDIC12	4.79	1	4.79	6.29	.013
GENKNOW	38.87	1	38.87	51.12	.000
INDUSTRY	19.84	1	19.84	26.09	.000
FDDIC12 BY GENKNOW	2.46	1	2.46	3.24	.074
FDDIC12 BY INDUSTRY	1.26	1	1.26	1.65	.201
GENKNOW BY INDUSTRY	14.71	1	14.71	19.34	.000
FDDIC12 BY GENKNOW BY INDUSTRY	.25	1	.25	.33	.566
(Model)	90.60	7	12.94	17.02	.000
(Total)	193.24	142	1.36		
R-Squared =	.469				
Adjusted R-Squared =	.441				

Table 4.11
ANOVA of Accuracy: Genknow = 0

Tests of Significance for ACCURACY using UNIQUE sums of squares					
Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	94.29	61	1.55		
INDUSTRY	32.11	1	32.11	20.77	.000
FDDIC12	6.59	1	6.59	4.27	.043
INDUSTRY BY FDDIC12	1.23	1	1.23	.80	.376
(Model)	43.49	3	14.50	9.38	.000
(Total)	137.78	64	2.15		
R-Squared =	.316				
Adjusted R-Squared =	.282				

Figure 4.5
Industry versus Ability: Accuracy



4.4.2 Logistic regression. To accommodate logistic regression, a binary version of the dependent variable was created by collapsing the accuracy variable into the two mutually exclusive categories. Participants who scored at least two out of three questions correctly were classified as having succeeded at the task. Those who scored one or less were classified as having failed. The variable, *accdic*, is used to differentiate it from the dependent variable, *accuracy*.

Logistic regression was computed with industry training,

ability and gender being entered into the model as potential predictors.¹¹ As Panel A of Table 4.12 shows, industry training and ability were the only predictors to enter the equation. Gender was insignificant.

The classification table presented in Panel B of Table 4.12 indicates that the model correctly predicted the success or failure of 52 participants out of 65. The off-diagonal counts of 5 and 8 are observations that were not correctly classified by the model. Overall, the interpretation of this observation is that the model allowed the correct classification of 80% of the participants.

Another way to assess goodness of fit is to review the Model Chi-Square statistics shown in Panel C of Table 4.12. The model Chi-Square tests the null hypothesis that the coefficients of industry training and ability are zero. The small significance value indicates that the null hypothesis should be rejected. For the low management accounting knowledge group, industry training and ability appear to affect performance.

4.4.3 OLS regression The results of the OLS regression, as shown in Table 4.13, are consistent with the logistic regression analysis in that industry training and ability are

¹¹ Prior accounting research (Awathi and Pratt, 1990) found a gender effect. Gender was entered in all regressions to eliminate this factor as a potential explanatory predictor.

Table 4.12
Logistic regression of Accdic

PANEL A: LOGISTIC REGRESSION EQUATION

----- Variables in the Equation -----							
Variable	B	S.E.	Wald	df	Sig	R	Exp(B)
INDUSTRY	2.7040	.6870	15.4926	1	.0001	.3927	14.9395
FDTOT	.1913	.0821	5.4336	1	.0198	.1981	1.2109
Constant	-2.6190	.9662	7.3478	1	.0067		
----- Model if Term Removed -----							
Based on Conditional Parameter Estimates							
Term Removed	Log Likelihood	-2 Log LR	df	Significance of Log LR			
INDUSTRY	-42.335	21.540	1	.0000			
FDTOT	-34.712	6.295	1	.0121			
----- Variables not in the Equation -----							
Residual Chi Square		.560 with	1 df	Sig = .4543			
Variable	Score	df	Sig	R			
GENDER	.5599	1	.4543	.0000			

PANEL B: Classification Table for ACCDIC

		Predicted		Percent Correct
		.00	1.00	
Observed		0 "	1	
.00	0	" 18 "	8 "	69.23%
1.00	1	" 5 "	34 "	87.18%
		Overall		80.00%

PANEL C: Chi-Square Statistics

	Chi-Square	df	Significance
Model Chi-Square	24.362	2	.0000
Improvement	6.125	1	.0133

Table 4.13
OLS regression of Accuracy

Multiple R	.57611
R Square	.33190
Adjusted R Square	.29905
Standard Error	1.22844

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	3	45.73109	15.24370
Residual	61	92.05352	1.50907

F = 10.10136 Signif F = .0000

----- Variables in the Equation -----

Variable	B	SE B	Beta	T	Sig T
INDUSTRY	1.498535	.306590	.514567	4.888	.0000
FDTOT	.100201	.038921	.275847	2.575	.0125
GENDER	-.166515	.322232	-.055641	-.517	.6072
(Constant)	.148995	.437109		.341	.7344

significant. Gender is not significant. The conclusion is unchanged when measurement error in ability is considered. As shown in Table 4.14, industry training and ability are the only significant variables.

In conclusion, as shown in figure 4.6, the results supported H_1 , the positive effect of industry training and H_2 , the positive effect of ability for those with low levels of management accounting knowledge.

The study had predicted that industry training would provide the treatment group with knowledge about the complexity of the production process in a multi-color printing plant. Based on the results, such knowledge appeared to help the treatment group recognize the effect of a change in product mix on production complexity.

Ability also seemed to affect performance for the low management accounting group. Since the slides and scripts provided no explicit accounting information, the successful participant needed to make the connection between a change in production complexity and the need to abandon the simplistic cost driver heuristic shown in figure 2.1. According to the manipulation check discussed in section 4.2.2, most of the treatment group recognized the relationship between colors and

Table 4.14
Corrected OLS regression of Accuracy

Multiple R	.58471
R Square	.34189
Adjusted R Square	.30952
Standard Error	1.21923

Analysis of Variance

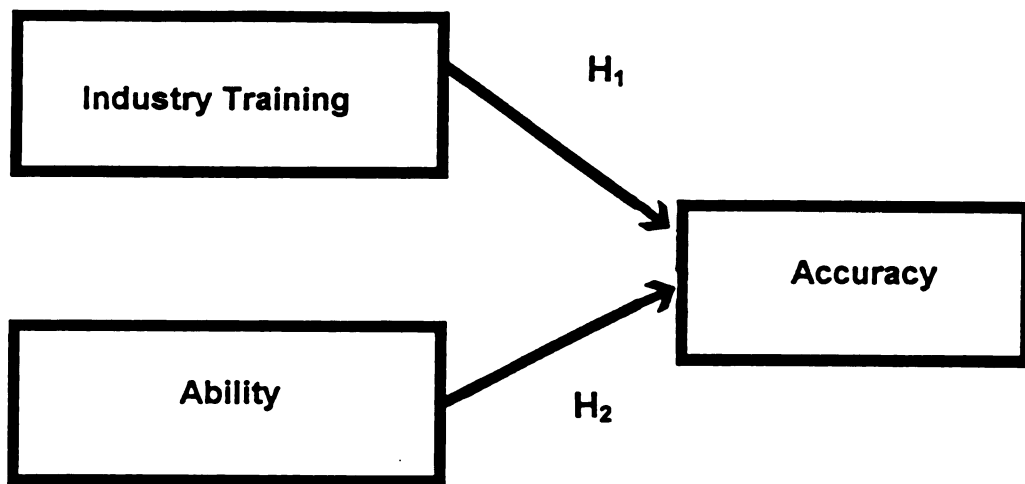
	DF	Sum of Squares	Mean Square
Regression	3	47.10688	15.70229
Residual	61	90.67773	1.48652

F = 10.56312 Signif F = .0000

----- Variables in the Equation -----

Variable	B	SE B	Beta	T	Sig T
INDUSTRY	1.498946	.304287	.514708	4.926	.0000
FDTOT	.107024	.038684	.294630	2.767	.0075
GENDER	-.184096	.320275	-.061516	-.575	.5675
(Constant)	.089522	.433512		.207	.8371

Figure 4.6
Accuracy Hypotheses



production complexity. Nevertheless, certain of the lower ability participants appeared to have difficulty applying that knowledge to the task at hand. It is conceivable that, for the low management accounting group, the task was somewhat novel and difficult. Given a novel task, a positive effect of ability would be expected and would be consistent with previous behavioral research. Auditing behavioral research (Bonner and Lewis, 1990; Libby and Tan ,1994) suggests that novel tasks require ability.

In contrast, neither industry training nor ability seem to be needed if management accounting knowledge is high. One explanation of this result focuses on the effect of strong data analysis skills on performance. During debriefing many of the high management accounting participants cited recent training in regression as a key factor in their success. Previous regression training may have sensitized participants to importance of carefully examining patterns of resource usage. Knowledge of data analysis techniques may be critical to application of substantive knowledge about the production process to system design decisions. As such, the results provide some preliminary evidence that superior knowledge of data analysis techniques may be able to substitute for both industry training and ability. In this study, high levels of management accounting knowledge,

specifically familiarity with regression, seemed to allow participants to know when to abandon the simple cost driver selection rule.¹²

4.5 H₃ and H₄: determinants of skill at noticing tracking cost

H₃ predicted that industry training would positively affect the tracking cost portion of the problem while H₄ predicted the positive effect of management accounting knowledge. Similar to the results with accuracy, the first section of hypothesis testing includes an analysis using graphs and ANOVA to test for interaction effects. Both hypotheses were tested using logistic regression and OLS regression.

To make the tracking cost variable suitable for logistic regression, the responses were dichotomized into those who got three out of four cost driver questions correct and those who did not. The binary cost driver variable is shown as trackdic to differentiate it from the tracking cost variable. In dichotomizing the tracking cost variable, two borderline cases were noted in which the participants scored exactly two out of the four questions correctly. It could be argued that these two cases are difficult to classify as either successes or failures. Therefore, the statistical tests were run with and without these cases. The results were

¹² The recent training in regression involved a class project unrelated to printing and activity-based costing.

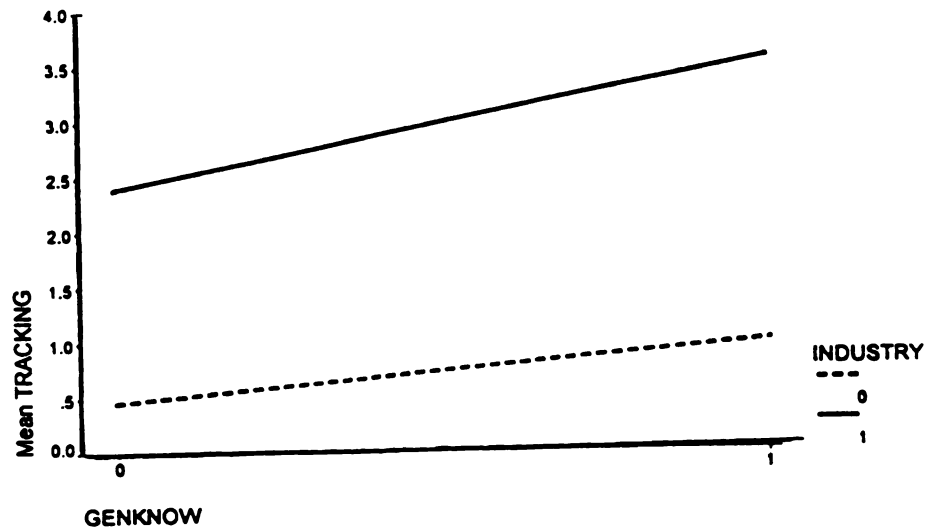
not substantially changed with the exclusion of the borderline cases.

Each test was run first with all 116 participants and then with the borderline cases eliminated. Section 4.5.1 covers the ANOVA results. Section 4.5.2 covers the logistic regression results. Section 4.5.3 through section 4.5.5 cover OLS regression. Section 4.5.3 shows regression results assuming perfect measures. Section 4.5.4. shows the results with the borderline cases eliminated. Section 4.5.5 presents the linear regression results when the two borderline cases are eliminated and the resulting correlation matrix is corrected for measurement error in ability.

4.5.1 Potential interaction effects: tracking cost A series of five graphs were developed to examine the potential for two-way and three-way interactions. The two way interactions are examined in figure 4.7 through figure 4.9. The three way interactions are considered in figures 4.10 and 4.11.

Figure 4.7 , the management accounting knowledge versus industry training graph, indicates that industry knowledge and management accounting knowledge have positive effects on performance. There is no indication of an interaction.

Figure 4.7
Genknow versus Industry: Tracking cost



The graph of industry training versus ability, Figure 4.8, shows a positive effect for industry training. The ability line is slightly positive for both the treatment and control groups. There is no indication of an interaction.

Figure 4.8
Industry versus Ability: Tracking cost

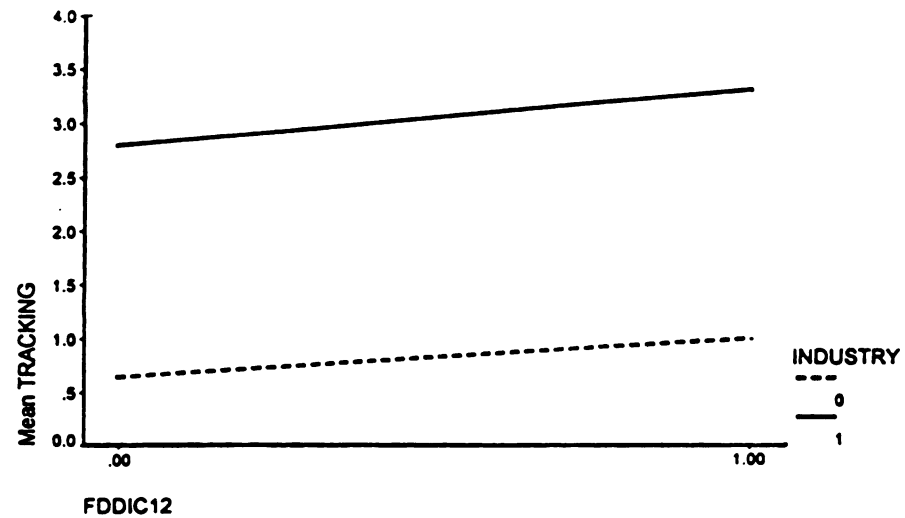
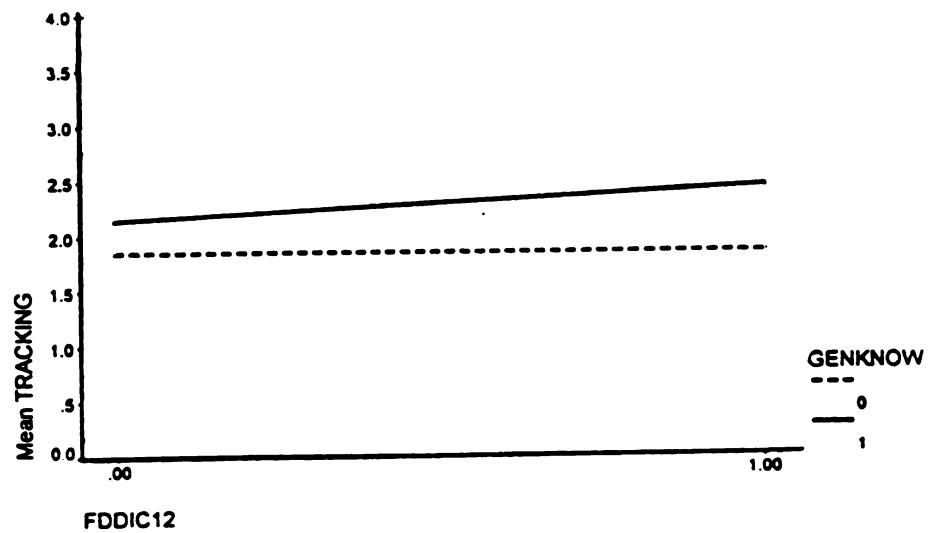


Figure 4.9, the management accounting knowledge and ability graph, shows a positive management accounting knowledge effect and little or no effect for ability. The ANOVA results, shown in Table 4.15 and Table 4.16, indicate that the interaction between management accounting knowledge and ability is not significant.

Figure 4.9
Genknow by Ability:Tracking cost



The next two charts were developed to examine the possibility of a three way interaction. To accomplish this, the sample was first split into high and low management accounting knowledge groups and the means for each management accounting knowledge group were plotted by industry training and ability.

TABLE 4.15
ANOVA of Tracking cost

Tests of Significance for tracking cost using UNIQUE sums of squares					
Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	268.14	108	2.48		
INDUSTRY	110.76	1	110.76	44.61	.000
GENKNOW	15.53	1	15.53	6.26	.014
FDDIC12	2.83	1	2.83	1.14	.288
INDUSTRY BY GENKNOW	1.36	1	1.36	.55	.461
INDUSTRY BY FDDIC12	.24	1	.24	.10	.757
GENKNOW BY FDDIC12	.14	1	.14	.06	.812
INDUSTRY BY GENKNOW BY FDDIC12	.51	1	.51	.20	.652
(Model)	166.41	7	23.77	9.57	.000
(Total)	434.55	115	3.78		
R-Squared =	.383				
Adjusted R-Squared =	.343				

TABLE 4.16
ANOVA of Trackdic

Tests of Significance for Trackdic using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	18.08	108	.17		
INDUSTRY	6.91	1	6.91	41.28	.000
GENKNOW	1.23	1	1.23	7.36	.008
FDDIC12	.08	1	.08	.48	.489
INDUSTRY BY GENKNOW	.11	1	.11	.68	.410
INDUSTRY BY FDDIC12	.01	1	.01	.04	.834
GENKNOW BY FDDIC12	.01	1	.01	.05	.827
INDUSTRY BY GENKNOW BY FDDIC12	.04	1	.04	.22	.639
(Model)	10.78	7	1.54	9.20	.000
(Total)	28.86	115	.25		
R-Squared =	.374				
Adjusted R-Squared =	.333				

Figure 4.10, the high management accounting knowledge graph shows a large industry training effect with the ability line showing virtually no effect on performance.

Figure 4.10
Industry versus Ability: Tracking cost
Genknow = 1

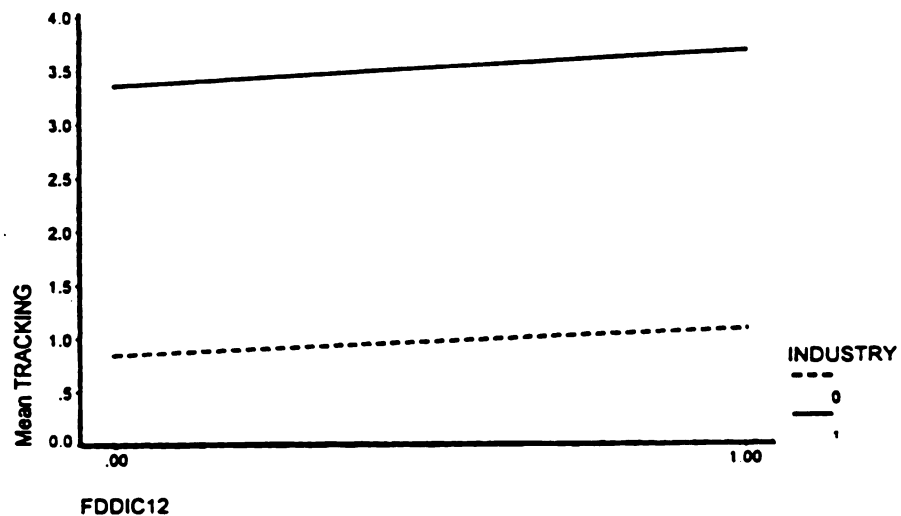
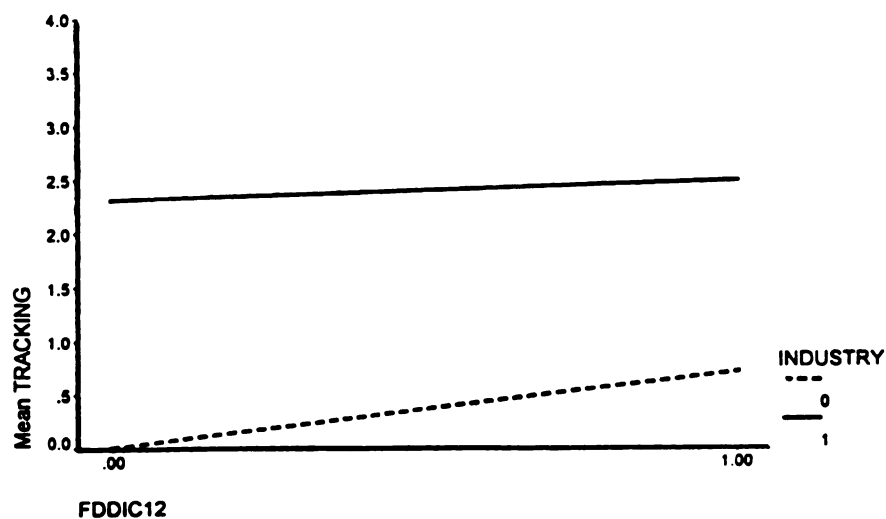


Figure 4.11, the low management accounting knowledge graph, also shows a large industry effect. Although the ability line for the control group appears slightly steeper than the ability line for the treatment group, the ANOVA results indicate that the interaction is not significant.

Figure 4.11
Industry by Ability: Tracking cost
Genknow = 0



4.5.2 Logistic Regression Industry training, management accounting knowledge, ability and gender were entered into the model as potential predictors of success. As the results in Panel A of Table 4.17 indicate, industry training and management accounting knowledge were the only predictors to enter the equation. Ability and gender were not significant.

Table 4.17
Logistic regression of trackdic: N=116

PANEL A: LOGISTIC REGRESSION EQUATION:

----- Variables in the Equation -----							
Variable	B	S.E.	Wald	df	Sig	R	Exp(B)
INDUSTRY	3.1732	.5734	30.6246	1	.0000	.4226	23.8847
GENKNOW	1.7499	.5759	9.2336	1	.0024	.2125	5.7541
Constant	-2.8290	.6440	19.2958	1	.0000		
----- Model if Term Removed -----							
Based on Conditional Parameter Estimates							
Term Removed	Log Likelihood	-2 Log LR	df	Significance of Log LR			
INDUSTRY	-80.348	48.390	1	.0000			
GENKNOW	-61.967	11.627	1	.0007			
----- Variables not in the Equation -----							
Residual Chi Square		1.539 with	2 df	Sig = .4633			
Variable	Score	df	Sig	R			
FDTOT	1.5268	1	.2166	.0000			
GENDER	.0250	1	.8744	.0000			

PANEL B: Classification Table

		Predicted		Percent Correct
		.00	1.00	
Observed	0	0	1	
		"	"	
.00	0	38	16	70.37%
1.00	1	10	52	83.87%
Overall				77.59%

PANEL C: Chi-Square Statistics

	Chi-Square	df	Significance
Model Chi-Square	47.951	2	.0000
Improvement	11.021	1	.0009

In terms of goodness of fit, the classification table presented in Panel B of Table 4.17, indicates that the model allowed correct classification of 77.59% of the participants.

The Chi-square statistics presented in Panel C show that the model containing the industry training and management accounting knowledge variables is significant.

Logistic regression was rerun with the two borderline cases eliminated. The results, shown in Table 4.18, were not substantially different.

4.5.3 OLS regression. OLS regression, shown in Table 4.19, assumes perfect measurement and indicates that industry and management accounting knowledge are the only significant variables. Ability and gender were not significant at conventional levels. OLS Regression was also run using the binary dependent variable, trackdic. The results, shown in Table 4.20, are not substantially different.

4.5.4 OLS regression- without the borderline cases The regression program was run again without the borderline cases. The results are shown in Table 4.21 and Table 4.22. Consistent with the logistic regression, industry training and management accounting knowledge were the only two variables entering the regression equation.

Table 4.18
Logistic regression of trackdic: N=114

PANEL A: LOGISTIC REGRESSION:

----- Variables in the Equation -----							
Variable	B	S.E.	Wald	df	Sig	R	Exp(B)
INDUSTRY	3.1594	.5725	30.4548	1	.0000	.4255	23.5569
GENKNOW	1.6836	.5780	8.4832	1	.0036	.2031	5.3847
Constant	-2.7340	.6428	18.0890	1	.0000		
----- Model if Term Removed -----							
Based on Conditional Parameter Estimates							
Term Removed	Log Likelihood	-2 Log LR	df	Significance of Log LR			
INDUSTRY	-78.897	47.887	1	.0000			
GENKNOW	-60.223	10.539	1	.0012			
----- Variables not in the Equation -----							
Residual Chi Square		1.911 with		2 df	Sig = .3847		
Variable	Score	df	Sig	R			
FDTOT	1.9054	1	.1675	.0000			
GENDER	.0145	1	.9040	.0000			

PANEL B: Classification Table

		Predicted				Percent Correct
		.00	1.00			
		0	"	1		
Observed	.00	0	"	37	"	71.15%
	1.00	1	"	10	"	83.87%
Overall						78.07%

PANEL C: Chi-Square Statistics

	Chi-Square	df	Significance
Model Chi-Square	47.252	2	.0000
Improvement	10.005	1	.0016

Table 4.19
OLS regression of Tracking cost: N=116

Multiple R .61979
 R Square .38414
 Adjusted R Square .36194
 Standard Error 1.55275

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	4	166.92775	41.73194
Residual	111	267.62398	2.41103

F = 17.30878 Signif F = .0000

----- Variables in the Equation -----

Variable	B	SE B	Beta	T	Sig T
INDUSTRY	2.421341	.298897	.616143	8.101	.0000
GENKNOW	.857610	.318923	.209323	2.689	.0083
FDTOT	.052600	.034676	.116115	1.517	.1321
GENDER	.088670	.292889	.022687	.303	.7627
(Constant)	-.474352	.509692		-.931	.3540

Table 4.20
OLS regression of Trackdic: N=116

Multiple R	.61033
R Square	.37250
Adjusted R Square	.34989
Standard Error	.40393

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	4	10.75125	2.68781
Residual	111	18.11082	.16316

F = 16.47341 Signif F = .0000

----- Variables in the Equation -----

Variable	B	SE B	Beta	T	Sig T
INDUSTRY	.611731	.077755	.604008	7.867	.0000
GENKNOW	.247308	.082964	.234220	2.981	.0035
FDTOT	.010862	.009020	.093038	1.204	.2311
GENDER	.008946	.076192	.008882	.117	.9067
(Constant)	-.120137	.132591		-.906	.3669

Table 4.21
OLS regression of Tracking cost: N=114

Multiple R	.62115
R Square	.38583
Adjusted R Square	.36329
Standard Error	1.56467

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	4	167.63907	41.90977
Residual	109	266.85216	2.44818

F = 17.11871 Signif F = .0000

----- Variables in the Equation -----

Variable	B	SE B	Beta	T	Sig T
INDUSTRY	2.439374	.302966	.615066	8.052	.0000
GENKNOW	.840855	.323674	.203038	2.598	.0107
FDTOT	.051754	.035125	.113511	1.473	.1435
GENDER	.069023	.297237	.017503	.232	.8168
(Constant)	-.455895	.514656		-.886	.3777

Table 4.22
OLS regression of Trackdic: N=114

Multiple R	.61436
R Square	.37744
Adjusted R Square	.35460
Standard Error	.40190

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	4	10.67431	2.66858
Residual	109	17.60639	.16153

F = 16.52098 Signif F = .0000

----- Variables in the Equation -----

Variable	B	SE B	Beta	T	Sig T
INDUSTRY	.612732	.077820	.605563	7.874	.0000
GENKNOW	.233090	.083140	.220610	2.804	.0060
FDTOT	.012108	.009022	.104091	1.342	.1824
GENDER	.006744	.076349	.006703	.088	.9298
(Constant)	-.116657	.132196		-.882	.3795

4.5.5 OLS regression---Corrected for measurement error

The regressions were rerun with the correlation matrix corrected for measurement error in ability. As shown in Table 4.23, industry training and management accounting knowledge are the only variables that enter the equation. One more regression was run without the borderline cases and with the correlation matrix corrected for measurement error in ability. The results shown in Table 4.24 are not substantially different from the previous regressions. Accounting for measurement error and exclusion of the borderline cases did not change the conclusions regarding determinants of performance.

In conclusion, as shown in figure 4.12, the results supported H₃, the positive effects of industry training, and H₄, the positive effects of management accounting knowledge. Both industry training and management accounting knowledge seem to affect skill at selecting the least costly driver.

To succeed, the participant needed to notice that resources were used in direct proportion to the number of colors and that the color driver was least costly to track. The positive effect shown for industry training suggests that knowledge of the production process helps participants identify the number of colors as a major factor affecting press setup complexity.

Table 4.23
Corrected OLS regression of Tracking cost: N=116

Multiple R	.62225
R Square	.38720
Adjusted R Square	.36511
Standard Error	1.54889

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	4	168.25718	42.06429
Residual	111	266.29455	2.39905

F = 17.53373 Signif F = .0000

----- **Variables in the Equation** -----

Variable	B	SE B	Beta	T	Sig T
INDUSTRY	2.427020	.298248	.617588	8.138	.0000
GENKNOW	.841504	.318741	.205392	2.640	.0095
FDTOT	.058715	.034679	.129614	1.693	.0932
GENDER	.087991	.292153	.022514	.301	.7638
(Constant)	-.538762	.508465		-1.060	.2916

Table 4.24
Corrected OLS regression of Tracking cost: N=114

Multiple R	.62320
R Square	.38838
Adjusted R Square	.36593
Standard Error	1.56142

Analysis of Variance

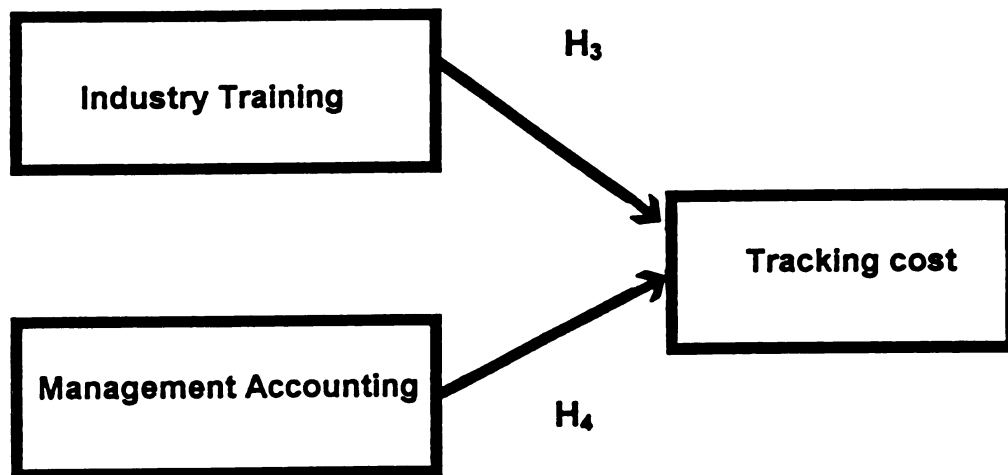
	DF	Sum of Squares	Mean Square
Regression	4	168.74676	42.18669
Residual	109	265.74446	2.43802

F = 17.30365 Signif F = .0000

----- Variables in the Equation -----

Variable	B	SE B	Beta	T	Sig T
INDUSTRY	2.444379	.302428	.616328	8.083	.0000
GENKNOW	.824697	.323845	.199136	2.547	.0123
FDTOT	.057079	.035167	.125189	1.623	.1075
GENDER	.068820	.296614	.017451	.232	.8170
(Constant)	-.510471	.513374		-.994	.3223

Figure 4.12
Tracking cost Hypotheses



Though knowledge of the link between color and the complexity of press setup seems beneficial, familiarity with management accounting also has an effect on performance. This result was expected since the industry training scripts and slides contain no explicit information about the accounting implications of the relationship between colors and resource usage. Nor did the scripts use terms such as cost driver or correlation in describing the production process. For those reasons, management accounting knowledge may have helped the participant recognize the accounting significance of the relationship between resource use and colors. In this study, both industry training and management accounting knowledge increased the participant's likelihood of success.

4.6 Summary

Sections 1 discussed the confirmatory factor analysis for both dependent variables. As a result of the confirmatory factor analysis, a three item scale was used for the accuracy variable and a four item scale was used for the tracking cost variable.

Before testing the hypotheses, manipulation checks were examined. The manipulation of industry knowledge appeared to work well for the both high and low management accounting knowledge participants. Industry training allowed easy

acquisition of knowledge about the link between colors and production complexity.

The experimental results supported both H_1 , the positive effect of industry training, and H_2 , the positive effect of ability for the low management accounting group. The positive effect of ability suggests industry training alone does not guarantee success. This result may indicate that ability is critical to *application* of industry knowledge when management accounting knowledge is low. Among those with low levels of management accounting knowledge, lower ability participants appeared to have difficulty in applying industry knowledge to the accuracy task. In contrast, nearly all of the high management accounting knowledge participants were able to distinguish between an accurate and distorted cost system. Due to recent training in regression, the high management accounting group may have been more aware of the importance of examining resource patterns than their low management accounting counterparts. As a consequence, industry training and ability had no effect on performance for the high management accounting group.

H_3 , the positive effects of Industry training, and H_4 , the positive effects of management accounting knowledge, were supported. Industry training appears to help participants identify

color as a factor affecting production complexity. Management accounting knowledge appears to help participants recognize the accounting implications of the relationship between colors and resource use.

The chapter that follows summarizes the study and provides suggestions for future extensions to this work.

CHAPTER V CONCLUSION

5.0 Overview

In this chapter, a summary of the research results is presented, including a discussion of the limitations, contributions and future extensions of the research. A summary of the research results is presented in the first section. Limitations are discussed in Section 2. Contributions and future extensions in systems are presented in Section 3. Contributions related to education are discussed in Section 4 and future extensions related to economic implications are shown in the final section.

5.1 Summary of Results.

In the current study, superior management accounting knowledge allowed high and low ability participants to identify inaccurate systems without the benefit of specific industry training. In contrast, given the same task, ability and industry training showed a positive effect on performance for low management accounting knowledge participants. For the low management accounting knowledge group, industry training and ability seemed to mitigate a tendency to rely on an inappropriate heuristic for cost driver selection. The results suggests that low management accounting knowledge participants have difficulty

identifying when a simple heuristic does not apply. One preliminary implication of this finding is that superior levels of management accounting knowledge may allow participants to differentiate between significant and superficial aspects of a given problem. Competence at differentiating between relevant and irrelevant facts may assist the skilled performer at recognizing when simple decision rules need to be abandoned.

In terms of the tracking cost part of task, both types of knowledge, industry specific and general management accounting, positively affected performance. Whereas the high management accounting knowledge participant brings superior command of data manipulation techniques to the task, the industry trained participant brings knowledge of the production process. Both types of knowledge appear to aid the participant in noticing the high correlation among competing cost drivers.

5.2. Limitations

The stated objective in the performance instrument was to find the most accurate driver subject to minimizing tracking costs. Using an accuracy criterion is consistent with previous analytical work on cost driver optimization (Babad and Balachandran, 1993). By adopting an accuracy criterion, the experiment did not ask participants to explicitly quantify the cost of making incorrect

decisions. As a consequence, participants were not making a tradeoff between the opportunity cost of incorrect decisions and tracking costs. This simplification of the task was done for reasons of experimental control and to avoid an extremely long experimental session for the participants. In an earlier version of the instrument, the correct cost driver answer required the participant to explicitly compute the opportunity cost of an incorrect decision in terms of a single decision and single decision maker. The overwhelming response from pretest participants was that the single decision single decision maker setting was unrealistic. Using a single decision setting was also judged unrealistic for the institutional setting chosen for this study, package printing. In package printing, the practical uses of cost information include a variety of decisions including contract negotiation, capital investment decisions and long term strategic planning issues. Adding multiple decisions to the experimental stimuli would have required a significant increase in the length and complexity of the experiment. In addition, participants may have different attitudes about the costs associated with making incorrect decisions. This difference in attitude would be expected to confound the results making it impossible to classify a response as right or wrong. Therefore,

the final version of the experimental stimuli asks the subject to select the most accurate set of cost drivers subject to minimizing tracking costs.

The study also assumes perfect correlations between the number of colors in the design and the components of variable setup cost. In reality, some variance from planned resource usage would be expected. In this particular industry, however, there is an extremely high correlation between the between number of colors and setup resource usage. In the course of validating the case materials, a package plant controller reviewed all the resource and cost information and judged them to be realistic. Beyond that, the study had six participants who had multi-color printing experience.¹³ One of these individuals was a trained accountant who works as a consultant to the printing industry. All six of the experienced individuals answered the accuracy and tracking cost aspects of the task correctly *without* the benefit of the industry training session. During debriefing, all six individuals indicated that the materials appeared realistic based on their personal experiences in the field.

Another potential limitation is that this study focused on cost driver selection in one major industry. In addition, the scope of

¹³ The six individuals were not part of the statistical results. Please refer to section 3.3.3.

the industry knowledge manipulation was deliberately limited for reasons of experimental control. Therefore, the results may not be applicable to other tasks and other institutional settings. Nevertheless, demonstrating the effect of a specific element of knowledge on performance is a logical starting point for a research agenda that examines the relationship between technology and knowledge in an ABC environment. If knowledge reduces task complexity in cost driver selection, similar knowledge effects may be applicable in other tasks and settings. In fact, Libby and Luft (1993) make the following suggestion to accounting behavioral researchers outside the audit area:

"We recommend a similar approach to that taken in the audit literature, beginning with an analysis of key attributes of the settings and task requirements. (p.40)"

5.3 Contributions and Future Extensions: Systems

By providing insight about individual differences in performance, this study has two major implications for systems development. First, the research provides preliminary evidence on the effect of different types of knowledge on cost driver selection. The results suggest that both management accounting knowledge and industry training contribute to simplification of the

process of selecting and evaluating cost drivers. The preliminary evidence about different types of knowledge may be helpful in developing guidelines for selection of team members for cost system development projects. Including individuals with different perspectives may enhance the productivity of an ABC development team. It is conceivable that a team comprised of individuals with different cost perspectives may have synergies that would facilitate the design of ABC systems. An extension of this current research could examine the effects of management accounting and industry specific knowledge in a group decision making setting.

Second, a better understanding of knowledge effects is also expected to help systems designers build effective cost systems. By increasing awareness of knowledge effects, this study is expected to highlight the need to consider individual differences when designing computer-based decision aids. The user interfaces and decision aids are likely to be quite different depending upon the expertise level assumed for the user of the system. Future research is expected to use the results of this study to plan experiments that examine the relationship between knowledge and specific decision aids.

5.4 Contributions: Education

By examining the relationship between performance and individual differences, this research has implications for designing training and instructional materials. The research results may be helpful in designing learning experiences that allow efficient acquisition of knowledge in formal educational settings. This study demonstrated that a short presentation on real world production processes can dramatically improve participants' performance.

5.5 Future extensions --- Economic Implications

In this study, knowledgeable individuals were able to recognize situations in which use of a simplistic heuristic would result in a system with distorted costs. Skill at recognizing when to abandon a simple decision rule may be a valuable skill in dealing with a less than accurate cost accounting system. Surveys of practice have consistently shown that decision makers rely heavily on costs to set prices (Cornick, et al.1988, Govindarajan and Anthony, 1983). By recognizing distortions in cost, the knowledgeable system user may be able to minimize the opportunity cost of relying on an inaccurate cost system. The well-trained user, as a component of the management accounting

system, may be able to compensate for lack of accuracy in the accounting system. The quality of the decisions made may depend not only on the formal accounting system but also on the type and level of expertise of the systems user.

One extension of this research would examine the economic implications of transferring knowledge from human experts to the formal control system. Jensen and Meckling (1992) indicate that control systems are a means of dealing with diverse knowledge and decision rights within a decentralized institutional setting.

According to Jensen and Meckling, effective firms carefully consider the costs and benefits of transferring knowledge and decision rights. Firms that are adopting ABC may have found it impractical to continue to rely on human expertise. The decision to replace the cost system may reflect a decision to transfer some of the human expertise to the control system.

APPENDIX A

APPENDIX A

THE INDUSTRY TRAINING SESSION

The training session was derived from training materials developed and used by the industry trade association (Flexographic Technical Association, 1991; Flexographic Technical Association, 1986 ; Flexographic Technical Association and Graphics Arts Technical Foundation, 1982). According to the industry expert, the material includes a sufficient amount of basic information to provide an understanding of the fundamentals of the production process to non-technical employees. Typically, the materials are used for in-plant training of salesman, accountants, marketing managers, personnel managers and other non-technical employees.

The training materials were reviewed by two committee members with extensive management accounting experience. To keep the treatment to a reasonable length, some material was eliminated as part of this review process. For example, flexographic printing can accommodate two types of design, line art and continuous-tone art. The industry training materials include a sizable amount of information about both types of design. The case materials in this study, on the other hand, only involve one type of design, line art. Therefore, the decision was made to exclude the material related to continuous-tone art for purposes of this study.

Before a final decision was made about which material to use in the study, the industry expert was again consulted. The industry expert, who had administered the training materials countless times, had specific suggestions given the scope and objective of this study. These suggestions were incorporated into the treatment used in this study. The final training package used in this study included 30 audio visual slides and scripts covering the following topics:

1. History of printing
2. Pre-Press activities
3. Printing Press Equipment
4. Press setup

The first series of slides provide an overview of the history of printing. The history lesson includes a review of products that use packages that are printed with flexography. The products shown in the slides include many common, everyday products. A key characteristic of the products shown in the slides is the use of packaging with multiple colors in the design.

After the history slides are shown, the next group of slides cover key activities done prior to press setup. The descriptions of these activities imply that there is a relationship between the complexity of the job and the number of colors in the design.

Two additional slides show other products that make use of flexography in their packaging. The scripts related to these slides discuss the

fact that many companies feel that colorful packaging helps to sell their product.

The next series of slides and scripts cover the components of a typical printing press. The central impression press, the same equipment used by the company in the case materials, is highlighted in this part of the lesson. These slides also introduce the significance of the print station in flexographic printing. Modern flexographic presses have up to eight print stations which allow printing up to eight colors with one pass through the printing press.

Press setup is covered in two slides. The first slide shows a central impression press with the print stations around a metal cylinder. The next slide summarizes the activities that go into setting up a central impression press for a multi-color job. The accompanying script states that the number of print stations that need to be used on any given job depends on the number of colors to be printed. The lesson concludes with more examples of products that use printed packaging.

APPENDIX B

APPENDIX B

CASE STUDY

Mike Thompson's printing press setup costs.

Background

Mike Thompson is the owner of a printing business that supplies printed bags to food businesses. Until recently, all of Mike's business was printed in one plant located in the town of Webfield. Last week, Mike finalized the acquisition of another printing plant in the nearby town of Scotsport.

Mike plans to judiciously schedule production at both plants to maximize profitability. As a result, some of the jobs that are currently produced at Webfield may eventually be produced at Scotsport and visa versa.

Because of the acquisition of Scotsport, Mike hired you as a consultant. He wants you to make a recommendation about the adequacy of his current record keeping practices given the acquisition of the Scotsport business. Your first priority is to examine the record keeping practices surrounding press setup. Mike wants accurate information about variable setup costs but he doesn't want to spend any more than necessary tracking the data.

What is involved in the Press setup activity?

Because of the large size of the press machinery, each printing press requires two press operators be involved in setting up the press.

Setting up the press requires the press operators place the printing plate cylinders for that particular job onto the printing press. The printing plate cylinder holds the image to be printed for the given production run. Then the operators place ink into an ink pan. Once these steps are done, the printed images are aligned with each other. Lastly, the press machinery is started and the settings between and among the various component parts of the press are made.

Current Record Keeping Practices

Currently, the Webfield plant does not track any information about variable setup costs on a per order basis. Instead, management keeps track of total variable setup costs on an aggregate basis. Last year, total variable setup costs were \$98,000 for 500 customer orders. Total variable setup costs consists of three types of the costs: (1) \$45,000 in setup labor (2) \$40,500 in ink wasted during setup and (3) \$12,500 for plastic film setup rolls. A total of 750 setup labor hours, 13,500 pounds of ink and 500 setup rolls were used in setting up the 500 customer orders last year.

The practice of relying on averages has led to the use of a "Rule of Thumb" that estimates variable setup cost at flat amount of \$196.00 per order. The "Rule of Thumb" of \$196.00 per order is very accurate for estimating variable setup costs for the Webfield business. Although each customer orders their bags to their own design specifications, the setup costs of any two of these orders tends to be very similar.

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The Typical Webfield order

The typical order currently produced at the Webfield plant has the following specifications:

Type of design	line art
# of setups per order	1
# of setup rolls per setup	1
# of colors in the design	3
# of setup labor hours per setup	1.5
# of ink lbs wasted per setup.	27

As the above specifications show, printing for the typical Webfield customer requires only one press setup per order. This is because these customers are willing to take shipment of a whole order of bags at once. This has allowed Mike to print each customer's individual order in one single press run. As a consequence, the cost per order and the cost per setup are both \$196.00 for these customers. (\$196.00 per setup X 1 setup per order = \$196.00 per order). Mike is confident that the variable setup cost for these orders will continue to be \$196.00 per order in the future.

The Scotsport Plant

Mike is much less certain about using \$196.00 per order to estimate the setup costs for the Scotsport customers. Although the newly acquired Scotsport plant is virtually identical to the Webfield plant in production capacity, the typical orders produced at each individual plant may be different. Mike wants you to compare the typical Webfield order to the typical Scotsport order and compute an estimate of the annual variable setup cost for the Scotsport customers.

In computing variable costs, Mike assures you that the setup labor rate per hour, the ink price per pound and cost per setup roll for the Webfield and Scotsport plants are the same and are expected to remain so in the future. There are only two salient differences between the two plants: (1) the specifications of the typical order currently produced at each location and (2) the total number of customer orders each plant currently produces.

After you compute an annual variable cost amount, Mike also wants you to recommend whether or not he needs to keep track of more detailed information (called a cost driver) about each order. He wants the cheapest system that provides him with accurate costs.

To help you in the cost driver part of the assignment, Mike reduced the number of cost driver alternatives you need to evaluate to the five listed in Table 1 on the next page. The five alternatives along with the annual tracking cost of each are shown on the next page. One of the five alternatives is to maintain the current system and continue to use the \$196.00 per order to compute variable setup costs for the Webfield and Scotsport business. One of the advantages of the current system is that it doesn't cost anything to maintain. This advantage is lost, however, if the using the current system would result in

inaccurate variable setup costs. Mike works on long-term contracts and needs accurate cost information.

Table 1
Annual Tracking Costs

Alternative Number	Alternative Systems Designs	Annual Tracking Cost
1	# of orders (the current system)	\$0
2	# of setups per order	\$1,000
3	# of colors in the design & # of setups	\$2,500
4	# of setup hours per setup & # of setups	\$3,000
5	# of ink lbs wasted per setup & # of setups	\$10,000

Alternatives 2 - 5 shown above require that Mike keep track of additional information over and above the number of orders.

Required:

You will be given 10 different problem sets (numbered 1-10) and asked to complete the same two questions shown for each. Answer each of the problem sets **INDEPENDENTLY** of the others.

The two questions are as follows:

- a. What is the annual variable setup cost for the Scotsport customers?(Five multiple choice answers will be provided for each of these questions.)

In completing this question, you should first determine the accurate cost per order for the Scotsport business. This requires that you compare the specifications of the Webfield and Scotsport orders. Once you have computed the accurate setup cost per order for the Scotsport business, use the following formula to compute annual variable costs.

$$\text{Annual costs (Scotsport business)} = \text{Scotsport cost per order} \times \# \text{ of Scotsport orders.}$$

- b. Which of the following alternatives will allow computation of accurate variable setup costs per order at the lowest tracking cost?

- (1) # of orders (the current system)
- (2) # of setups per order
- (3) both # of setups per order and the # of colors in the design
- (4) both # of setups per order and the # of setup hours per setup
- (5) both # of setups per order and the # of ink lbs wasted per setup.

For this question, assume that accurate costs per order are needed and select the system that is accurate and the least costly.

PLEASE SHOW YOUR WORK

(Continue to Next Page)

Problem Set 1

Given the background information, supplemental information and the following additional information about the Scotsport customers, answer questions a and b below:

**Estimated Annual Order Quantity and Variable Setup cost
Webfield vs. Scotsport Customers**

	Webfield	Scotsport
# of orders per year	600	450
Variable Setup cost per year	\$98,000	?

**Specifications of the The Typical Order
Webfield versus Scotsport**

	Webfield	Scotsport
# of setups per order	1	1
# of setup rolls used per setup	1	1
# of colors in the design	3	3
# of setup hours per setup	1.5	1.5
# of ink lbs wasted per setup	27	27
Variable setup costs per order	\$196.00	?

a. What is the annual variable setup cost for the Scotsport customers?

- (1) \$196.00
- (2) \$98,000
- (3) \$186,200
- (4) \$88,200
- (5) none of the above.

b. Which of the following alternatives will allow computation of accurate variable setup costs per order at the lowest tracking cost?

- (1) # of orders (the current system)
- (2) # of setups per order
- (3) both # of setups per order and the # of colors in the design
- (4) both # of setups per order and the # of setup hours per setup
- (5) both # of setups per order and the # of ink lbs wasted per setup.

Problem Set 2

Given the background information, supplemental information and the following additional information about the Scotsport customers, answer questions a and b below:

**Estimated Annual Order Quantity and Variable Setup cost
Webfield vs. Scotsport Customers**

	Webfield	Scotsport
# of orders per year	500	200
Variable Setup cost per year	\$98,000	?

**Specifications of the The Typical Order
Webfield versus Scotsport**

	Webfield	Scotsport
# of setups per order	1	3
# of setup rolls used per setup	1	1
# of colors in the design	3	3
# of setup hours per setup	1.5	1.5
# of ink lbs wasted per setup	27	27
Variable setup costs per order	\$196.00	?

a. What is the annual variable setup cost for the Scotsport customers?

- (1) \$117,600
- (2) \$102,600
- (3) \$294,000
- (4) \$39,200
- (5) none of the above.

b. Which of the following alternatives will allow computation of accurate variable setup costs per order at the lowest tracking cost?

- (1) # of orders (the current system)
- (2) # of setups per order
- (3) both # of setups per order and the # of colors in the design
- (4) both # of setups per order and the # of setup hours per setup
- (5) both # of setups per order and the # of ink lbs wasted per setup.

Problem Set 3

Given the background information, supplemental information and the following additional information about the Scotsport customers, answer questions a and b below:

**Estimated Annual Order Quantity and Variable Setup cost
Webfield vs. Scotsport Customers**

	Webfield	Scotsport
# of orders per year	500	50
Variable Setup cost per year	\$98,000	?

**Specifications of the The Typical Order
Webfield versus Scotsport**

	Webfield	Scotsport
# of setups per order	1	6
# of setup rolls used per setup	1	1
# of colors in the design	3	3
# of setup hours per setup	1.5	1.5
# of ink lbs wasted per setup	27	27
Variable setup costs per order	\$196.00	?

a. What is the annual variable setup cost for the Scotsport customers?

- (1) \$9,800
- (2) \$51,300
- (3) \$58,800
- (4) \$588,000
- (5) none of the above.

b. Which of the following alternatives will allow computation of accurate variable setup costs per order at the lowest tracking cost?

- (1) # of orders (the current system)
- (2) # of setups per order
- (3) both # of setups per order and the # of colors in the design
- (4) both # of setups per order and the # of setup hours per setup
- (5) both # of setups per order and the # of ink lbs wasted per setup.

Problem Set 4

Given the background information, supplemental information and the following additional information about the Scotsport customers, answer questions a and b below:

**Estimated Annual Order Quantity and Variable Setup cost
Webfield vs. Scotsport Customers**

	Webfield	Scotsport
# of orders per year	500	300
Variable Setup cost per year	\$98,000	?

**Specifications of the The Typical Order
Webfield versus Scotsport**

	Webfield	Scotsport
# of setups per order	1	4
# of setup rolls used per setup	1	1
# of colors in the design	3	3
# of setup hours per setup	1.5	1.5
# of ink lbs wasted per setup	27	27
Variable setup costs per order	\$196.00	?

a. What is the annual variable setup cost for the Scotsport customers?

- (1) \$392,000
- (2) \$235,200
- (3) \$58,800
- (4) \$205,200
- (5) none of the above.

b. Which of the following alternatives will allow computation of accurate variable setup costs per order at the lowest tracking cost?

- (1) # of orders (the current system)
- (2) # of setups per order
- (3) both # of setups per order and the # of colors in the design
- (4) both # of setups per order and the # of setup hours per setup
- (5) both # of setups per order and the # of ink lbs wasted per setup.

Problem Set 5

Given the background information, supplemental information and the following additional information about the Scotsport customers, answer questions a and b below:

**Estimated Annual Order Quantity and Variable Setup cost
Webfield vs. Scotsport Customers**

	Webfield	Scotsport
# of orders per year	500	100
Variable Setup cost per year	\$98,000	?

**Specifications of the The Typical Order
Webfield versus Scotsport**

	Webfield	Scotsport
# of setups per order	1	5
# of setup rolls used per setup	1	1
# of colors in the design	3	3
# of setup hours per setup	1.5	1.5
# of ink lbs wasted per setup	27	27
Variable setup costs per order	\$196.00	?

a. What is the annual variable setup cost for the Scotsport customers?

- (1) \$19,600
- (2) \$490,000
- (3) \$85,500
- (4) \$98,000
- (5) none of the above.

b. Which of the following alternatives will allow computation of accurate variable setup costs per order at the lowest tracking cost?

- (1) # of orders (the current system)
- (2) # of setups per order
- (3) both # of setups per order and the # of colors in the design
- (4) both # of setups per order and the # of setup hours per setup
- (5) both # of setups per order and the # of ink lbs wasted per setup.

Problem Set 6

Given the background information, supplemental information and the following additional information about the Scotsport customers, answer questions a and b below:

**Estimated Annual Order Quantity and Variable Setup cost
Webfield vs. Scotsport Customers**

	Webfield	Scotsport
# of orders per year	500	90
Variable Setup cost per year	\$98,000	?

**Specifications of the The Typical Order
Webfield versus Scotsport**

	Webfield	Scotsport
# of setups per order	1	6
# of setup rolls used per setup	1	1
# of colors in the design	3	2
# of setup hours per setup	1.5	1
# of ink lbs wasted per setup	27	18
Variable setup costs per order	\$196.00	?

a. What is the annual variable setup cost for the Scotsport customers?

- (1) \$75,060
- (2) \$81,560
- (3) \$17,640
- (4) \$105,840
- (5) none of the above.

b. Which of the following alternatives will allow computation of accurate variable setup costs per order at the lowest tracking cost?

- (1) # of orders (the current system)
- (2) # of setups per order
- (3) both # of setups per order and the # of colors in the design
- (4) both # of setups per order and the # of setup hours per setup
- (5) both # of setups per order and the # of ink lbs wasted per setup.

Problem Set 7

Given the background information, supplemental information and the following additional information about the Scotsport customers, answer questions a and b below:

**Estimated Annual Order Quantity and Variable Setup cost
Webfield vs. Scotsport Customers**

	Webfield	Scotsport
# of orders per year	500	300
Variable Setup cost per year	\$98,000	?

**Specifications of the The Typical Order
Webfield versus Scotsport**

	Webfield	Scotsport
# of setups per order	1	4
# of setup rolls used per setup	1	1
# of colors in the design	3	4
# of setup hours per setup	1.5	2
# of ink lbs wasted per setup	27	36
Variable setup costs per order	\$196.00	?

a. What is the annual variable setup cost for the Scotsport customers?

- (1) \$58,800
- (2) \$303,600
- (3) \$273,600
- (4) \$235,200
- (5) none of the above.

b. Which of the following alternatives will allow computation of accurate variable setup costs per order at the lowest tracking cost?

- (1) # of orders (the current system)
- (2) # of setups per order
- (3) both # of setups per order and the # of colors in the design
- (4) both # of setups per order and the # of setup hours per setup
- (5) both # of setups per order and the # of ink lbs wasted per setup.

Problem Set 8

Given the background information, supplemental information and the following additional information about the Scotsport customers, answer questions a and b below.

**Estimated Annual Order Quantity and Variable Setup cost
Webfield vs. Scotsport Customers**

	Webfield	Scotsport
# of orders per year	500	400
Variable Setup cost per year	\$98,000	?

**Specifications of the The Typical Order
Webfield versus Scotsport**

	Webfield	Scotsport
# of setups per order	1	2
# of setup rolls used per setup	1	1
# of colors in the design	3	1
# of setup hours per setup	1.5	.5
# of ink lbs wasted per setup	27	9
Variable setup costs per order	\$196.00	?

a. What is the annual variable setup cost for the Scotsport customers?

- (1) \$156,800
- (2) \$78,400
- (3) \$65,600
- (4) \$45,600
- (5) none of the above.

b. Which of the following alternatives will allow computation of accurate variable setup costs per order at the lowest tracking cost?

- (1) # of orders (the current system)
- (2) # of setups per order
- (3) both # of setups per order and the # of colors in the design
- (4) both # of setups per order and the # of setup hours per setup
- (5) both # of setups per order and the # of ink lbs wasted per setup.

Problem Set 9

Given the background information, supplemental information and the following additional information about the Scotsport customers, answer questions a and b below:

**Estimated Annual Order Quantity and Variable Setup cost
Webfield vs. Scotsport Customers**

	Webfield	Scotsport
# of orders per year	500	80
Variable Setup cost per year	\$98,000	?

**Specifications of the The Typical Order
Webfield versus Scotsport**

	Webfield	Scotsport
# of setups per order	1	7
# of setup rolls used per setup	1	1
# of colors in the design	3	5
# of setup hours per setup	1.5	2.5
# of ink lbs wasted per setup	27	45
Variable setup costs per order	\$196.00	?

a. What is the annual variable setup cost for the Scotsport customers?

- (1) \$173,600
- (2) \$15,680
- (3) \$109,760
- (4) \$159,600
- (5) none of the above.

b. Which of the following alternatives will allow computation of accurate variable setup costs per order at the lowest tracking cost?

- (1) # of orders (the current system)
- (2) # of setups per order
- (3) both # of setups per order and the # of colors in the design
- (4) both # of setups per order and the # of setup hours per setup
- (5) both # of setups per order and the # of ink lbs wasted per setup.

Problem Set 10

Given the background information, supplemental information and the following additional information about the Scotsport customers, answer questions a and b below:

**Estimated Annual Order Quantity and Variable Setup cost
Webfield vs. Scotsport Customers**

	Webfield	Scotsport
# of orders per year	500	60
Variable Setup cost per year	\$98,000	?

**Specifications of the The Typical Order
Webfield versus Scotsport**

	Webfield	Scotsport
# of setups per order	1	2
# of setup rolls used per setup	1	1
# of colors in the design	3	6
# of setup hours per setup	1.5	3
# of ink lbs wasted per setup	27	54
Variable setup costs per order	\$196.00	?

a. What is the annual variable setup cost for the Scotsport customers?

- (1) \$41,040
- (2) \$11,760
- (3) \$44,040
- (4) \$23,520
- (5) none of the above.

b. Which of the following alternatives will allow computation of accurate variable setup costs per order at the lowest tracking cost?

- (1) # of orders (the current system)
- (2) # of setups per order
- (3) both # of setups per order and the # of colors in the design
- (4) both # of setups per order and the # of setup hours per setup
- (5) both # of setups per order and the # of ink lbs wasted per setup.

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