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Editors

Amy E. Hurley-Hanson, Ph.D.
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🕊 In Memory of Ellen Fagenson Eland 🕊

It is with great sadness that we write of the passing of Professor Ellen Fagenson-Eland. The news of Ellen's passing came as a great shock to us. Ellen was a wonderful person. She was very proud of our editorship of the journal and when Amy wrote to her to invite her to be on JBM's editorial board, her response was "Congratulations on your great accomplishment! I know that you will be a great editor!" Her first thought was of someone else and not herself. She also said she would be honored to be on the board. We came to find out later that this was all happening as she was beginning to deal with her illness. Ellen was supportive of our leadership from the beginning. Although she did not live to see this first issue under our editorship, we can only hope she would be very pleased with it. Ellen had very high standards. She did not give breaks to anyone, even close friends. She lived what she worked. She wrote of mentoring, and she was a great mentor. She wrote of leadership, and she was a wonderful leader. She wrote of balancing work life, and she was a terrific mother and wife. She wrote of respecting life, and she did not eat animals. She wrote of being a good person, and she was a great person.



This issue is dedicated to Ellen Fagenson Eland and everything she meant to all of us.

In order to further the work to which Dr. Eland dedicated her professional life, a scholarship fund has been established in her honor. The objective of the fund is to carry on Dr. Eland's legacy of scholarly research in the areas of leadership, justice, equity and business mentoring.

To make a donation to the scholarship fund, please make your check payable to **The Ellen Fagenson Eland Leadership & Justice Fund, Inc.** and mail it to their Virginia office at the following address: 2265 Cedar Cove Court, Reston, VA 20191.

Thank you so much for your support of the Fund and for helping extend the legacy of this truly special woman, professor, researcher and mother.

World Class Manufacturing: Blueprint for Success

Paul Mylnek

Mark A. Vonderembse

S. Subba Rao

Bhal J. Bhatt

The University of Toledo

Manufacturers are facing new challenges as global competition accelerates and supply chain management intensifies. Consumers are demanding short delivery times for customized products with exceptional quality and high performance. To respond, firms are examining their strengths and weaknesses and considering how to change their practices and capabilities to be effective world-class competitors. This paper provides managers with an overview of World Class Manufacturing, describes a process to implement it, and discusses building commitment for it. To succeed, firms should set business goals and understand customer expectations, define the essential competencies needed to achieve those goals, create metrics for each competency, establish target levels for each metric, develop plans and programs to achieve the targets, organize and manage the implementation process, and evaluate and revise the efforts as needed.

Expanding global competition, rapidly changing markets, and the world-wide spread of advanced manufacturing technology are creating a complex and uncertain environment (Bayus, 1994; Manufacturing Studies Board, 1986). As customers become more demanding and global competition intensifies, manufacturers feel the pressure to meet tighter quality, cost, and delivery requirements (Doll & Vonderembse, 1991; Skinner, 1985). To effectively respond to these challenges, many manufacturers are striving to become world-class competitors.

Simply stated, world-class manufacturers design, produce, and deliver products that delight customers and enable firms to compete with the best in the world (Schonberger, 1996). World Class Manufacturing (WCM) is a process, based on employee development and involvement, that unites key cross-functional actions such as product development (Wheelwright & Clark, 1995), material acquisition (Senter & Flynn, 2000; Tracey & Vonderembse, 2000), lean manufacturing (Womack & Jones, 1996), and quality management (Deming, 1986; Juran, 1981a, 1981b) in ways that meet precisely specified customer requirements. Success is achieved by (1) setting business goals and understanding customer expectations, (2) defining essential manufacturing competencies that determine a firm's ability to meet or exceed customer expectations, (3) creating metrics for these competencies, (4) benchmarking performance, (5) determining target levels for each metric, (6) developing plans and programs that enable the firm to meet these targets, (7) organizing and managing the implementation process, and (8) evaluating performance and revising the system. When properly executed, these actions lead to customer satisfaction and positive business results (Gunn, 1992; Schonberger, 1996).

For many years, manufacturing was an internally focused activity aimed primarily at efficiency and cost reduction. Employees often completed tasks without understanding the effects of their actions on customers. The internal focus was perpetuated by separating critical functions such as marketing, engineering, manufacturing, purchasing, and quality control. This separation was often described as the "over-the-wall" approach to manufacturing. These walls inhibited direct and continuous interaction between functions and shielded decision-makers from internal and external customers. The results of separating tasks by functions are the loss of time, information, and money, and the creation of finished products that do not meet customer needs (Doll & Vonderembse, 1991). World-class manufacturers build cross-functional processes that focus outward on customers and build strategic relationships with internal and external suppliers (Swinehart, Miller, & Hiranyavasi, 2000). These efforts at supply chain management and customer relationship management unify actions and focus attention on the customers of the final rather than intermediary products (Panizzolo, 1998; Schonberger, 1996).

This paper provides practicing managers with an overview of WCM as an integrated, cross-functional effort that focuses on customers and strives for business success. Its primary contributions are to describe a process for implementing WCM and to discuss ways to build commitment for its success. The paper provides managers with a set of actions to guide implementation and a set of metrics to measure performance.

World Class Manufacturing

WCM is a cross-functional process for designing, producing, and delivering goods that delight customers and lead to exceptional organizational performance. It combines skills and resources from various functions to focus on opportunities and threats in the environment. By seeking leadership in the global marketplace, organizations are choosing to be "world-class." The popularity of Richard

Schonberger's *World Class Manufacturing: The Next Decade* (1996) helps to raise awareness and give definition to a new and better approach to manufacturing.

At the strategic level, Gilgeous and Gilgeous (1999) describe a framework for success that shows how programs and their enablers combine to link company strategy to activities at the operating level in order to achieve manufacturing excellence. Munda and Hendry (2002a, 2002b) describe the development and implementation of WCM for firms involved in make-to-order operation. This approach relates the organization's areas of strength to key make-to-order principles and ultimately to potential improvements. Swinehart, Miller, and Hiranyavasi (2000) describe strategies that can be used to achieve WCM status in a globally competitive environment. These strategies require manufacturing operations to be externally supportive and play a key role in helping firms build a competitive advantage. Flynn, Schroeder, and Flynn (1999) provide strong support for the use of WCM, alone and in combination with other manufacturing practices, as a way to achieve competitive advantage. In a survey of 229 Canadian firms, Lagace and Bourgault (2003) provide insights into the association between WCM and competitive positioning.

Billo, Needy, and Bidanda (1996) discuss the supporting role played by information technology (IT) in companies seeking WCM outcomes while Saxena and Sahay (2000), in their survey of Indian manufacturing, stress the need to align IT initiative with WCM objectives. As part of a longitudinal case study of a Swedish firm, Lind (2001) discovered that WCM involves change in methods of control, empowerment, and the process for implementing new ideas.

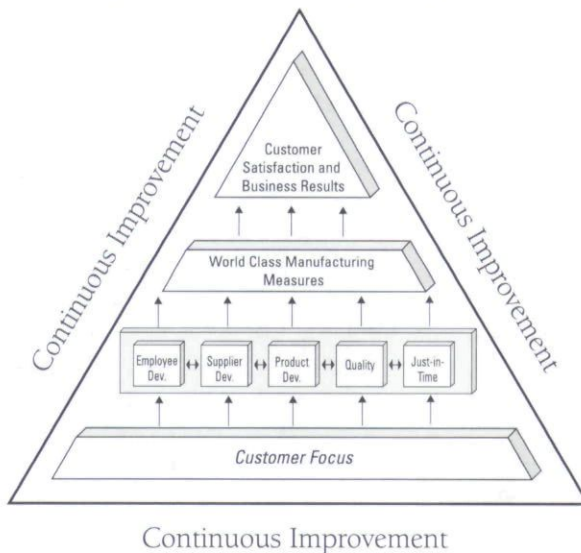
Gunn (1992) describes the WCM environment as having sophisticated customers, global manufacturing systems, a faster pace and wider scope of activities, and an emphasis on product quality.

1. **Sophisticated Customers:** Increasing consumer sophistication and wealth as well as more sophisticated marketing are leading to a proliferation of products that target more diverse tastes and accommodate special market niches (Clark & Fujimoto, 1991; Cooper & Kleinschmidt, 1994). The growth in stock keeping units (SKUs) compounds manufacturing complexity exponentially. This increases the need for flexible systems to design, produce, and deliver these products (Blackburn, 1991; Doll & Vonderembse, 1991).
2. **Global Manufacturing Systems:** Design expertise and production capabilities are sourced globally. Subassemblies may be produced on three different continents while final assembly takes place on a fourth. Coordination and control are managed through integrated, worldwide information and distribution systems that work to meet customer needs (Flaherty, 1996; Hill, 2000).
3. **Pace and Scope of Business Activities:** Time and distance are being compressed by the electronic movement of information in all forms including television's influence on consumer desires, electronically connected markets, and the influence of e-mail, fax machines, and mobile telephones on management styles. Business activities that took weeks now take days, or are performed in "real time" (Blackburn, 1991).

4. **Demand for Higher Quality:** Customers cannot afford to buy unreliable products. Their lifestyles and schedules leave little time for getting products serviced or returning defective ones to their supplier. The conventional wisdom that zero defects is unachievable has been debunked by a flood of products that work and work well (Deming, 1986, 2000; Juran 1981a, 1981b).

As illustrated in Figure 1, WCM focuses on customers, relies on critical manufacturing competencies, and develops measures that lead to customer satisfaction and positive business results (Gunasekaran, 2000; Schonberger, 1996). The key differences between WCM and traditional manufacturing begin with a shift in focus from internal operations to customers. Employees and suppliers must understand customer needs and how their efforts impact those needs. Key competencies shift from engineering effectiveness, quality control, and efficiency to employee development (Badore, 1992), supplier development (Handfield and Nichols, 1999), product development (Clark & Fujimoto, 1991), quality improvement efforts (Deming, 1986, 2000; Juran, 1981a, 1981b), and just-in-time (JIT) (Mondon, 1983). As organizations adopt WCM principles, outcome measures tend to become multi-dimensional with throughput time, supplier capability, employee skills, and other measures being added to more traditional financial measures such as labor costs or material variances.

Figure 1: World Class Manufacturing Model



The top of the WCM model lists the overall goals, which are customer satisfaction and business results. Good customer service has long been a primary objective of manufacturers. Over time, the objective with respect to customers has changed as the word “service” became “satisfaction” or even “delight.” From meeting specifications and delivery dates reasonably well, the criteria now include anything relevant to ensuring complete customer satisfaction. The Malcolm Baldrige National Quality Award describes business results as key measures and/or indicators of company

operational and financial performance. Surrounding the WCM model is continuous improvement. Striving to achieve WCM status is an on-going, iterative process that seeks continuous improvements to meet rising expectations. Recognizing, evaluating, and acting on opportunities for improvement set world-class manufacturers apart from their competitors.

Process for Implementing World Class Manufacturing

Even though WCM depends heavily on continuous improvement, initiating these concepts and ideas may require radical change (Hammer, 1996). Radical change requires top management commitment, support, and involvement. Each of those words implies different things. Top management commitment implies the consent of organizational leadership to pursue WCM. Top management support is the allocation of sufficient resources in people and capital to design and implement WCM. It requires the time and talent of the best and brightest people from across the organization. Top management involvement includes the time of top executives in defining the concept of WCM, communicating its importance, and breaking down barriers to change (Gunasekaran, 2000; Hammer, 1996; Schonberger, 1996).

Success requires a process that integrates WCM initiatives into the business planning process. A process for achieving this integration, illustrated in Figure 2, has eight steps.

1. Set *business goals* and understand *customer expectations*,
2. Define essential *manufacturing competencies*,
3. Create *metrics* for these competencies,
4. *Benchmark* performance,
5. Determine *target* levels for each metric,
6. Develop *plans* and *programs* to achieve the targets,
7. *Organize and manage the implementation process*, and
8. *Evaluate performance and revise the systems*.

While steps 1, 7, and 8 may apply generally to the achievement of any radical change, it is important to discuss each briefly. The primary focus is on understanding manufacturing competencies, metrics, benchmarks, targets, plans and programs, and implementation.

Business Goals and Customer Expectations

Business goals and customer expectations are two sides of the same coin. A firm's performance and profits are directly related to its ability to add value and delight customers (Cooper & Kleinschmidt, 1994). Business goals define the organization's direction. They should be as specific as possible, such as "We want to have the highest level of customer satisfaction in the industry" or "We want to have a 25 percent market share." They should relate to both business performance and customer satisfaction. These goals guide and motivate an organization to initiate change. The process of goal setting should involve all levels of the organization in order to achieve buy-in and commitment (Dettmer, 1998; Gunn, 1992).

Figure 2: Management Overview of the Process for Achieving World Class Manufacturing Success

Approach	Issues to Address
<div>▼</div> <div>1</div> <div>Set Business Goals and Understand Customer Expectation</div>	<ul style="list-style-type: none"> • What goals does the firm want to achieve? • How can WCM improve customer satisfaction?
<div>▼</div> <div>2</div> <div>Define Essential Manufacturing Competencies</div>	<ul style="list-style-type: none"> • What manufacturing competencies are essential to achieve positive business results? • What competencies should the firm possess to achieve the speed, productivity, quality and flexibility demanded by customers?
<div>▼</div> <div>3</div> <div>Create Metrics for these Competencies</div>	<ul style="list-style-type: none"> • What metrics are important to my customers? • What metrics are important to achieving positive business results?
<div>▼</div> <div>4</div> <div>Benchmark Performance</div>	<ul style="list-style-type: none"> • Where does the organization stand in relation to "best-in-class" and World Class Manufacturers? • What areas need improvement? • What technical knowledge will be required?
<div>▼</div> <div>5</div> <div>Determine Target Levels for Each Metric</div>	<ul style="list-style-type: none"> • What is the process for setting performance targets? • Who should be involved in setting performance targets? • How should these targets be communicated?
<div>▼</div> <div>6</div> <div>Develop Plans and Programs to achieve the Targets</div>	<ul style="list-style-type: none"> • Develop plans that enable the firm to meet performance targets. • Design programs that focus on improving the metrics.
<div>▼</div> <div>7</div> <div>Organize and Manage the Implementation Process</div>	<ul style="list-style-type: none"> • Define a phased approach. • Who needs to perform the actions and by what time? • What is needed to continue progress? • What is needed to support personnel?
<div>▼</div> <div>8</div> <div>Evaluate Performance and Revise the Systems</div>	<ul style="list-style-type: none"> • Are the plans and programs sufficient for supporting WCM? • Do the metrics need revision because of changes in customer demands or in the business environment?

Manufacturing Competencies

The foundation for success in WCM is the five manufacturing competencies: employee development, supplier development, product development, quality, and JIT shown in Figure 1. These elements, summarized in Table 1, are interrelated, and they provide a foundation that enables firms to create a win-win environment for customers and shareholders.

Employee Development

Organizations that strive to be world-class manufacturers create systems that integrate decisions across functions and develop new methods and procedures to streamline operations. The roles of managers and shop floor employees change substantially as decision-making is pushed down the organization. Teamwork,

Table 1: *World Class Manufacturing Competencies*

Competency	Reason								
Employee Development	An organization's most important assets are its employees. WCM relies heavily on all employees. Management is responsible for providing all employees with the proper tools to do their jobs. In addition, employee growth through learning, motivation, and opportunities for advancement contribute to WCM success (Badore, 1992; Hammer, 1996; Nonaka & Takeuchi, 1995).								
Supplier Development	Raw material and purchased part quality directly affect manufacturing processes and their output, including productivity. By choosing to work with a supplier as a manufacturing partner, the supplier's processes become an extension of their customer's processes. Many benefits await companies that develop their supply chain, including reduced waste, enhanced quality, and improved problem solving capability (Handfield & Nichols, 1999; Senter and Flynn, 2000; Tracey & Vonderembse, 2000).								
Product Development	The ability to bring new and better products to the marketplace faster has become a determinant for sustaining competitive advantage and enhancing performance. A structured approach is necessary to ensure a fast and effective product development cycle (Clark & Fujimoto, 1991; Cooper & Kleinschmidt, 1994; Wheelwright & Clark, 1995).								
Quality	<p>Today's consumer demands a quality product. Manufacturing products have several quality dimensions.</p> <table> <tr> <td>1. Performance</td><td>5. Durability</td></tr> <tr> <td>2. Features</td><td>6. Serviceability</td></tr> <tr> <td>3. Reliability</td><td>7. Aesthetics</td></tr> <tr> <td>4. Conformance</td><td>8. Perceived quality</td></tr> </table> <p>Customers want products that meet their quality requirements. Quality is defined by customers and must be the driving force for any company regardless of the type of product (Deming, 1986, 2000; Juran, 1981a, 1981b; Schlickman, 1998).</p>	1. Performance	5. Durability	2. Features	6. Serviceability	3. Reliability	7. Aesthetics	4. Conformance	8. Perceived quality
1. Performance	5. Durability								
2. Features	6. Serviceability								
3. Reliability	7. Aesthetics								
4. Conformance	8. Perceived quality								
Just-In-Time Manufacturing	Customers want the lowest cost and fastest delivery. The methods for manufacturing product will be one of the determinants for meeting customer demands of low cost and fast response. Effective and efficient methods of manufacturing are necessary to reduce and eliminate manufacturing waste and to preserve investments in manufacturing equipment (Dettmer, 1998; Koufteros, Vonderembse & Doll., 1998; Monden, 1983; Womack & Jones, 1996).								

training, and shared knowledge become critical ingredients for success. Managers facilitate, coordinate, and integrate activities that move the organization towards its objectives rather than command and control the actions of a few subordinates. Shop floor employees participate in the planning and execution of key manufacturing practices such as set-up time reduction and quality improvement efforts (Badore, 1992; Nonaka & Takeuchi, 1995).

World-class manufacturers invest in people. They understand that employees grow more valuable with time and experience. They expend significant resources to develop the full potential of their employees through job training and continuing education (Badore, 1992). World-class manufacturers also create many opportunities for people to contribute to their success. They encourage and obtain high levels of employee participation in a wide variety of formal and informal improvement efforts (Lind,

2001). These improvement efforts should not go unrecognized. Company-wide celebrations of special achievements and financial participation in the profits and savings are ways to provide positive feedback and to keep employees involved (Dettmer, 1998; Gunn, 1992; Schonberger, 1996).

Supplier Development

Advocates of WCM recognize that competition is no longer between individual firms; rather, it is between their supply chains. For example, the development, design, production, marketing, and delivery of a car should be a coordinated team effort that begins with extracting raw materials from the earth, continues through fabrication and assembly, and ends with fit and finish in the dealer's showroom. When customers buy cars from Ford, they choose the output of the entire supply chain and pay all the participants. For Ford to be successful, the entire supply chain must work effectively. Ford should develop methods to manage the supply chain from its roots in basic materials such as iron ore, sand, and crude oil all the way to the dealer network. That does not mean ownership or even direct control, but it does imply mechanisms that coordinate actions, influence decision-making, and impact performance. Supplier relations and development are critical to success in product development, quality improvement efforts, and JIT (Handfield & McNichols, 1999; Senter & Flynn, 2000; Tracey & Vonderembse, 2000).

In today's environment, suppliers are often selected on the basis of quality, delivery reliability, and flexibility. The benefits of consistent quality and JIT deliveries are often more valuable than a few cents off the piece-part price. In many cases, supplier-customer relationships governed by strategic partnerships lead to lower prices than competitive bidding (Vonderembse & Tracey, 1999; Vonderembse, Tracey, Tan, & Bardi, 1995). Joseph Juran developed a framework for distinguishing between adversarial and teamwork relationships among customers and suppliers (see Table 2). These partnerships allow suppliers to become an extension of the world-class manufacturer's operations. The benefits can include integrated information and quality systems and cross-company problem solving efforts (Juran, 1981a, 1981b).

Product Development

Companies and their associated supply chains vie with competitors to be first with innovative new products. As the rate of technological advance increases and as competition between domestic and foreign companies heats up, it becomes increasingly important to bring new and improved products to market quickly. Many world-class manufacturers have set clear targets for improving speed and quantity of new product introduction. Quality Function Deployment (QFD) and Concurrent Engineering are tools that help world-class manufacturers quickly deliver the right product to the customer.

QFD is a broad-based product development tool that combines aspects of value analysis with market research. The primary objective of QFD is to specify the product and the process correctly from the outset. QFD translates the voice of the customer into product specifications by associating customer wants with appropriate technical requirement at each stage of product development and production. It bridges the gap

Table 2: *Adapted from Juran's Supplier Relationship Framework
(Juran, 1981a, 1981b)*

Competency	Adversary Concept	Teamwork Concept
Pattern of collaboration	Arm's length; secrecy; mutual supervision	Mutual visits; disclosures; assistance
Supplier selection	Single criterion usually via competitive bidding; in most cases a 2 or 3 percent reject rate may be acceptable	Multiple criteria including price, delivery and source with high quality; a low (zero) percent reject rate is essential
Product specifications	"Tight" specifications which inhibit suppliers from suggesting improvements	"Loose" specifications which allow suppliers wide latitude in designing products and processes
Quality planning	Separate	Joint
Criteria for quality	Conformance to specifications	Fitness for use
Number of suppliers	Multiple; often many	Few; often single source
Duration of supplier contracts	Annual	Three years or more

between customer-driven specifications and concurrent engineering constraints. QFD enables managers and engineers to make trade-offs between conflicting objectives in a way that maximizes the benefits to the customer (American Supplier Institute, 1989; Vonderembse, Van Fossen, & Raghunathan, 1997).

Concurrent Engineering is a nonlinear approach to product design where all phases of engineering and manufacturing operate at the same time. It is a process where engineering and manufacturing professionals, both in-house and supplier, provide input during the entire design cycle. It reduces downstream problems and builds quality, cost reduction, and reliability into the process. When combined with QFD, concurrent engineering brings problems to the surface early and creates an environment where better decisions can be made in less time (Sanderson, 1992; Susman & Dean, 1992). Concurrent engineering is based on the following principles:

- Concurrence: Product and process design run in parallel
- Constraints: Process constraints are considered part of the product design. This ensures parts that are easy to fabricate, handle, and assemble and facilitates the use of simple, cost-effective process, tooling, and material handling solutions (also known as Design for Manufacture and Assembly).

- Coordination: Product and process are closely coordinated to achieve optimal matching of requirements for effective cost, quality, and delivery.
- Consensus: High-impact product and process decision-making involves the full team's participation and consensus.

Quality

Formal quality systems play an important role in organizing a company to support quality as a key business objective (Deming, 1986, 2000; Juran, 1981a, 1981b). In the 1990's, the United States saw a large increase in the number of companies pursuing quality systems registration to the ISO 9000 and QS-9000 standards. In particular, QS-9000 has been a major focus of the automobile industry (Schlickman, 1998). In addition, many companies are using Six Sigma to achieve better quality and thus better 'bottom line' results. Six Sigma applies important quality tools such as experimental design and total productive maintenance to the quality control process (Evans & Williams, 2002; Pyzdek, 2003). In addition to helping secure future business, formal quality systems benefit companies by:

- defining authority and responsibility within the quality system,
- clearly communicating the objective of the quality system,
- promoting continuous improvement throughout the organization,
- monitoring quality system continuously, and
- ensuring consistent performance within the quality system.

Just-In-Time

Many different manufacturing techniques have been developed to improve production. Each technique has its own benefits such as reducing lot size, increasing machine availability, or using computers to run part programs. The goal is to improve process control capability while reducing manufacturing time and cost. JIT is a systematic approach to eliminate waste and reduce throughput time. JIT can be accomplished by using a combination of manufacturing techniques, including setup redesign, cellular manufacturing, total productive maintenance, and synchronous manufacturing/pull production (Koufteros, Vonderembse, & Doll, 1998; Monden, 1983; Womack & Jones, 1996; Sakakibara, Flynn, & Schroeder, 1993).

Each of these techniques may require substantial changes in manufacturing practices. All employees affected by the changes need to be open to changes, willing to learn, and involved in the planning process. Overcoming the resistance to changes is often the most difficult part of successfully implementing an advanced manufacturing technique such as JIT.

Metrics

The old saying "you can't manage something if you can't measure it" holds true for the five manufacturing competencies. Davies and Kochhar (2000, 2002) claim that the disappointing results from the implementation of best practices are caused by a failure to link practices to specific measurable objectives. As shown in Figure 2, defining metrics for these elements is critical. Companies need to know how well they are

achieving the goals they laid down for customer satisfaction and business results. It is important to choose a small number of pertinent performance measures that enable the company to assess progress continuously. Employees concentrate on what the organization measures and how they are evaluated. Normally, when a firm measures, reports, and rewards the results of an employee's work, that person will be motivated to improve those dimensions of their work.

There is no absolute set of WCM Metrics because different customers in different industries expect and emphasize different outcomes. Table 3 contains a list of metrics that may be helpful in getting started. As metrics are selected from this list and new ones are created, it is critical to understand how these metrics contribute to the organization's overall business and profitability goals. Metrics were selected from readings and cases found in the following references (Blackburn, 1991; Deming, 1986, 2000; Dettmer, 1998; Handfield & Nichols, 1999; Hoop & Spearman, 2000; Schonberger, 1996; Womack & Jones, 1996).

Benchmarks

Benchmarking, the next step in Figure 2, is an external focus on internal activities, functions, or operations that enables a firm to improve performance. The objective is to understand existing processes and to identify points of reference or standards by which activities can be measured or judged. Selecting practices to benchmark is an important one and it should be based on the relationship between practices and performance objective (Davies & Kochhar, 2000, 2002). Benchmarking continuously measures product characteristics, service capabilities, and management practices against industry leaders. It is externally focused, and it is action generating. Benchmarking signals management's willingness to pursue a philosophy that embraces change in a proactive rather than a reactive manner. It can establish meaningful goals and performance measures that reflect an external customer focus, foster quantum leaps in thinking, and concentrates on high-payoff opportunities. It promotes teamwork that is based on competitive need and driven by data, not intuition.

Benchmarking begins with an understanding of unmet customer needs and/or performances gaps. Armed with this information, management identifies core processes that determine the firm's ability to meet those needs and close those gaps. As these core processes are identified, process flow maps help to identify current operating practices and to establish baseline performance levels for critical outcomes such as percent of on-time delivery to customers and labor turnover rate. Data are gathered from outside the organization to provide comparison points for these key performance attributes. The internal and external data are analyzed and the results of the benchmarking studies are used as input to the process of setting targets and developing plans and programs to achieve the targets.

Targets

Setting targets is not as simple as benchmarking competitors, determining the best performer for each metric, and selecting that performance level as the target. Benchmarking studies are useful inputs when setting targets, but benchmarking can only tell management what other companies have achieved not what might be

Table 3: *World Class Manufacturing Metrics*

Competency	World Class Metrics
Employee Development	<ul style="list-style-type: none"> • formal training hours per employee • labor turnover rate • % certified trainers • improvement suggestions • safety indicators
Product Development	<ul style="list-style-type: none"> • customer satisfaction • ability to meet customer-specified requirements • product development cycle time • competitive pricing • ability to set premium prices • number of new products introduced • sales from products developed in the past three years
Supplier Development	<ul style="list-style-type: none"> • level of cooperation with suppliers • level of trust with suppliers • involvement in product and process design • involvement in quality planning and continuous improvement • on-time delivery • parts-per-million (PPM) defective • process capability (Cpk) • assessment to quality system requirements • duration of contracts with suppliers
Quality	<ul style="list-style-type: none"> • assessment to quality systems requirements (ISO-9000, QS-9000) • customer parts-per-million (PPM) defective • on-time delivery • scrap/rework • costs of quality • process capability (Cpk)
Just-in-Time	<ul style="list-style-type: none"> • manufacturing cycle time • setup time • machine availability • process capability (Cpk) • material availability • distance of material movement • WIP turns • inventory turns

achieved. In fact, setting targets that are equal to other firm's current achievements may lead an organization to set low targets. Even if the company achieves the target at some point in the future, it may still be behind the competition because the competition has gotten better. Setting targets is a matter of investigation, judgment, and risk taking. The investigation is part benchmarking and part understanding the capabilities of the firm. Judgment is using experience and knowledge to have a feel for what is possible. Risk taking means setting stretch goals that test the limits of the firm's creativity.

These targets cannot be imposed from the top of the organization. To build commitment, the process for setting these targets must involve a cross-section of employees working together. Marketing has knowledge of customer expectations; engineering understands the technology and the important elements of product and process design, and manufacturing makes it work on the factory floor. Without the involvement of manufacturing managers, supervisors, and shop-floor employees, firms may be unable to build the support needed to reach its targets.

Plans and Programs

As illustrated in Figure 2, organizations should develop plans, programs, and practices that influence manufacturing competencies and enable the firm to achieve the targets. World-class manufacturers support employee development through (1) formal learning and training programs, (2) employee empowerment which enables them to apply that knowledge, (3) continuous improvement programs that seek better ways to meet objectives, and (4) reward and incentive programs that focus on systems wide objectives rather than personal goals. Employees learn problem solving skills, conflict management and resolution skills, and how to conduct meetings effectively.

Supplier development involves working closely with vendors to develop supportive relationships that create win-win opportunities. In many cases, larger companies are able to offer training to groups of suppliers who do not have the resources to develop these training programs on their own. Supplier certification programs, supplier involvement in continuous improvement and product development activities, and strategic partnerships provide opportunities to manage the supply chain in ways that benefit the final customer as well as the suppliers.

In this environment, product development shifts from an internal, functional, and sequential process to a process that focuses on customers. It attempts to achieve system level objectives through cross-functional activities. QFD gathers customer requirements and drives them from design requirements, to part characteristics, to manufacturing process, and finally, to production requirements. QFD focuses the product development process on customer expectations and attempts to cut time and cost while enhancing product design (American Supplier Institute, 1989; Vonderembse, Van Fossen, & Raghunathan, 1997).

Quality improvement efforts involve a wide variety of programs from employee empowerment to statistical process control charts. There are many books and articles that can help to define a set of actions. Some that are certainly important are Design of Experiments (DOE), Failure Mode and Effects Analysis (FMEA), error proofing, cause and effect diagrams, quality improvement teams, and supplier certification efforts (Deming, 1986, 2000).

JIT attempts to strip time and cost from the production process by the elimination of waste and responsiveness to customer demands. JIT involves employees in setup redesign, manufacturing cells, preventive maintenance, and quality improvement efforts to achieve pull production (Koufteros, Vonderembse, & Doll, 1998; Monden, 1983; Sakakibara, Flynn, & Schroeder, 1993).

Organize and Manage the Implementation Process

Implementation is the key to success. The efforts and coordination for achieving WCM should be driven from the top of the organizations (Hammer, 1996). In most cases, the shift to WCM involves significant changes in policies, procedures, and method of operations. Product development efforts, supplier relations, quality improvement activities, and JIT create complex changes. To cope with this, coordinated actions must take place across multiple functions in order for these efforts to be successful. The only group that can drive these changes is top management. That does not mean that top management makes the decisions and imposes them on the organization. Top management provides overall direction, makes resources available including the time of key participant, and champions the efforts. Top management walks a delicate balance, insisting that these changes take place and communicating the important roles for middle managers, first-line supervisors, and shop-floor employees.

These are two other important aspects. It may be necessary to develop a phased approach so that everything is not changing at once. This can occur across several dimensions. In larger companies with many products, product lines, and manufacturing facilities, it may be possible to consider the change to WCM in one group, division, product line, or plant. In this way, what is learned can be shared as WCM is rolled out to other parts of the organization. Within these pilot operations and in small firms, it is possible to break the process into even smaller parts. In examining the manufacturing competencies, employee development is a prerequisite for success in product development, quality improvement, and JIT. If employees are expected to participate in decision-making, they must have a positive attitude and the training to do the job well. Supplier development is important for quality improvement and JIT. Implementing JIT when key suppliers have poor quality and unreliable deliveries negates many of its benefits. Product development may not be important in firms that focus on manufacturing and have limited design responsibility. The second aspect is the application of project management tools to determine who is responsible for performing tasks and when those tasks should be complete. This approach should focus activities and increase the probability of an on-time delivery.

Evaluate Performance and Revise the Systems

Feedback is a fundamental element of any continuous improvement activity. Performance enhancement involves setting goals, evaluating actions, providing information about performance, and revising actions to improve outcomes. So, becoming a world-class manufacturer requires feedback loops that enable the organization to enhance learning and focus on improvement efforts. Customer requirements are monitored because they drive the process. Competitor's actions and performance outcomes should be assessed to determine the firm's competitive position. Monitoring competitors' actions on a continuing basis allows the firm to assess progress, to understand and create new metrics, to set new target levels for these metrics, and to develop new plans and programs for the next cycle of continuous improvement.

Building Commitment

Becoming a WCM company requires *vision and commitment* from top management as well as continuous improvement. Top management's vision initiates the process and drives it to a successful conclusion. Edonsomwan (1996) outlines six steps that keep management committed to the *continuous improvement* efforts needed to become a WCM company.

- Step 1: Train top management on continuous improvement tools and techniques, managing change, and creating a total quality culture. Involve top managers in continuous improvement training for middle managers, supervisors, and other professionals.
- Step 2: Make continuous quality, productivity, and total customer satisfaction improvement the chief executive officer's personal mission. Encourage executive participation in the continuous improvement steering committee to oversee continuous improvement project plans, allocate resources, and monitor progress.
- Step 3: Require annual continuous improvement plans from line executives and managers. Such plans should depict a blueprint for comprehensive implementation of specific improvement projects. The plan should include specifics on training requirements, customer satisfaction improvement, supplier management, information analysis, process control and data management, employee job satisfaction and human resources issues, benchmarking of competitors, and a cost-of-quality estimate for each business unit.
- Step 4: Include discussion about continuous improvement projects in all staff meetings. Top managers should participate in continuous improvement projects, recognition events for quality excellence, and the enterprise suggestion program for continuous improvement.
- Step 5: Put executives and top managers in touch with outside customers, suppliers, and professional organizations. An executive will have a greater appreciation of the requirements, needs, and problems of customers and suppliers if one-on-one contact is made. Such contact also provides a unique opportunity for the executive to share and exchange ideas on continuous improvement goals and on specific projects. The outside contact with professional organizations also provides positive exposure for the enterprise and professional validation of new ideas.
- Step 6: Provide opportunity for top management to participate in benchmarking projects. This will enhance their knowledge of world-class improvement initiatives and programs.

Conclusion and Future Research

This paper describes a process for successfully implementing WCM. The process begins with top management commitment to pursue WCM and to provide the resources to support its activities. It also requires top management to communicate the importance of these efforts as well as break down the barriers to change. It must include a planning process that links business goals, customer expectations, and organizational capabilities. The process should define essential manufacturing competencies to achieve these goals, and it should select metrics to measure the competencies. Benchmarks may be used to help the organization set target levels for each metric. To institute change, firms should develop plans and programs to achieve these target levels, and they should organize and manage the implementation process. Periodically, the process change should be evaluated and the system should be revised.

This paper also provides a method for building commitment for this change. This method requires active participation in the process from all levels of management as well as supervisors and shop-floor employees. It clearly identifies top management as the driving force for these changes including involvement in training efforts, service on steering committees, and participation in continuous improvement projects.

Future efforts could involve empirical research to develop valid and reliable measures of WCM and to test the models described in Figure 1 and Figure 2. The development of in-depth case studies of the implementation process would be helpful for practicing managers.

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Changes In Students' Perceptions Of Programming Skills Using Class Projects

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Recent college graduates face challenges when entering the workforce related to confidence with their job-related skills. An application and test of self-efficacy theory using information systems (IS) projects and students' perceptions of their programming skills resulted in students' positively changing their perceptions of their programming ability. The perceptions were impacted by changes in intellectual interest and encouragement of peers and mediated by changes in outcome expectancy. Additionally, changes in self-efficacy impacted changes in perceptions of programming skills mediated by changes in outcome expectancy. The empirical results validate, at least partially, self-efficacy theory in the context of programming and IS projects. Results are discussed along with conclusions and directions for future research.

A variety of challenges exist for new entrants to the work force. Individuals who have recently completed an undergraduate degree should have a skill set allowing them to successfully transition into the work environment. An important part of this transition involving students' skills is the individual's confidence in their ability to successfully use these skills. This confidence can be captured by student's self-efficacy regarding their job-related skills. In general, self-efficacy is the individual's perception of possessing the requisite abilities to successfully perform a specific task (Bandura, 1977; 1982; 1986). A companion to self-efficacy is outcome expectancy which reflects

the individual's perception regarding the result or gain from successful completion of these tasks. Expectancies have significant influence in a variety of settings involving behavioral and affective outcomes (Henry & Stone, 2001).

In order to improve a student's transition from the university environment to the work force may depend on an understanding of self-efficacy and outcome expectancy (Jenkins & Garvey, 2001). The research presented below focuses on improving this understanding by applying self-efficacy theory to the development of undergraduate skills in a technical, skill-dependent discipline, information systems (IS). Specifically, the research uses a theoretical foundation of self-efficacy theory to study the development of programming skills which, for undergraduate students majoring in IS is a job-related skill. Furthermore, a unique aspect of this study is the examination of changes within the context of the self-efficacy model from the beginning to the completion of a project requiring programming. In this way, some insights into the development of these expectancies over time may be gained.

For recent graduates, a strong foundation in logic and programming allows migration and adaptation of their IS skills to a variety of business contexts. Encouraging students to continue developing their logic and programming skills necessitates faculty to consider changing the IS curriculum. IS faculty, at one university, undertook this challenge and developed an approach to integrate logic and programming skills across the curriculum. Students were required to complete projects in six IS courses (i.e., four required classes and two electives) with an objective of developing their programming and logic skills beyond the required programming course. The specific objective was to reinforce and improve students' knowledge of programming and logic as the student progresses through the curriculum rather than compartmentalizing these efforts in the required programming class. This setting provides test conditions in which to examine and study self-efficacy and its changes in a job skill environment.

The remainder of this paper is organized into sections presenting the details of this examination of self-efficacy theory and its impact on students' perceptions of their programming skills. First, a theoretical model based on self-efficacy theory is discussed. Second, the classes using these programming assignments and the details of the assignment are described. The hypotheses to be tested are derived from the theoretical framework and the project specifics are stated. An empirical study using a survey of students who have completed at least one of the classes requiring these projects is presented. Finally, the results are discussed followed by conclusions and directions for future research.

The Theoretical Model

The model used to guide the development of a foundation of programming and logic skills in the IS curriculum is rooted in self-efficacy theory. The theory (Bandura, 1986; Bandura, 1982) links an individual's cognitive state to a variety of affective and behavioral outcomes and perceptions of future outcomes (i.e., loss of control, low self-confidence, low achievement motivation) (Staples, Hulland, & Higgins, 1998). Self-efficacy theory has in the past been used to explain user reactions to information

technologies (Bandura, 1986; Baronas & Louis, 1988; Hasan, 2003; Havelka, 2003; Martinko, Henry, & Zmud, 1996; Meier, 1985; Potosky, 2002), inclusive of programming and logic skills. Recent research on computer self-efficacy investigated demographic predictors' (e.g., academic major, gender, computer-related experience) influence on business students' self-efficacy (Havelka, 2003). Significant differences in self-efficacy ratings resulted for IS and economics majors compared to management majors as well as those who have greater than five years experience working with computers. Gender differences did not result in any different self-efficacy ratings.

According to self-efficacy theory, expectations (e.g., motivation, performance, and feelings of frustration associated with repeated failure) in large part determine affect and behavioral reactions in numerous situations. Bandura (1986) separated expectations into two distinct types, self-efficacy and outcome expectancy. An individual's belief that he or she possesses the skills and abilities to successfully accomplish a specific task represents self-efficacy. In addition, an individual's persistence to learn a task impacts his or her perceptions of future outcomes influencing their self-efficacy. Outcome expectancy is an individual's belief that by accomplishing a task, a desired outcome is attained. Outcome expectancy is the consequence of the act and not the act itself. Self-efficacy and outcome expectancy have separate impacts on behavior and affect. However, self-efficacy typically has a larger effect than outcome expectancy (Bandura, 1986) and generally self-efficacy has a direct impact on outcome expectancy (Stone & Henry, 2003).

Four groups of variables or experiences identified by Bandura (1977) impact an individual's expectancy evaluations of a specific task. The strongest is the individual's personal mastery or accomplishments regarding the task. Prior success at performing a task increases self-efficacy and outcome expectancy of that task. On the other hand, failing repeatedly at performing a task lowers these expectations (Gist & Mitchell, 1992). In the context of programming skills, experiences focusing on installation and repairs of computer hardware and software as well as experiences solving computer problems could be viewed as appropriate personal mastery experiences (Coffin & MacIntyre, 1999; Hasan, 2003).

Vicarious experience or modeling the behavior of others who successfully completed the task is the second group of variables. The observer can improve his or her own performance through observing others successfully completing the task (Bandura, 1977; Gist & Mitchell, 1992). In this study, vicarious experience can be viewed as watching teammates or others as they work on similar programming related projects.

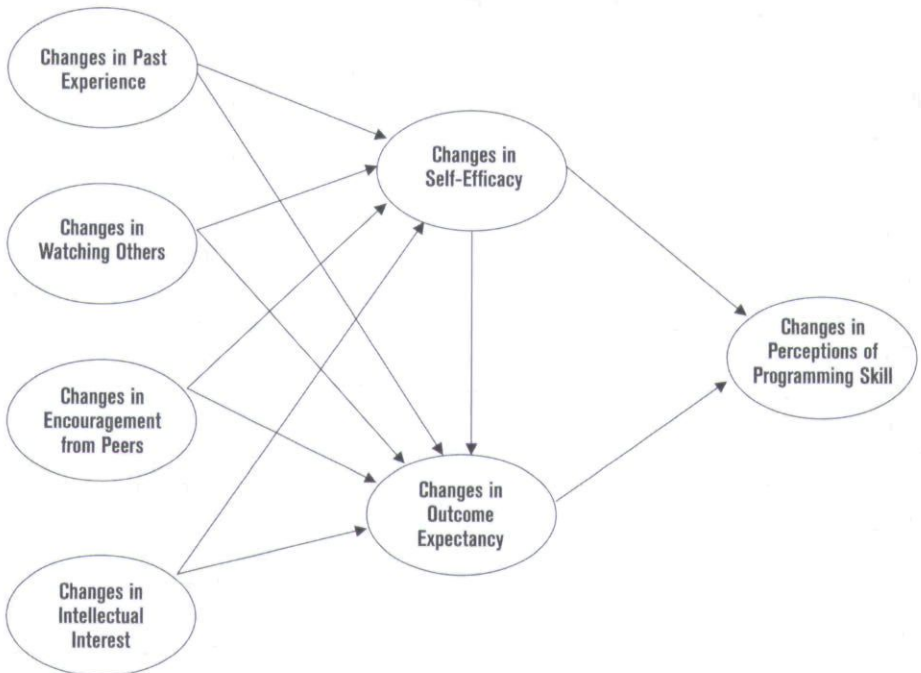
Social persuasion is the third group of antecedents to self-efficacy and outcome expectancy. Social persuasion occurs when individuals are led or have it suggested to them that they can successfully complete the task in question and experience the resulting outcome. Common forms of social persuasion are verbal encouragement, coaching, and providing performance feedback (Bandura, 1977). In this study, one form of social persuasion is the encouragement from peers, other students, and faculty to successfully complete a project requiring programming.

The last group of antecedent variables is physiological arousal and emotional states. From here after, this will be referred to as physiological arousal. Physiological

arousal of the individual impacts his or her expectancy judgments regarding specific tasks (Bandura, 1977). Improving perceptions of self-efficacy and the value of completing the task occur when there is intellectual interest in a task. Negative judgments of one's efficacy and the task outcome can be produced from anxiety regarding a specific task (Bandura, 1986). For the study at hand, the intellectual interest and stimulation of students regarding a project requiring programming efforts can impact the individual's self-efficacy and outcome expectancy about one's programming skills.

Based on the literature presented above, a model was developed. This model relates the antecedents of self-efficacy and outcome expectancy to students' perceptions of their programming skills, mediated by self-efficacy and outcome expectancy. Because the focus of the research is the changes in students' perceptions of their programming skills due to changes in the model's variables as a result of completing IS course projects, the model is presented in this differential format.

Figure 1: The Theoretical Model



The Classes and IS Project Assignments

There are six courses using IS project assignments requiring programming and logic skills. These courses are described below, the first of which is Introductory Systems Development. This course is the required programming course in the major and is the first course in the major completed by students. It is taught at the

sophomore level. The current programming language used is Visual Basic.Net. Numerous programming assignments are required in the course beginning with simple form development and culminating with the development of a program interfacing with data in a database.

The second course is a required, junior level course called Modern Information Technology. The course presents the fundamentals of computer hardware and operating systems. In this course, the required IS project develops a simulation of central processing unit (CPU) operations. The simulation is developed in Visual Basic.Net and allows the user to step through a simple program. The simulation must allow the user to initiate the fetch cycle and execute cycle for each instruction in the program and to observe how the register values change.

Systems Analysis and Design is the third required course using IS projects. It is a one semester systems analysis and design course with a greater emphasis on analysis than design. The course is taught at the junior level. The students in this course complete a project based on a case developed by the instructor. Required deliverables are models from the analysis and design of the system based on the case. The last installments of the project require students to design and build a database in Microsoft Access and develop a user interface in Visual Basic.Net to access and update the database.

The fourth class, Business Telecommunications Management is taught at the senior level and is required of IS majors. The project in this course requires students to program a simulation of TCP/IP operations on a network. Specifically, the simulation demonstrates the transmission of a message packet as it walks through the layers between computers. As with the projects in the other courses, the simulation is done using Visual Basic.Net.

The final two courses implementing a required programming project are Database Design and IS Project. Both are senior level courses. Database Design is required in the IS major while the IS Project course is an elective. In Database Design, students develop a trigger and a procedure with a cursor for an Oracle database. The programming component requires students to use PLSQL to accomplish the task. The IS Project course has teams of students performing analysis and design to build a system for a real world client. Because the projects are based on the needs of a client, each project has different programming needs. Typically these projects are extensions or components of a database with a user interface built in Visual Basic.Net.

Hypotheses

The theoretical framework is summarized by hypotheses relating the theoretical model to the empirical study. The model and the hypotheses relating to the theoretical model are displayed in Figure 1. It should be noted that Bandura's original model did not include paths from the antecedents to outcome expectancy as well as the path from self-efficacy to the dependent variable (i.e., perceptions of programming skill). The model used in this study is a variation of Bandura's model that has been previously published in the literature (Stone & Henry, 2003; Henry & Stone, 1995). The theoretical model implies a series of hypotheses presented below.

- Hypothesis 1 (H1): Past experience (personal mastery) has a significant and positive impact on self-efficacy.
- Hypothesis 2 (H2): Past experience (personal mastery) has a significant and positive impact on outcome expectancy.
- Hypothesis 3 (H3): Watching others (vicarious experience) has a significant and positive impact on self-efficacy.
- Hypothesis 4 (H4): Watching others (vicarious experience) has a significant and positive impact on outcome expectancy.
- Hypothesis 5 (H5): Encouragement of peers (social persuasion) has a significant and positive impact on self-efficacy.
- Hypothesis 6 (H6): Encouragement of peers (social persuasion) has a significant and positive impact on outcome expectancy.
- Hypothesis 7 (H7): Intellectual interest (physiological arousal) has a significant and positive impact on self-efficacy.
- Hypothesis 8 (H8): Intellectual interest (social persuasion) has a significant and positive impact on outcome expectancy.
- Hypothesis 9 (H9): Self-efficacy has a significant and positive impact on outcome expectancy.
- Hypothesis 10 (H10): Self-efficacy has a significant and positive impact on students' perceptions of programming skills.
- Hypothesis 11 (H11): Outcome expectancy has a significant and positive impact on students' perceptions of programming skills.

The Empirical Study

Data collection for the empirical study was conducted by a pre- and post-survey of students during one semester. The six courses with a programming project identified above provided the target population of IS students to survey. Students accessed the survey via a web site prior to working on the assigned IS project and then following the projects' completion. After providing students a statement of informed consent, they were directed to the URL of this site. Participation was completely voluntary, although some incentives were provided to encourage participation depending on the instructor. In some courses, students were given a few minutes of class time to complete the survey whereas in other courses students received two points added to the next in-class quiz if they completed the survey. If participants were enrolled in more than one IS course at a time, they were only able to take the questionnaire for one course. There was a total of 106 IS students eligible to complete the questionnaire. The total response rate for the survey was 78 participants (74% response rate) with 41 responses completing either the pre- or post-survey but not both. Therefore, the number of participants who completed both the pre and post project questionnaire was 37. One explanation for the rather low number of students who completed both questionnaires is a lack of substantial incentive to complete the questionnaire a second time (i.e., after completing the project). In several of the classes, students were given 2 or 3 extra credit points for completing the initial questionnaire. No such extra credit was offered for completing the questionnaire after the project was completed. These

observations were used in the empirical analysis presented below. All the statistical analyses were performed in PC SAS version 8.2.

The Sample Characteristics

The summary statistics for the sample are shown in Table 1. The respondents had an average age of 23.6 years and an average GPA of 3.13. Approximately 35 percent of the sample was female. Almost three quarters of the respondents were in either Introductory Systems Development or Systems Analysis and Design when they completed the survey. The percentage of respondents from the remaining courses ranged from 0 to 13 percent. Approximately 38 percent of the sample contained information systems majors without an additional major while another 51 percent were information system majors with a second major in another area. The remaining 11 percent of the sample were majors in Accounting, Computer Science, or undecided as to their major.

Nonresponse Bias

As is the case of any research depending on data collected using a survey, nonresponse is a concern. To examine the possible presence of nonresponse bias, the sample characteristics were compared to the corresponding values of all IS students. IS students enrolled in the College represent the population of students that could have been selected into the sample for this study. The average GPA of all students declared as an IS major within the College was 2.98. Statistical tests indicate that the difference between these two GPAs is not significant at a 20% level in two-tail tests. The average age among all IS students in the College was 21.6 years. Statistical tests show the average ages are not statistically different at a 5% level of significance. IS majors in the College represent 39% of the female population and 61% male. Tests comparing proportions show no significant differences at a 10% significance level.

Also shown in Table 1 are the percentages by major for the College. There are no significant differences using a chi-square goodness of fit test and a 10% level of significance. Based on the comparison of these demographic variables between the sample and IS majors in the College, it is concluded that nonresponse bias does not present a problem.

The Measures

The measures of the constructs in the model were developed in the context of a generic IS project. The generic use of IS projects was necessary since the questionnaire was administered across six different IS courses, each with different requirements for its project. The common thread across the projects in all the classes was development of a functional computer program.

These measures were formed by summing the respondents' answers to selected questionnaire items. The items were summed due to the relatively small sample size of the data set and the estimation technique employed. The individual items are shown in Table 2 grouped in their construct measures. The measures of self-efficacy and outcome expectancy were modified from previously published work by Henry and Stone. Self-efficacy was developed based on Henry and Stone (1995), while outcome

Table 1: The Sample Characteristics

Age

Average	Low	High	Number of Observations
23.60	19	48	37

GPA

Average	Low	High	Number of Observations
3.13	2.20	4.00	37

Gender

Gender	Number	Percentage
Female	13	35.14
Male	24	64.86

Enrolled Class

Class	Number	Percentage
Introductory Systems Development	9	24.32
Modern Information Technology	5	13.51
Systems Analysis & Design	18	48.65
Business Telecommunication Management	0	0.00
Database Design	4	10.81
IS Project	1	2.70

Major

Major	Number	Percentage
Accounting & Information Systems	8	21.62
Computer Science	1	2.70
Information Systems	14	37.84
Information Systems & Marketing	2	5.41
Information Systems & Production Operations Management	5	13.51
Computer Science & Information Systems	2	5.41
Information Systems & Finance	2	5.41
Accounting	2	5.41
Other/Undecided	1	2.70

Table 2: *The Items and Summated Measures*

Questionnaire Item	Mean Difference	Min/Max
Self-Efficacy	1.08	-4/13
In general, I am able to successfully complete any IS project I am given.		
I feel more competent working on IS projects than most of my classmates.		
I know enough to successfully complete my IS projects.		
I fully understand how to complete IS projects.		
I am always successful when given IS projects.		
Outcome Expectancy	-0.11	-6/4
Completing IS class projects.....		
Have improved my knowledge of IS concepts.		
Help me learn IS concepts.		
Make it easier to learn IS concepts and skills.		
Past Experience	-0.16	-6/6
I have worked as an IS technician installing hardware, networks, and software.		
I have helped others solve computer problems.		
While not a formal job, I have installed or repaired computer hardware numerous times.		
While not a formal job, I have installed computer software numerous times.		
Watching Others	-0.19	-4/5
Watching and listening to my teammates working on an IS project helps me understand it.		
Watching and listening to other teams working on an IS project helps me understand it.		
Encouragement of Peers	0.38	-4/3
Students who have taken the class help me with the project by encouraging me.		
Friends encourage me about the project.		
Intellectual Interest	-0.19	-6/4
I have found the IS projects required in class to be		
Interesting.		
Challenging.		
Stimulating.		
Perceptions of Programming Skill	0.81	-7/11
I understand the logic related to creating a computer program.		
I can create effective algorithms in any programming language.		
I can explain the difference between inputs, processes, and outputs.		
I understand structured programming.		

expectancy was developed from Henry and Stone (2001; 1995). The measures were modified for the given context of this study, IS projects. For all items, respondents were given a five-point Likert-type scale upon which to respond. The response options provided were strongly agree (5), agree (4), neutral (3), disagree (2), and strongly disagree (1).

Table 2 also displays the descriptive statistics of the measures. The mean differences (pre and post project responses) for the measures range from -0.19 (Watching Others and Intellectual Interest) to 1.08 (Self-Efficacy). Along with these mean differences, the minimum and maximum values for the measures and the number of observations for each measure are displayed.

Other properties of these measures were also examined. The correlations among the measures are displayed in Table 3. The values of these correlations ranged from a high of 0.58 (Outcome Expectancy and Intellectual Interest) to a low, in an absolute value sense of 0.01 (Self-Efficacy and Perceptions of Programming Skill; Self-Efficacy and Encouragement of Peers). The reliabilities of these measures were also examined by calculating the reliability coefficient (i.e., Cronbach's Alpha) for each measure which are also shown in Table 3. The values of these reliability coefficients ranged from a low of 0.62 (Intellectual Interest) to a high of 0.81 (Outcome Expectancy). It should also be noted that several of the measures had rather low reliability coefficients. A potential explanation for this is the rather small size of the sample.

The Estimation of the Model

The estimation of the theoretical model was performed using the mean differences of the summated measures for the 37 paired observations. Each measure represented the construct with the same name in the theoretical model. The estimation approach was a system of simultaneous equations using CALIS (i.e., Covariance Analysis of Linear Structural Equations) in PC SAS version 8. The estimation method used was maximum likelihood.

The fit of the model to the data is summarized in Table 4. The goodness of fit index was 0.96 and adjusted for degrees of freedom it was 0.73. The root mean square residual was 0.05. The chi-square statistic was 5.53 with 4 degrees of freedom which was not significant. The normed chi-square statistic was 1.38. Bentler's comparative fit index was 0.93 and the incremental fit measures ranged from 0.33 to 0.96. These fit measures provide mixed results regarding the fit of the model to the data. The goodness of fit index, root mean square residual, the chi-square statistic, the normed chi-square statistic, Bentler's comparative fit index, and the Bollen non-normed fit index all indicate an acceptable fit (Hair, Anderson, Tatham, & Black, 1992). The remaining incremental fit indexes and adjusted goodness of fit index do not indicate an acceptable fit.

The estimates for the paths in the model are shown in Figure 2. All the path coefficients are reported as standardized values. There are several groups of results regarding these significant path coefficients. These are reported and discussed below.

The first paths discussed are those with significant, positive impacts on students' perceptions of programming skills. Changes in intellectual interest from completing the IS project lead to positive changes in outcome expectancy. Similarly, changes in

Table 3: *The Correlations and Reliability Coefficients**Correlation Coefficients*

Changes in	Self-Efficacy	Outcome Expectancy	Past Experience	Intellectual Interest	Encouragement of Peers	Watching Others	Perceptions of Programming Skills
Self-Efficacy	1.00						
Outcome Expectancy	0.34	1.00					
Past Experience	-0.03	0.19	1.00				
Intellectual Interest	0.24	0.58	0.24	1.00			
Encouragement of Peers	-0.01	0.37	0.03	0.14	1.00		
Watching Others	0.14	0.10	0.30	0.18	0.17	1.00	
Perceptions of Programming Skills	-0.01	0.29	0.25	-0.04	0.13	-0.06	1.00

Reliability Coefficients

Changes in	Cronbach's Alpha
Self-Efficacy	0.69
Outcome Expectancy	0.81
Past Experience	0.66
Intellectual Interest	0.62
Encouragement of Peers	0.69
Watching Others	0.72
Perceptions of Programming Skills	0.65

encouragement from peers also lead to positive changes in outcome expectancy. Changes in self-efficacy from completing the IS project had meaningful positive impacts on outcome expectancy. It is also the case that changes in outcome expectancy produced changes in students' perceptions of their programming skills.

The antecedents of changes in self-efficacy and outcome expectancy were also allowed to pair-wise correlate. One pair of these variables, changes in watching others (i.e., vicarious experiences) and changes in past experience (i.e., personal mastery) was statistically significant. All the estimated correlations among the antecedents are shown in Table 5.

Table 4: *The Summary Statistics of The Model's Fit*

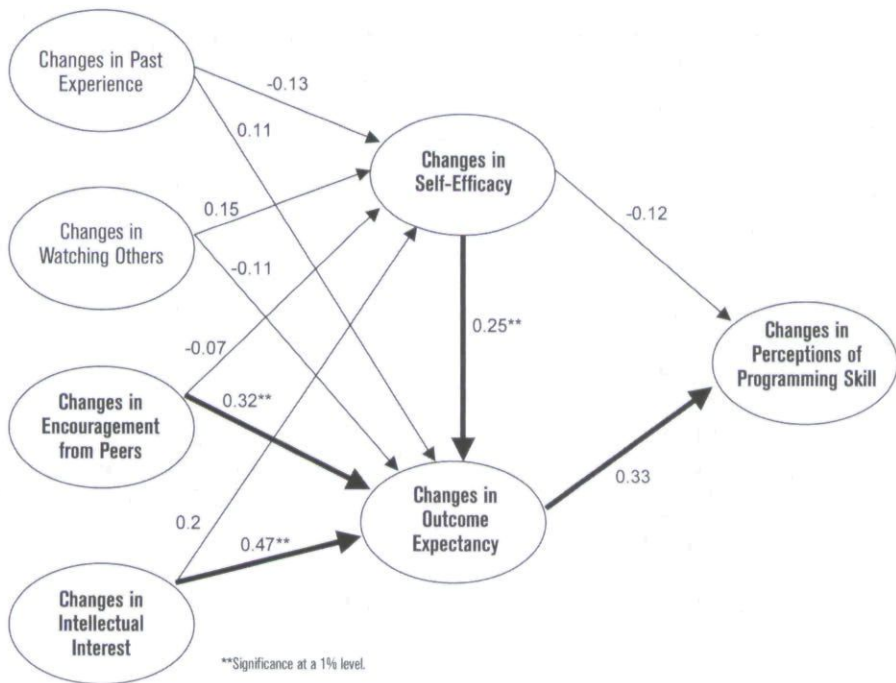
Statistic	Value
Goodness of Fit Index	0.96
Adjusted Goodness of Fit Index	0.73
Root Mean Square Residual	0.05
Chi-Square Statistic	5.53
Degrees of freedom	4
Normed Chi-Square Statistic	1.38
Bentler's Comparative Fit Index	0.93
Bentler & Bonett's Non-Normed Fit Index	0.64
Bentler & Bonett's Normed Fit Index	0.87
Bollen Normed Fit Index	0.33
Bollen Non-Normed Fit Index	0.96

Discussion of the Results

The presented study was designed to examine changes in perceptions of a job-related skill based on changes in the self-efficacy model. The specific environment was students completing IS projects requiring the use of programming skills. The job-related skill examined was students' perceptions of their programming skill before and after completing the class project. The empirical results confirm at least part of what was expected. Completing IS projects improve students' perceptions of their programming skills (i.e., job-related skill) through improving their outcome expectancy (H11). The desired outcome was to improve students' actual programming skills and their appropriate perceptions of this job-related skill. The completion of the project improved student's perceptions of job-related knowledge and skills which significantly influenced perceptions of their programming skills. This result reinforces adding projects with programming components to a series of courses in the IS curriculum.

Three variables in the model had significant impacts on changes in outcome expectancy and ultimately changes in perceptions of programming skills. These variables were changes in self-efficacy (H9), changes in encouragement from peers (H6), and changes in intellectual interest (H8).

Completing the project created changes in self-efficacy which positively impacted perceptions of programming skills mediated by changes in outcome expectancy. An interesting result is that changes in the antecedents to self-efficacy had no impact on changes of self-efficacy. The implication is that the experience of completing the project positively influences self-efficacy, but this change is not explained in the model. Intuitively, it would seem that this influence would be captured by the past

Figure 2: *The Estimated Model Using Standardized Path Coefficients*

experience measure. A potential explanation for not observing this relationship is that students did not link project completion to past experience. The wording of the individual items forming this measure makes this a distinct possibility.

Changes in intellectual interest in the IS project were found to positively impact changes in outcome expectancy. These changes ultimately impacted the perceptions of students' programming skills. The implication of this result lies in the subject and design of the class programming project. If, after completing the project, students find these projects more interesting, stimulating, meaningful and challenging than before completing the project, it positively impacts their perceptions of programming skills through changes in outcome expectancy. This provides instructors opportunities to influence their students through the careful and creative design of projects.

Similarly, changes in the encouragement of peers positively impacted changes in students' perceptions of programming skills, mediated by changes in outcome expectancy. It appears by completing the project, the encouragement from peers convinced students of the value of the project thereby positively impacting their outcome expectancy. Outcome expectancy therefore had a positive impact on students' perceptions of their programming skills.

The measures of changes in past experience and changes in watching others did not have meaningful impacts in changes in outcome expectancy or perceptions of programming skills. As discussed in regard to the similar results for changes in self-

Table 5: *The Correlations Among the Antecedents of Self-Efficacy and Outcome Expectancy from the Model's Estimation*

Antecedent Pair	Correlation
Past Experience and Intellectual Interest	0.24
Past Experience and Encouragement of Peers	0.03
Intellectual Interest and Encouragement of Peers	0.14
Past Experience and Watching Others	0.30**
Intellectual Interest and Watching Others	0.18
Encouragement of Peers and Watching Others	0.17

** Denotes significance at a 1% level.

efficacy, students probably did not link project completion to past experience. It also appears that watching others work on the project does not impact changes in either expectancy or perceptions of programming skills.

Conclusions and Directions for Future Research

Tentative conclusions can be drawn from the empirical results of this study. The meaningful changes in intellectual interest of projects and peer encouragement over the course of project completion have impacted students' perceptions of their programming skills. Furthermore, completing the IS projects has produced positive changes on self-efficacy which ultimately positively impacts changes in perceptions of programming skills. All these impacts are mediated by outcome expectancy. These results support the authors' motivation for requiring IS projects with programming content across multiple courses in the curriculum. The hope was to improve students' perceptions of their programming skills and to help address the "crisis of confidence" observed in many students nearing graduation. These results are sufficiently encouraging to continue with IS projects across the curriculum and to expend effort modifying the projects.

The first of these modifications is to change the projects to help students better make connections between completing the project and improvement in their IS skills and knowledge, including programming skills. In other words, placing the completion of the project in the broader perspective of how completing the IS project improves students' IS skills. One way to provide these linkages is through faculty discussion and persuasion regarding the project and these linkages. A potentially more effective approach would be to use recent graduates as class speakers to help make these linkages. Additional modifications, i.e., questionnaire items, would focus on the discovery of why changes in self-efficacy did not influence changes in perceptions of programming skills. Future research is also needed to determine what factors influence changes in self-efficacy in a significant fashion.

In the future, data on the implementation of the changes discussed above will be collected similar to this study. As an extension of this study, comparison of pre-change and post-change will also include changes to the project, student team, and faculty interaction with student teams. Using this method, the impact from these changes can be studied. As each course builds on a foundation from the preceding courses, projects also become a scaffold. Future research should look at the degree of scaffolding occurring in IS courses and the effect on scaffolded projects. Implicit in these future research studies is the longitudinal nature of this research. Studying the longitudinal data will hopefully lead to answers regarding the role of self-efficacy in impacting changes in the perceptions of programming skills as well as the antecedents to these self-efficacy changes. Data will be collected and analyzed over time to continually evaluate the theoretical model. In addition, measuring changes in actual programming skills rather than perceptions of these changes is being considered. The limiting issue is how to measure actual programming skills. Consideration is being given to a standard exam administered before and after the project's completion.

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Discussion on the Behavior Intention Model of Consumer Online Shopping

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The objective of this study was to test the sufficiency of the Theory of Planned Behavior (TPB) and extended TPB models by looking at the added variables of past experience and channel knowledge in predicting consumer online shopping. Data was collected by questionnaire from employed students in junior college and university (n=334), and by web-based survey from Internet users (n=92). Using Multi-regression analysis, the results of the study demonstrate that the TPB is applicable to measuring behavioral intentions in online shopping. Furthermore, adding past experience and channel knowledge to the TPB model improves the prediction of online shopping behavior.

People's shopping habits have changed. According to the forecasting of Forrester Research, by 2010, online sales will reach \$331 billion in America. The growing number of online shopping households combined with retailer innovations and website improvements will drive e-commerce to account for 13% of total retail sales in 2010, up from 7% in 2004. Between 2004 and 2010, online sales will grow at a 15% compound annual growth rate (Johnson, 2004). In addition, MIC of the Institute for Information Industry estimated online shopping in 2003 was \$0.6 billion (NT\$20.4 billion), and would grow by 30% to \$0.81 billion (NT\$26.6 billion), and increase by 88% in 2005 to \$1.52 billion (NT\$50.1 billion) in Taiwan. Currently, online shoppers in Taiwan only represented 20% of the Internet population. Compared with America in which B2C e-business accounted for 1.5% of total retailing sales, B2C in Taiwan (0.39% of total retailing sales) still had a large growth space (Wu, 2004). As the

Internet becomes an increasingly common medium for consumer transactions throughout the world, it becomes increasingly important to identify the factors affecting consumer adoption of e-commerce.

Several studies (James & Cunningham, 1987; Scansaroli, 1997; Li, Kuo, & Russell, 1999; Chen, 2000; Abend, 2001) explore the factors affecting consumer online shopping. But, Goldsmith (2001) claims that a lot of research concerning online consumer behavior is rather descriptive in nature and not based on consumer theory. One aim of this study, therefore, is to use consumer theory to predict consumer online shopping behavior intention.

According to the research of Bagozzi (1981) and Shimp and Kavas (1984), the TPB in attitude and behavior could be applied to research in different fields, and it could also help to clearly understand the effects of every dimension of the behavior intention. For example, TPB has been applied in a number of areas: decision making (Venkatesh, Morris, & Ackerman, 2000), environment protection (Cordano & Frieze, 2000), science and technology (Morris & Venkatesh, 2000; Gary, Franklin, Alan, & Mohammed, 1995), marketing (Huff & Alden, 2000; Shaoyi, Yuan, Huaiqing, & Ada, 1999; Shirley & Peter, 1995), and health behavior (Armitage & Conner, 2001). However, applications toward online shopping are rare.

In addition, some prior studies have challenged the assumption that the three variables in the TPB model are sufficient in order to predict behavioral intentions. Some argue that additional variables could further enhance the model's predictive utility and significantly improve its predictive power (Conner & Armitage, 1998; Norman, Conner, & Bell, 1999). For this reason, the study adds online purchase experience (Steven, Gerald, & Eric, 1999; Gerald et al., 2000) and Channel Knowledge (Li, et al., 1999) to further enhance its predictive power. Therefore, the purpose of the study is two-fold: to apply TBP to the online shopping area and to extend TPB models in predicting consumer online shopping behavior.

We will first provide a detailed discussion of the TPB and hypotheses, develop the research methodology, present the results, and finally discuss the implications of the study and provide suggestions for further research.

Theory, Literature Review and Hypotheses

The Theory of Planned Behavior (TPB)

The Theory of Planned Behavior (Ajzen, 1985; 1988; 1991) was developed from the extension of the Theory of Reasoned Behavior (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975). However, assumptions put forward by the TPB were basically identical to those of the Theory of Reasoned Behavior. The main difference is that TPB explains that all human behavioral decisions are not completely controlled by personal will, but are somewhere between being completely and incompletely controlled by personal will. Therefore, TPB added one decision factor of uncertain time and chance, i.e. the so-called Perceived Behavioral Control (PBC). This factor would not only indirectly affect behavior through behavior intention, but also directly affect behavior. The TPB could be expressed by the following equation (1):

$$BI = \beta_1 * ATT + \beta_2 * SN + \beta_3 * PBC \dots \dots \dots (1)$$

Where BI refers to behavior intention, ATT refers to attitude toward the behavior, SN refers to subject norm, and PBC refers to perceived behavioral control. β_1 , β_2 , and β_3 are empirical standard multi-regression coefficients.

First, behavior intention was defined as the intention or motive one has when trying to adopt a specific behavior. The theory explains that the most direct deciding factor when one adopts a certain behavior is behavior intention, and considering all possible factors affecting behaviors indirectly through behavior intention. Behavior intention was the best method to predict individual behavior, while behavior intention was highly correlated with behavior (Ajzen, 1991).

The theory further explains that the first deciding factor affecting behavior intention is attitude toward the behavior, i.e. the overall evaluation of this behavior. This attitude does not refer to attitudes toward general affairs, but rather to particular attitudes toward the behavior in question. According to the research on empirical rules, an individual often has five to nine important beliefs (Ajzen & Fishbein, 1980). In TPB, attitudes (ATT) are calculated by multiplying the strength of each behavioral belief by the subjective evaluation of the belief's attribute. The function was as follows; equation (2). Behavioral belief refers to the individual's belief that certain, specific behaviors will result in some consequences. Outcome evaluation refers to the importance of the behavior result to the individual. Therefore, attitude is a combination of the individual's idea of the result of a certain behavior and that individual's evaluation of those results. In other words, attitude is determined both by the consequence that the individual believes will result from a behavior compared with other behaviors, and the importance of the results to the individual. When the individual's attitude to behavior is more positive, the behavior intention will be higher. On the contrary, when the individual's attitude to behavior is more negative, the behavior intention will be lower.

$$ATT = \sum E_j * B_j \dots \dots \dots (2)$$

Where B_j refers to the individual's belief of the result j caused by adopting this behavior and E_j refers to the individual's evaluation of result j after adopting this behavior.

The second deciding factor of the theory is subject norm (SN), i.e. the effects of salient individuals or groups (social pressure) on individuals on whether to take certain behaviors when predicting individual behavior. As stated by the TPB, subject norm is calculated by multiplying the strength of each normative belief by the person's motivation to comply with the referent in question, as shown in the equation (3) below. Normative belief is defined as the opinions of other individuals and groups and/or social pressure as perceived by an individual in reference to certain behaviors. The motivation to comply referred to the comply intention to the expectation of salient individuals or groups when the individual has certain behaviors. Subject norm is the individual's belief in the opinions by the salient individuals or groups on whether the individual should take certain behaviors. Therefore, the subject norm is decided by a normative belief of other individuals and groups on the individual taking

certain behavior, and individual motivation to comply. In other words, when either social pressure or motivation to comply is higher, the subject norm and behavior intention is also higher. In contrast, when social pressure or intention to comply is lower, the subjective norm and the behavior intention is lower.

$$SN = \sum MC_j * NB_j \dots\dots\dots (3)$$

Where NB_j refers to an individual's belief that the important reference subject as to whether he/she should have certain behaviors and MC_j refers to an individual's motivation to comply with the important reference subject.

Finally, the third deciding factor of this theory is perceived behavioral control (PBC). Ajzen (1988) believes that behavior control belief can not only predict behavior intention, but also directly predict behavior. As stated by the TPB, perceived behavioral control is the sum of the multiplication of each control belief by the perceived power of a particular control factor to facilitate or inhibit behavioral performance, as shown in the equation (4) below. Control belief refers to the control degree of chance and resources needed for taking behaviors, also the cognition of individuals on the resources, chances, and barriers on taking certain behaviors. Perceived facilitation refers to the individual's belief on effects of behaviors by chances and resources needed or barriers.

$$PBC = \sum PF_j * CB_j \dots\dots\dots (4)$$

Where CB_j refers to the belief as to whether necessary technology, resources, chances j for certain behaviors are available and PF_j refers to the individual perceived affecting degrees on obtaining this technology, resources, and chances.

In short, according to TPB, we can predict if an individual's thought process about adopting a particular behavior will lead him/her to expect certain consequences. Also, if important social pressure groups or individuals believe he/she should follow this particular behavior, if he/she will be very willing to comply with their opinions. Further, if the individual feels he/she easily can control this behavior, and that there are few barriers to doing so, that individual will form the intent to pursue this behavior. Therefore, from the perspective of individual behavior changes, if we can understand the deciding factors between behavior intention and actual behavior, then it will greatly benefit and help us understand behavioral change.

Literature Review

According to Goldsmith's (2001) research, Goldsmith claims that much research concerning online consumer behavior is rather descriptive in nature and not based on consumer theory. The first area of research relevant to TPB was about convenience and transportation. For example, James and Cunningham (1987) believed that online shopping consumers paid more attention to the convenience of shopping. On the Internet, consumers can make purchases 24 hours a day without the limitations of location and national boundaries. It is also convenient to purchase foreign goods, without having to endure the transportation hassles of traditional shipping methods

(Scansaroli, 1997). Similarly, Li, Kuo, and Russell (1999) and Swaminathan, Lepkowska-White, and Bharat (1999) pointed out that the Internet provide consumers with a more convenient shopping method to save time. Therefore, the more emphasis that the consumer puts on convenience, the more likely it is that the consumer will choose online shopping. Also, by searching online consumers can quickly find the products they want, information on relevant products, and can reduce the time and effort spent searching for information (Ainscough & Luckett, 1996; Klein, 1998; Scansaroli, 1997).

Literature also exists on the other positive aspects to shopping online. For example, Alba et al (1997) and Scansaroli and Eng (1997) discovered that to some consumers with little shopping experience, who did not like to make purchases on the street or in stores, the anonymity of online shopping allows them to enjoy shopping without any negative influence by the external environment. Alba et al. (1997) and Scansaroli and Eng (1997) pointed out that the anonymity of the Internet allows consumers to purchase privately products that may embarrass them to purchase in public, or to purchase products about which they do not want others to know. The Internet also offers more goods and services, and it is easier to purchase new, unique or special products not available in typical retail stores. It also helps consumers research products needed in the future, and satisfy particular interests and habits (Peterson, Balasubramanian, & Bronnenberg, 1997; Larcener, 1999).

From the relevant literature on online shopping cited above, we see that when an individual's attitudes are more positive toward online shopping, the resulting behavior intention is higher. On the contrary, when an individual's attitudes are more negative, then the behavior intention is lower. Therefore, this study puts forward the following hypothesis:

H1: The higher the positive attitude to online shopping, the higher the behavior intention of purchasing online.

Regarding the second component of TPB, subject norm (SN), research by Hansen, Jensen, and Solgaard (2004) found that an online shopper would be influenced by family members, friends, and acquaintances regarding whether or not to shop online. In other words, the higher the social pressure faced by an online purchaser or the higher the motivation to comply, then the higher the subject norm and behavior intention would be. On the contrary, the lower the social pressure, or the lower the motivation to comply, then the lower the subject norm and behavior intention would be. Therefore, the study put forward the following hypothesis:

H2: The more positive the subject norm belief for online shopping, the higher the behavior intention for online shopping.

Moving to the third component of TPB, personal behavioral control (PBC), issues arise regarding individual data confidentiality and security. Freehill, Hollingdale & Page (2000), pointed out that 18% of websites had options to protect users' privacy, and 12% of websites had an online declaration for user's privacy. Only 6% of websites used external inspectors to examine privacy standard regulations. As website owners paid

less attention to the privacy and security of personal data, a consumer's intention to use online shopping was significantly reduced (Chen, 2000). Regarding hardware, most consumers complained that websites were difficult to browse, and it was difficult to find specific product services (Abend, 2001; Fram & Grady, 1997). In addition, Hoffman, Novak, and Peralta (1999) also pointed out that Internet users refused to shop online when they did not trust the security of transactions.

According to the Taiwan MIC (1997) of the Institute of Information Industry, among the reasons for consumers' refusal to shop online were that online shopping was not a habit for them, or they were suspicious of online transactions, complicated transaction procedures, inconvenient return or exchange policies, and/or acknowledged transaction standards. Also, according to a survey of CNET (2001), other reasons included that consumers could not find the products they wanted, found it difficult to find the shopping cart, thought it took too long to finish the transaction, believed online transactions were not safe, and felt that there was a long browsing time.

Therefore, we see that when individuals found that a behavior was easy to control, and there were fewer barriers and more assistance in this behavior, then the higher the behavior intention. On the contrary, the opposite conditions would result in a lower behavior intention. Therefore, the study has the following hypothesis:

H3: The higher the positive perceived behavioral control the consumer has for online shopping, the higher the behavior intention for online shopping.

Past Experience

Consumers' previous shopping experience affects future shopping decisions. Therefore, when consumers have more purchase experience with a given product, they acquire sophisticated product knowledge more easily (Childers, 1986). Previous purchase experience had similar affects on Internet users for the same reason. When consumers do after-purchase-evaluations, they generate relevant psychological feedback. Those experiences will continue to affect consequent shopping decisions (Schiffman & Kanuk, 1997). Therefore, the shopping decision is a circular feedback activity. Additional studies pointed out that the online shopping experiences affect purchase intention (Steven, Gerald, & Eric, 1999; Gerald et al., 2000).

Even though using the Internet to shop has only been possible for a few years, the more experiences that the consumer has on the Internet, the more likely it is that he/she will become an online shopper. The online shopping experience has some effect on consumer's shopping intention. Therefore, the study has the following hypothesis:

H4: The more online shopping experience the consumer had, the higher behavior intention of online shopping.

Channel Knowledge

A consumer's knowledge of various purchasing methods, or channel knowledge, may influence the shopping decision. As online shopping was an emerging consumption channel, Li, et al., (1999) believed that in addition to particular resources, Internet literacy was important to Internet shopping. The capability of using

the Internet to shop was called channel knowledge. The research also shows that, with improving channel knowledge, the intention to use online shopping also increases. Therefore, this study had the following hypothesis:

H5: The more Internet channel knowledge the consumer had, the higher the behavior intention of online shopping.

Research Methodology

Procedures and Sample

First, regarding the manipulation of the TPB, according to concept construction and scale table development of the Reasonable Behavior Theory of Ajzen and Fishbein (1980), manipulation of the tool in each composition scale can be divided into five steps. The first three steps are the theoretical structure of the TPB; the next two steps are the important behavioral belief of behavior intention (outcome belief, normative belief, and control belief). Therefore, the five steps are:

- 1) To choose the behavior under discussion, and define this behavior from action, the final objective, its connotation and time factors.
- 2) To define the corresponding behavior intention for this behavior.
- 3) To define related attitudes, subject norm and behavior control beliefs.
- 4) To conclude on important outcome belief, normative belief and control belief
- 5) Then according to the results in step four, to develop questions about composition scale of the theory (measurement indicators).

Therefore, we developed measurement indicators from three groups of on-the-job students (126) through non-structured questions (i.e., open-ended questions where there is no list of answers from which to choose, but respondents are simply asked to write their response to a question). Initial results were 18 items of ATT, 12 items of SN, and 24 items of PBC. To assess the impact of the items, two experts, three doctoral students, and one academic professor did the evaluation. Based on this pretest, several changes were made, and the final version of the TPB was created.

In the first part, from the question "What do you think are the benefits of online shopping?", we derived 12 relevant variables. In the second part, from the question "Which individuals or groups do you think will agree or disagree with your online shopping?", we derived nine relevant variables. In the third part, from "Which factors, status or occasions will prevent you from online shopping, or encourage your online shopping?", we derived 17 relevant variables.

Four hundred on-the-job students from junior college and university participated in this study. The subjects came from a variety of majors (Business Administration, MIS, Industry Management, and Accounting). Some were full-time students. After eliminating 66 questionnaires, there were 334 effective questionnaires. The response rate was 334/400 (83.5%). We also used online questionnaires with a total of 92 usable online questionnaires. In total, 426 questionnaires formed the basis of our data.

Measures

Attitude (ATT). Attitude refers to an individual's attitude towards online shopping. In manipulation, we designed through scale development with a reference of the suggestions of Ajzen and Fishbein (1980). Based on the above procedure, we developed 12 questions, modified by two experts, three Ph.D. students, and one academic professor to match the Internet shopping environment. Measurement questions all used the Likert 7-point scale: 1 represented very possible (important, approval, agree), 7 represented impossible (unimportant, disapproval, disagree).

Subject Norm (SN). Subject norm refers to the social pressure the individual felt during online shopping. Just as for attitude, we developed nine questions, using the same Likert 7-point scale.

Perceived Behavioral Control (PBC). Perceived behavioral control is the control capability on needed chance and resources when the individual performs online shopping. Similarly, we developed 17 questions on PBC, also all using the same Likert 7-point scale.

Behavior Intention (BI). Behavior intention refers to when individuals intend to adopt certain behaviors (e.g. online shopping). Again, using the same procedure as above, we developed four questions, on the Likert 7-point scale.

Past Experience (PE). Past purchase experience refers specifically to consumers' online shopping experience. Through scale development, with reference of suggestions of Steven, et al., (1999) and Gerald, et al., (2000), we developed 4 questions, modified by two experts, three Ph.D. students, and one academic professor to match the Internet shopping environment. Measurement questions all used the Likert 7-point scale: 1 represented strong agreement, 7 represented strong disagreement.

Channel Knowledge (CK). Channel knowledge refers to a consumer's understanding of an online shopping website procedure and its relevant system. Through scale development, with reference of suggestions of Li, et al., (1999), we developed 6 questions, modified by two experts, three Ph.D. students, and one academic professor to match the Internet shopping environment. Measurement questions all used the Likert 7-point scale: 1 represented strong agreement, 7 represented strong disagreement.

Controls

Based on previous research in this area, we chose as the control *gender*, *age*, and *education* (Greenfield Online, 1999; Li, et al., 1999; Donthu & Garcia, 1999; Yam, 2000). Greenfield Online (1999) showed that online shoppers were mostly males with a high income. Li, et al., (1999) concluded that the level of education would determine their intention to purchase online. The research result also showed that the level of education significantly correlated to shopping intention. In addition, Donthu and Garcia (1999) discussed the difference between the common consumer and the online consumer. The result was that there was a significant difference on age and income, but no significant difference in education and gender. Similar to the survey of Yam (2000), the research showed that people over 25 years old dominated the online consumption group. The older the person, the higher the level of online shopping.

Validity and Reliability

We used content validity to assess questionnaire validity. The questionnaires we developed are according to the suggestions of Ajzen and Fishbein (1980) and with reference of suggestions of Steven, et al., (1999), Gerald, et al., (2000), and Li, et al., (1999), with the modifications described above, so the content validity of the questionnaire should fit demand.

To assess reliability, we used item-to-total correlation and Cronbach's Alpha. In the 12 questions on attitude, the relevant correlation of item-to-total all were greater than 0.5, therefore all were kept. In the 9 questions on subject norm, the sixth question was deleted, and eight questions were reserved. In the 17 questions on perceived behavioral control, insignificant variables including items 1, 2, 3, 4, 13, 15, and 17 were deleted and 10 questions retained. In the 4 questions on behavior intention, the relevant correlation of the item-to-total were all larger than 0.5, therefore all were kept. In the 7 questions on past purchase experience, items 1 and 6 were deleted, with five left. In the 6 questions on channel knowledge, item 6 was deleted, with five left. Also, we used Cronbach's Alpha, with the traditional value of 0.70 as the threshold to demonstrate consistency. All of the scales surpassed 0.70, ranging from 0.84 to 0.93. Therefore, we concluded that this was an adequate level of reliability.

Data Analysis

SPSS was used to run linear regression statistical testing. To test the hypotheses, gender, age, and education were included as controls in all tests. Descriptive statistics were used to understand respondents' reactions to the three variables of the TPB.

Results

Demographic Information

A description of various demographic variables relating to the respondents is shown in Table 1 and Table 2.

Correlation

Descriptive statistics and pearson product moment correlations for variables used in testing the hypotheses are shown in Table 3.

Tests of Hypotheses

We used multi-regression analysis for hypothesis testing. For our first hypothesis, we see from model 2 in Table 4 that it reaches a level of significance ($\beta=.528$ $p<0.01$), which shows that a consumer's attitude will affect his/her shopping behavior. Therefore, Hypothesis 1 is accepted. For the second hypothesis, we see from model 3 in Table 4 that it reaches a significance level ($\beta=.477$ $p<0.01$), which means a consumer's subject norm to online shopping will affect his/her purchase behavior, and therefore Hypothesis 2 is accepted. For Hypothesis 3, we see from model 4 in Table 4 that it reaches a significance level ($\beta=.165$ $p<0.01$), which means a consumer's perceived behavioral control to online shopping will affect his/her purchase behavior,

Table 1: Demographic Variables

		N	%			N	%
Data sources	Common questionnaires	334	78.4	Average time online each time	Under 30 minutes	94	22.1
	Internet	92	21.6		31 minutes-1 hour	105	24.6
Gender	Male	220	51.6		61 minutes-2 hours	135	31.7
	Female	206	48.4		121 minutes-3 hours	44	10.3
Age	Under 18	16	3.8		181 minutes-4 hours	21	4.9
	19-23	237	55.6		201 minutes-5 hours	10	2.3
	24-28	59	13.8		Above 301 minutes	17	4.0
	29-33	63	14.8	Average online times each week	Below 10 hours	230	54
	34-38	28	6.6		11-20 hours	98	23
	Above 39	23	5.4		21-30 hours	50	11.7
Marital Status	Single	342	80.3		31-40 hours	18	4.2
	Married	84	19.7		Above 41 hours	30	7
Education Background	High school (Professional training)	33	7.7	Consumption amount each time shopping online	Below NT\$500	28	12.6
	Junior college	67	15.7		NT\$501-1000	82	36.8
	University	274	64.3		NT\$1001-2000	94	42.2
	Postgraduate and above	52	12.2		NT\$2001-3000	13	5.8
Profession	Student	187	43.9		NT\$3001-4000	4	1.8
	Commerce	20	4.7		Above NT\$4001	2	0.9
	Industry	42	9.9	Online shopping experience	Yes	223	52.3
	Army/public official/Teaching	57	13.4		No	203	47.7
	IT	3	0.7				
	Freelancer	2	0.5				
	Service	77	18.1				
	Other	38	8.9				

Table 2: Online Shopping Data

		N	%		N	%
What kind of products have been purchased on the Internet (more than one option may be selected)	Books	108	16.4	Air flight tickets, train tickets	106	16.1
	Peripherals of computer	50	7.6	Online traveling service	56	8.5
	CD	43	6.5	Flowers and gifts	24	3.6
	Cosmetics	59	9	Online financial management	31	4.7
	Computer software	24	3.6	Clothes	21	3.2
	Telecommunication and Electronic products (mobile phone, PDA,...)	21	3.2	Personal collection	16	2.4
	Online game	19	2.9	Food (cakes etc.)	3	.5
	ISP networking services	22	3.3	Others	55	8.4

Table 3: *Correlations and Descriptive Statistics*

Variable	Mean	s.d.	1	2	3	4	5	6
1.Attitude	11.6487	7.32376	(.9079)					
2.Subject Norm	13.3864	7.64750	.470**	(.8875)				
3.Perceived Behavioral Control	7.0056	5.74932	.197**	.239**	(.9213)			
4.Behavior Intention	3.6420	1.69283	.497**	.471**	.175**	(.9346)		
5.Past Shopping Experience	4.6638	1.56264	.362**	.309**	-.139**	.585**	(.8762)	
6.Consumer Channel Knowledge	3.4305	1.15227	.485**	.281**	.167**	.501**	.493**	(.8436)

Note: 1. Correlation is significant at the 0.01 level (2-tailed).

2. $ATT = \sum E_j * B_j$ (Value from 1 to 49); $SN = \sum MC_j * NB_j$ (Value from 1 to 49); $PBC = \sum PF_j * CB_j$ (value from 1 to 49).

therefore Hypothesis 3 is accepted. For Hypothesis 4, we see from model 5 in Table 4 that it reaches significance level ($\beta = .605$ $p < 0.01$), which means a consumer's past online shopping experience will affect his/her purchase behavior, therefore Hypothesis 4 is accepted. For Hypothesis 5, we see from model 6 in Table 4 that it reaches significance level ($\beta = .506$ $p < 0.01$), which means a consumer's Internet channel knowledge will affect his/her shopping behavior, therefore Hypothesis 5 is accepted.

Additionally, from the TPB equation, we find that $BI = .367 * ATT + .289 * SN + .033 * PBC$. The Perceived Behavioral Control is not significant, which means the explanation power of this variable in this model still needs improvement. However, from model 9 (with past purchase experience added) and model 10 (with consumer channel knowledge added), R^2 increased from .329 to .515 and .527, which shows that the variables added in this study improve the explanation power for the model. Model 9 and model 10, also indicate that every variable is significant, which means that all hypotheses we formulated are valid. It also proves that the opinions of Steven et al. (1999) and Gerald et al. (2000) that consumer's online shopping experience would affect his/her purchase intention. Similarly, the opinion of Li, et al., (1999) that a consumer's improved channel knowledge, results in greater online shopping intention is also supported in Hypothesis 5 of this study.

Descriptive Statistics Analysis

For consumer online shopping attitudes, the most important five factors are:

- 1.) Shopping freely without disturbance by others (shop assistant, or passersby) (consistent with Alba, et al., (1997) and Scansaroli and Eng (1997)).
- 2.) Reducing the trouble to go shopping outdoors (traffic, parking, crowds) (consistent with Scansaroli (1997), Li, et al., (1999), and Swaminathan, et al., (1999)).
- 3.) To buy particular or unique products (similar to the research of Alba, et al., (1997), Scansaroli and Eng (1997), Peterson, et al., (1997), and Larcener (1999)).
- 4.) Reducing the time cost on searching product information (consistent with Ainscough and Lockett (1996), Klein (1998), and Scansaroli (1997)).
- 5.) Surfing the products without time pressure (consistent with Alba, et al., (1997) and Scansaroli and Eng (1997)).

Table 4: Multi-Regression Results of Behavior Intention

	Model 1	Model2	Model3	Model4	Model5	Model6	Model7	Model8	Model9	Model10
Control variable										
1.Gender	-.030	.122*	-.046	-.009	.008	-.012	.066	.070	.088	.070
2.Age	-.104*	-.002	-.131**	-.086	.002	-.064	-.050	-.046	.041	.029
3.Education	-.021	-.049	.017	.010	.087	.067	-.017	-.011	.111**	.124**
Independent variables										
1.Attitudes		.528**					.369**	.367**	.220**	.166**
2.Subject Norm			.477**				.296**	.289**	.161**	.172**
3.Perceived Behavioral Control				.165**				.033	.205**	.181**
4.Past purchase experience					.605**				.521**	.464**
5.Consumer's Channel Knowledge						.506**				.142**
R ²	.012	.264	.238	.038	.350	.257	.328	.329	.515	.527
Adj R ²	.005	.257	.230	.028	.343	.249	.320	.320	.507	.518
F	1.723	37.748**	32.794**	4.101**	56.549**	36.313**	41.050**	34.276**	63.435**	58.144**

** p<0.01 * p<0.05

For subject norm questions, the most important five influences are: website salesperson, friend, user with experience, classmate, and teacher (consistent with the research of Hansen, et al., (2004)).

For perceived behavioral control questions, the most important five are:

- 1.) Inconvenient product return or exchange, (consistent with MIC, Institute of Information Industry (MOEA, 1997)).
- 2.) Poor product quality.
- 3.) Security of the transaction system (similar to research of Hoffman, Novak & Peralta (1999) and investigation research of MIC, Institute of Information Industry (MOEA, 1997)).
- 4.) Transaction rules are not clear (similar to research of CNET (2001)).
- 5.) Release of private information (consistent with Chen (2000)).

In addition, Table 1 shows that the average time spent shopping online was less than 10 hours per week for most people, consistent with Yam (2003). How to keep net users online longer and increase their motivation to shop would be another interesting topic for future research. The top five products consumers were willing to purchase online were: books, airplane or train tickets, cosmetics, telecommunication and electronic products, and computer software, which is consistent with research of the Institute of Information Industry, which ranked the top four products suitable for online shopping as books/magazines, cosmetics, telecommunication and electronic products, and computer peripherals. This also is consistent with research of the Institute of Information Industry, which showed that men shopped mostly for "3C" products and books, while women most often shopped for cosmetics (Wu, 2004).

Table 5: Means, Standard Deviations, and Rank.

Questions for measurement	Mean	s.d.	Rank
ATT			
A1 Cheap in price	12.5540	11.3562	
A2 To serve my curiosity	12.2207	10.3418	
A3 To easily buy private products which dare not be bought in common stores	10.1901	10.8228	
A4 It makes me feel satisfied and a sense of achievement	17.8451	10.8766	
A5 I can quickly obtain what I want	13.6009	10.8548	
A6 Reduce the trouble of going shopping outdoors(traffic, parking, stream of people)	8.3263	9.2898	2
A7 I can surf the commodities without time pressure	9.2958	9.6175	5
A8 Reduce the time cost of searching product information	8.9249	8.7123	4
A9 Freely without disturbance by others (shop assistant, and passerby)	7.0962	7.7470	1
A10 To buy particular or unique commodities	8.8568	9.4985	3
A11 To increase life recreation and entertainment	14.2864	12.0699	
A12 Obtain more emphasis and respect than shopping in traditional stores	16.5869	12.4956	
SN			
S1 Relative	15.2723	9.8160	
S2 Friend	11.7160	8.6150	2
S3 Classmate	12.8568	10.0280	4
S4 Teacher	13.6244	10.7408	5
S5 Family member (parents, brothers and sisters)	14.9624	10.8084	
S7 Website salesperson	11.5493	8.6279	1
S8 Expert in this field	14.7606	12.2390	
S9 User with experience	12.3498	10.4225	3
PBC			
P5 Poor product quality	5.7770	6.3742	2
P6 Release of private information	6.1737	7.6529	5
P7 Price higher than bricks and mortar stores	7.8920	7.4229	
P8 Transaction procedure overcomplicated	7.3685	7.4457	
P9 Transaction rules not clear	6.1244	6.7452	4
P10 Return or change of the products inconvenient	5.7512	6.1807	1
P11 Expense for connecting to Internet is too expensive	10.1103	9.8797	
P12 Inconvenient delivery of products	7.3028	6.9675	
P14 Security of the transaction system	5.9836	7.5173	3
P16 Reliable payment system approach (such as SSL)	7.5728	8.2838	

Our research showed that online shoppers still focus on low cost products below NT\$2000, and don't enter into large denomination purchases. This may be because of internal worries or external barriers (such as transaction system security or poor product quality). Therefore, it appears consumers tend to choose simple products with a low price. It appears that in order to encourage consumers to purchase more expensive products, Internet retailers should emphasize their products' unique qualities, make the purchase process easy, and emphasize system security.

Conclusion and Suggestions

The results of the study demonstrate that the TPB is applicable to the measurement of behavioral intentions in online shopping. This study provides empirical support for the adequateness of Ajzen's TPB model in online shopping behavior.

The findings in this study also demonstrate that past experience and channel

knowledge exert significant influence on online shopping behavior. Together with the three variables of the TPB, past experience and channel knowledge can also enhance the predictive utility of the TPB for the intention of engaging in online shopping behavior. Therefore, the addition of past experience and channel knowledge to the TPB model improve the prediction of online shopping behavior.

Some limitations of the study may have biased the conclusions drawn from the findings. First, this study did not classify products or services, and might not be completely accurate or extensive. Darby and Karni (1973) classified consumer's cognition to product quality into three groups: search goods, experience goods and trust goods. Research of Alba, et al., (1997) also suggested that search goods and trust goods were suitable for Internet marketing, while experienced goods were suitable for retailing stores. Kiang, Raghu, and Shang (2000) also classified products suitable for sales via the Internet, concluding that digitalized information and services were most suitable. Therefore, future research might cover the classification and characteristics of products/services, and how they affect online shopping behavior.

Second, subjects in the study were on-the-job students and Internet users, and while some were part-time, the final sample in the study still had about 43.9% full-time students. Therefore, the results may be limited or biased. A larger, more heterogeneous group of consumers should be studied to improve the applicability of the results to the larger population.

For Internet retailers, the study found that there were still many areas that needed improvement (except requirement on quality). For example, the website content should be more diversified, unique, interesting and substantial, so that individuals are more willing to spend time online. A website should make the purchase procedure simple, or clearly demonstrate it to insure consumers understand the entire process (including return or exchange procedures and time), step by step. Transaction system security and consumer data confidentiality still affect consumers' willingness to shop online. Safer transaction systems (such as SLL, Secure Socket Layer Protocol) or providing compensation should data be released in error, might improve customer trust in online shopping.

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Consider Cost and Strategy When Choosing Between Expatriate and Host-National Managers

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This paper develops an overseas staffing formula and seven propositions in international human resource management based on internalization costs and firm strategy. The formula and propositions outline the relative internalization costs of host-country managers versus expatriate managers. Our discussion centers on why firms, based on internalization costs, may choose expatriates over host-nationals (or vice-versa). The moderating effect of the organization's strategy on the relationship between internalization costs and the staffing decision is then presented. These topics should be of interest to practitioners who recruit and select managers for foreign assignments. The propositions and formula also should be of interest to global staffing researchers.

The success of an international business operation depends largely on the people in charge and the decisions they make (Bartlett & Ghoshal, 1992; Black & Gregersen, 1999; Hiltrop, 2002), and the human resource function is a critical part of that success (Jaw & Liu, 2004; Rodriguez & dePablos, 2002; Rowden, 2002; Tung, 1998). Unless the staffing practices that select those in charge are well aligned with business strategies and culture, success in international business is difficult to achieve and sustain (Henderson, 2002; Hiltrop, 2002; Laursen, 2002; Mendenhall, Kuhlmann, &

Stahl, 2001; Porter & Tansky, 1999). One study estimated that the direct cost of a poor international staffing decision ranges from \$200,000 to \$1.2 million (Swaak, 1995). In addition, firms that make poor international staffing choices may face additional indirect expenses such as damage to relationships with customers, suppliers, and employees (Patra, Khatik, & Kodwani, 2002). In contrast, it has been argued that appropriate international staffing policies can greatly enhance a firm's competitiveness in a global business (Adler & Bartholomew, 1992; Chen & Wilson, 2003).

Despite the importance of international staffing decisions, cost comparisons of expatriates and host-nationals are limited to direct costs such as travel, compensation, and benefits. Similarly, the impact of firm strategy on international staffing has received scant research attention. Some research has addressed global staffing (Henderson, 2002; Hiltrop, 2002; Laursen, 2002) and discussed the merits and disadvantages of host-national and expatriate managers (Petrovic & Kakabadse, 2003), but direct comparisons rarely have been researched. This paper applies two existing theories to develop an overseas staffing cost formula and related propositions.

We first consider Hill and Kim's (1988) internalization costs to propose a staffing formula that compares internalization costs for expatriate versus host-national managers. We then expand the formula by applying Gupta and Govindarajan's (1991) typology of international strategies to introduce firm strategy as a moderator of those costs.

Literature Review

A Human Resources Perspective

Human resources (HR) research has emphasized the importance of selection decisions for international businesses. However, both applied and theoretical discussions of how to integrate staffing practices with overseas business strategies are sparse. Many studies have emphasized the importance of the linkage between selection and business success (Caligiuri, 2000; Downes & Thomas, 2000; Sanchez, Spector, & Cooper, 2000). These studies tend to focus on how to select and train expatriates rather than how or why to choose one type of manager over another (i.e., expatriates versus host-country nationals). Even though several studies have explicitly tackled the issue of international selection decisions (Banai & Sama, 2000; Henderson, 2002; Hiltrop, 2002; Solomon, 1999; Wills & Barham, 1994), most of them simply listed the benefits of selecting one type of manager over another without detailed guidelines for selection itself.

Many organizations routinely apply either ethnocentric or polycentric staffing approaches without due consideration to the consequences (Adler, 2002; Hiltrop, 2002; Kedia & Mukherji, 1999; Petrovic & Kakabadse, 2003). Firms using an ethnocentric approach fill important management positions with parent-country nationals from the headquarters (Deresky, 1997). Deresky states that the advantages of the ethnocentric approach include the parent-country manager's familiarity with the company's policies and goals, product line, and unique technology. One disadvantage of this approach is the limited opportunity to develop host-country managers (thus possibly decreasing host-country employees' loyalty to the company). Another

disadvantage is that most expatriates are unable to quickly assimilate into foreign cultures (Adler, 2002).

In the polycentric approach, an organization hires a host-country national manager to assume a management position in his or her home country (Cullen, 1999). Advantages of polycentrism include a host-national manager's knowledge of the local culture, language, business practices, and local contacts. Disadvantages of this approach include coordination difficulties between the parent company and the foreign subsidiary and the potential for conflicting loyalties of the local manager (Adler, 2002; Solomon, 1999).

A company's leaders may have strong opinions that expatriates, or host-nationals, are preferred for overseas assignments, but it is essential for firms to move beyond this simple approach and align staffing policies with business strategies (Groh & Allen, 1998; Jaw & Liu, 2004; Monks & McMackin, 2001). Boyacigiller (1990) argues that any type of single staffing policy may be inappropriate given that cross-border firms operate in many different environments. Thus, unless the staffing practices that select those in charge are well aligned with business strategies and culture, success in international business is difficult to achieve and sustain (Henderson, 2002; Hiltrop, 2002; Laursen, 2002; Mendenhall, Kuhlmann, & Stahl, 2001).

This paper recognizes that firms have different strategic foci that should affect their selection decisions. Later in this paper we introduce Gupta and Govindarajan's (1991) four international strategies and we present how they influence the selection decision. However, instead of proposing a pure strategic management approach to managerial selection, this paper first emphasizes a fundamental cost analysis by introducing internalization costs. We believe that either approach (strategy or cost) is incomplete if considered alone; we demonstrate this by proposing firm strategy as a moderator of the relationship between internalization costs and the staffing decision.

A Perspective Based on Culture and Economic Costs

According to Dunning (1993), "One of the main tasks of a multinational enterprise (MNE) is to understand, reconcile and assimilate into its own corporate culture many disparate country or regional ideologies, perceptions, laws and regulations in a way which best advances its global strategies" (p. 4). Thus, managers must be cognizant of the dominant cultural forces at work and extract the best effort from their employees within that culture. Dunning states that different cultural perceptions may affect the transaction costs of maintaining labor relations and the resulting productivity. Employees in diverse cultures will come to work with very different values, norms, and expectations. If a manager does not understand these expectations, the policies and procedures he or she sets up to control the subsidiary may cause a backlash that results in lower productivity, higher absenteeism, or other labor problems (Hiltrop, 2002; Mendenhall & Oddou, 1985; Vance & Paderon, 1993). Firms, of course, must usually make timely managerial appointments, and the process of recruiting and selecting a manager for an overseas subsidiary may represent significant short-term costs for the organization. Nevertheless, the selection of a competent, culturally adept manager may have a long-term positive economic impact on the international subsidiary and ultimately on the whole organization.

If the above is true, then why can't organizations simply hire host country national managers to deal with cultural differences? As Rugman (1980) notes, multinational firms often "internalize" operations to take advantage of their knowledge advantages (also see: Buckley, 1988; Hennart, 1986; Rugman, 1982). These internalized operational techniques and procedures make up the technical aspects of the job. Since technical and organizational issues are as salient as cultural differences, firms must recruit culturally and technically competent managers to staff their international operations. Thus, while host-country national managers may be culturally competent, in some industries and for some types of proprietary knowledge the only technically-qualified candidates for the job may be expatriates.

Gillette's approach to international staffing may be instructive. Gillette strives to develop local foreign talent in developing nations. To accomplish this, the company hires top business students from local prestigious universities, trains the new managers at Gillette's local office in their home country, and then brings the new managers to the company's Boston headquarters for an extensive "mini-MBA" type development program (Compensation and Benefits Review, 1993). While instructive, the Gillette model is expensive and time consuming. Most organizations need a less complex approach that can be applied across different organizational sizes and strategies.

A Staffing Formula Based on Internalization Costs

According to Hill and Kim (1988), the costs of internalization are defined by four main elements, which the remainder of this section will apply in a staffing cost formula. First, there are the capital costs of establishing a physical presence overseas (P). Second, there are costs involved with familiarizing the organization with the local culture and market (F). Third, there are costs of transferring know how to foreign markets (T). Fourth, there are costs associated with controlling the expanded organization (C). Thus, internalization costs (IC) can be measured as follows:

$$IC = P + F + T + C$$

We assume that the capital costs of P are constant regardless of staffing decisions because the cost of capital is relatively constant. Thus, while P is an important element in overall IC, we remove P from the staffing formula. Therefore, the internalization costs of using an expatriate (IC_e) or a host country manager (IC_h) can be measured as follows:

$$IC_e = F_e + T_e + C_e$$

$$IC_h = F_h + T_h + C_h$$

Note: e indicates expatriate and h indicates host-country national

An organization can evaluate its internalization costs and make staffing decisions that minimize overall internalization costs. Thus,

Proposition 1: Other things being equal, organizations seek to minimize costs. Thus, management may apply the staffing formula and make international staffing decisions that minimize overall internalization costs.

Familiarization Costs

Regarding F_i we focus on: (1) the familiarization of the subsidiary with the local labor force, and (2) the familiarization of the parent firm with the local market. Our conceptual focus addresses the *establishment* of a new overseas operation because Hill and Kim argue that these costs are short run costs that decline as the firm becomes familiar with the culture, labor force, and expectations of the host country.

Hennart (1986) discusses the costs associated with intrafirm coordination. At the micro (employee) unit of analysis, Hennart states that "the productive activity of ... employees is not directed by prices, but by directives, either formalized through company rules, directly voiced by supervisors, or internalized through indoctrination" (p. 793). Hennart goes on to propose three tasks that an organization must perform when attempting to organize economic activities, "It must communicate to parties the impact of their decisions on others; it must curb bargaining; and it must reward individuals for taking into account the needs and preferences of others" (p. 794).

Clearly there are major cultural implications in each of Hennart's points. The methods and wording used by managers to communicate directives, develop rules and indoctrinate employees will vary from culture to culture in order to be effective. Likewise, the three organizational tasks proposed by Hennart would be accomplished in different ways in diverse cultural settings.

Managers adept at the local culture would be able to communicate with a new workforce without the cultural *faux pas* (and resulting expense) that may occur if an expatriate manager attempted to use his or her limited knowledge of the culture (Black, Mendenhall, & Oddou, 1991). For example, the global food company Nestlé fought an 8-year battle with the labor union, the local municipality, and local politicians over workforce reductions at its Perrier bottled water subsidiary in France (Fortune, 2000). Similarly, host country managers would be better placed to explain to the parent organization differences in local culture and markets. For example, American Disney managers opened Euro Disney in Paris with an American ethnocentric perception; American parents generally see no problem with taking their kids out of school for vacation. However, this practice is not generally accepted or practiced in France. Euro Disney management believed, incorrectly, that it could change French parents' attitudes toward this practice (Financial Times, 1997). A culturally adept Disney manager might have averted this costly strategic miscalculation.

The staffing cost of familiarization will be determined by comparing the two costs F_e and F_h . By the nature of their superior cultural knowledge and experience, we argue that host-country managers are in a better position than expatriate managers to reduce the cost of familiarizing the parent firm with the foreign market and culture (i.e., $F_e > F_h$). Thus,

Proposition 2: Other things being equal, familiarization costs for expatriate managers are higher than familiarization costs for host-country national managers ($F_e > F_h$).

Costs of Transferring Know-How

Regarding T, we will consider two types of know-how: (1) subsidiary knowledge of the corporate culture, and (2) subsidiary managers' access to and understanding of the general production technology to be used by the subsidiary. The first type of know-how includes corporate values, norms, expectations, and measures of success and failure. It is reasonable to assume that some aspects of the corporate culture, such as the formality of reporting relationships, would have to be transferred and taught to the new local workforce. Such knowledge transfer would involve a transition period that may be characterized by increased management involvement in day to day issues and lower than expected productivity at the outset.

In contrast, the second type of know-how includes technology, production equipment, and processes. The local labor force would have to be taught how to install, use, and maintain such equipment. There are training costs associated with this step. In keeping with Hill and Kim's framework, these costs are also considered short term because they decline as the knowledge transfer process is completed.

The extent to which information must be transferred and the speed of transfer will vary based upon the cultural distance between the investing and recipient country and the experience of the parent firm in the foreign country (Hennart, 1986). Managers, by their central involvement in the processes noted above, play crucial roles in determining the length and expense of these transfers.

Organizational methods in new subsidiaries are transferred almost exclusively by management actions, communications, and directives. Managers guide the transfer of values, methods, and control systems by adding their expertise to the implementation of subsidiary procedures and also by developing, directing, and often conducting training and socialization programs. Unlike technology, lengthy experience with and exposure to a corporate culture are hard to replace with a relatively short training program for a new outside manager. Expatriate managers from the parent organization, because of their in depth knowledge of, and lengthy experience with the corporate culture would minimize the internalization cost of transferring know how of corporate organizational methods compared to host country national managers hired for the implementation.

The staffing cost of transferring corporate know-how will be determined by comparing the two costs T_e and T_h . Thus,

Proposition 3: Other things being equal, know-how transfer costs for expatriate managers are lower than know-how transfer costs for host-country national managers ($T_e < T_h$).

Costs of Controlling the Expanded Organization

The costs associated with C can be explained by the information processing requirements necessary for the headquarters to control an overseas operation. In the case of technological know how, "once the overseas subsidiary has received the

technology it can be controlled in an arms length fashion" (Hill & Kim, 1988, p. 97). However, for marketing know how, information-processing requirements will be more substantial. A decline in quality may not be detected by home country, short run output measures of the subsidiary. The MNE, according to Hill and Kim (1988), must audit the operation and quality standards of the subsidiary on a regular basis beyond the arms length control required for technology. "In essence, the firm has to buy more information to guarantee product quality" (p. 97). When considering the managerial costs of controlling the expanded organization two factors must be considered; (1) the short term cost of technology transfer (C_{e-t} vs. C_{h-t}) and (2) the long term cost of controlling subsidiary quality (C_{e-q} vs. C_{h-q}).

When transferring technology, a company could potentially hire a manager from anywhere in the world and train that individual on the operation and maintenance of the machinery or the steps in the production process. That manager could then supervise the installation and help perform the training at the subsidiary location. Thus, although the technology might be proprietary (which would suggest the use of a home-based expatriate manager), a host national could be trained to do the job. The challenge for the organization is to find a manager who could best accomplish these tasks at the lowest cost.

Hennart (1986) argues that the success of employee training is, among other things, a direct result of management directives and supervisory interaction. Hennart goes on to argue that managers conducting training and implementing new methods must communicate successfully, curb bargaining, and appropriately reward individuals. The cultural implications are clear. The training methods and wording used by managers to communicate information, set evaluation standards, and determine if new methods are successfully implemented, will vary from culture to culture.

In terms of local communication, host-country managers have more in-depth knowledge and experience with the local workforce culture, local professional networks, and of course, are native language speakers. In terms of curbing bargaining, host-country managers may have established trusting relationships and rapport with the local workforce and they have knowledge of local labor/management issues. Host-national managers also possess superior knowledge of cultural norms for rewarding individuals. For example, in some cultures individual public recognition is coveted while in other cultures such public recognition would cause embarrassment and even draw ridicule (Adler, 2002).

By extending the application of Hennart's three tasks of an organization, we argue that host country national managers, because of their experience with the local culture, are better than expatriate managers at performing the three tasks of local communication, curbing bargaining, and rewarding individuals (i.e., $C_{e-t} > C_{h-t}$). Thus,

Proposition 4a: Other things being equal, technology transfer costs for expatriate managers are higher than technology transfer costs for host-country national managers ($C_{e-t} > C_{h-t}$).

When considering subsidiary quality (C_{e-q} vs. C_{h-q}), the organization must be cognizant of the need for regular corporate evaluations of subsidiary performance.

Hill and Kim (1988) argue that such evaluations necessitate substantial information processing requirements, and thus, increased costs of control. However, a firm may be able to minimize these costs by placing a subsidiary manager who is: (1) knowledgeable about corporate quality expectations, (2) experienced with the corporate communications network, and (3) experienced with the corporate evaluation process. Expatriate managers, because of their knowledge of the corporate culture, corporate management expectations, and internal communication networks maintain strong links between the headquarters and the subsidiary at a lower cost than host-country national managers (i.e., $C_{e-q} < C_{h-q}$). Thus,

Proposition 4b: Other things being equal, maintenance of quality costs for expatriate managers are lower than maintenance of quality costs for host-country national managers ($C_{e-q} < C_{h-q}$).

Thus far, we have presented a simple staffing cost equation for comparing the costs associated with international staffing decisions. We began with a simple proposition that the overall internalization costs should affect the selection decision. We then expanded that proposition by presenting how each of the three staffing-related costs of internalization; familiarization costs (F), the costs of transferring know how (T), and the costs of an expanded organization (C), influence overall internalization costs. An HR manager can add the estimated costs of F, C, and T for applicants for overseas assignments and determine the comparative costs of using expatriates versus hiring host national managers. Furthermore, managers facing overseas staffing decisions can consider the relative importance of each of the three internalization factors. If, for instance, T is a crucial part of the assignment, but F and C are relatively unimportant, then the company may prefer to send an expatriate manager on the assignment because of the cost advantage. However, these relative differences will be influenced by the firm's strategy.

Moderating Effects of Business Strategies on Staffing Policies

Propositions two and three are based on the simple assumption that cost considerations are constant regardless of organizational strategy. However, the effect of costs on staffing decisions is moderated by the types (and responsibilities) of foreign subsidiaries in international operations. According to Gupta and Govindarajan (1991), cross border firms have four specific types of subsidiaries: (1) Global Innovators, (2) Integrated Players, (3) Implementers, and (4) Local Innovators.

In a global innovator structure, the subsidiary serves as the center of some specific knowledge (i.e., research and development) for other subsidiaries and even the headquarters. Historically, this role has been played only by the domestic subsidiaries (Gupta & Govindarajan, 1991), but that is changing (Bartlett & Ghoshal, 1992).

The integrated player is similar to the global innovator because the strategy implies a responsibility for creating knowledge that can be utilized by other subsidiaries. However, unlike the global innovator, an integrated player subsidiary is not self sufficient in the fulfillment of its own knowledge needs.

When fulfilling an implementer role, the subsidiary engages in little knowledge creation of its own and relies heavily on knowledge inflows from either the parent or peer subsidiaries. Historically, this role has been opposite the global innovator; the domestic unit creates and the foreign subsidiary implements.

The local innovator role implies that the subsidiary has almost complete local responsibility for the creation of relevant know how in all key functional areas. However, this knowledge is seen as too context specific to be of much competitive use outside of the country where the local innovator is located.

The degree to which a subsidiary is required to familiarize the organization with the local culture implies varying levels of communication. Gupta and Govindarajan (1991) propose that the intensity (i.e., frequency, informality, openness, and density) of communication between a subsidiary and the parent organization will vary across the four strategic contexts. Specifically, it will be high for integrated players, medium for global innovators and implementers, and low for local innovators.

Proposition two states that host country national managers would be more cost effective in terms of familiarizing the organization with the local market and culture. Staying with the assumption that firms wish to minimize internalization costs, we argue that the parent would find a host country manager less expensive for familiarization responsibilities, *all else being equal*. However, if Gupta and Govindarajan's arguments are accepted, then internalization costs are moderated by the firm's strategy. In other words, the familiarization costs of a host-national manager are a function of the foreign subsidiary's strategy.

A local innovator operates alone serving a single market with little influence from (or back to) the larger organization. As such, familiarizing other parts of the organization about the local culture in which this subsidiary operates is not crucial to the organization's success. On the other hand, integrated players are not self sufficient and need to interact with other parts of the organization. This interaction would include the communication of local culture because the local culture may define specific local needs and potential local contributions. Global innovators and implementers may be working with products for worldwide application. If so, the culture and values of all the nations involved would be highly salient to the organization as a whole and would have to be communicated. Thus, following the logic of Gupta and Govindarajan's levels of communication:

Proposition 5: Host-country national managers' cost advantage for familiarization costs will be of (a) greater magnitude for integrated players, (b) moderate magnitude for global innovators and implementers, and (c) negligible for local innovators.

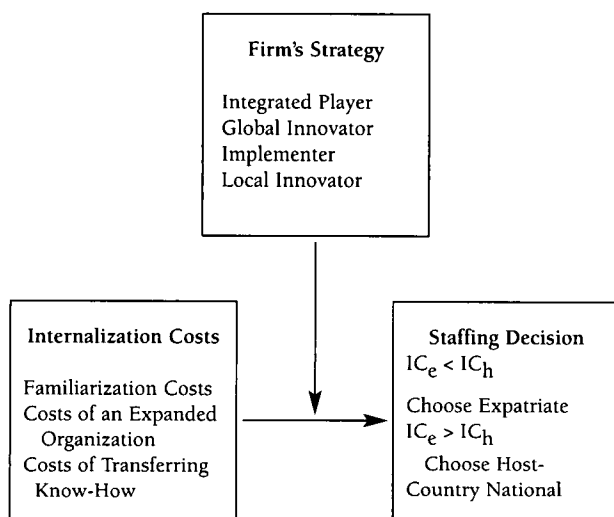
Proposition three states that expatriate managers are preferred when considering the internalization cost of transferring know how of organizational methods. Gupta and Govindarajan propose that the use of integrative mechanisms, and the degree of global corporate socialization, will vary across subsidiary strategic contexts; they will be high for integrated players, medium for global innovators and implementers, and low for local innovators. Thus, the costs of transferring know-how for an expatriate manager are a function of the foreign subsidiary's strategy. These relationships suggest

a moderating influence on the prescription made in proposition three. Thus,

Proposition 6: Expatriate managers' cost advantage for transferring know-how will be of (a) greater magnitude for integrated players, (b) moderate magnitude for global innovators and implementers, and (c) negligible for local innovators.

The relationships presented in this paper are graphically summarized in Figure 1.

Figure 1: Mean, Standard Deviation, and Rank



Discussion

Managers can apply the formula by considering the overseas manager's primary objective (T, C, or F) and the firm's current strategy (implementer, integrated player, etc.), to determine the most appropriate selection choice for that position. Examples:

1) An integrated player needs a manager whose primary responsibility is to transfer proprietary organizational methods to the foreign location. The lowest internalization cost alternative for this firm would be an expatriate manager.

2) A global innovator needs a manager whose primary responsibility is to familiarize the headquarters with the local market. Since the cost of familiarization is only marginally lower for host nationals in global innovator firms, the lowest internalization cost alternative for this firm also should include an analysis of the costs associated with T and C, even though these may be secondary responsibilities.

Another potential application of this paper is to provide a framework for firms that aim at a "moving target" of whom to select when. Competition may force firms to change the objectives of their international operations over time. At first, international operations may play a simple role such as implementers. Depending on

the level of competition in a certain host country or on a global basis, the role may change into local innovators or global innovators. In the long run, each foreign operation may converge into a coordinated multinational network playing the role of integrated players. Stopford and Wells (1972) argue that firms should adopt different organizational structures at different stages of international expansion. The arguments presented in the current paper expand on that view by offering guidance about why and how the cost, and advantage, of one type of international manager over another may change over time.

However, future extensions to the research can be made. A host national manager may or may not have experience working at the corporate level. Furthermore, the type of industry, the firm's level of overseas experience, and the organization's strategic and technical competencies may need to be included as additional moderators. These additions, however intuitive they may appear, should be based upon supported theories. Despite the limitations, we believe that this paper offers sound logic for managers struggling with overseas staffing decisions, and contributes to the literature on selection decisions for international assignments.

Conclusion

Many academic models have purported to assist managers with global selection decisions. However, many of these models isolate and control for so many of the real variables faced by businesspeople that, while strong in theoretical terms, they sometimes lack in practical application. By including two very real business considerations, internalization cost and strategy – and offering a testable formula, seven testable propositions, and a basic model for analysis and expansion for international HR scholars – the formula and propositions presented here offer sound guidance to business leaders undertaking the daunting task of staffing their international operations.

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Applying Matrixed Pareto Analysis With Activity Based Costing For Operations And Cost Management

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Management decisions made in operations planning and control determine what goods will be produced, when, and in what quantities; these determinations, in turn, shape other functional areas, including marketing, purchasing, receiving, storing, pricing, record keeping, inventory control, accounting, and other financial activities. Production management systems have long been effective at ensuring optimal efficiency in the flow of raw materials and finished goods through the production cycle. However, the accelerated proliferation of product varieties and product mixes that include both high volume and low volume specialty products has made it difficult for management to establish effective cost management and pricing policies. This paper expands traditional Pareto Analysis, a proven tool used in production and inventory control systems, by incorporating opposed metrics to create an effective low-cost tool to disaggregate product mixes and more accurately identify and control production costs.

Operations planning and control is concerned with the efficient and effective allocation of resources. Total quality management, just-in-time delivery, activity based accounting, optimized production technology, and the theory of constraints are among the many management procedures and concepts developed in managements' efforts to optimize the distribution of scarce resources (Berniker, 1997; Ronen & Spector 1992).

Pareto Analysis has been shown to be an effective measurement tool with applications in most of these procedures. Classification systems such as Pareto Analysis (ABC Analysis possibly the best known) have contributed significantly to the development of inventory controls and other production management systems (Bradford & Sugrue, 1997). Chu and Chu (1987) described an easy-to-follow six-step procedure for classifying products into their relevant Pareto categories.

The accelerated proliferation of product varieties and product mixes that include both high volume and low volume specialty products has made it difficult for management to establish effective cost management and pricing policies. Simple Pareto analysis does not provide the necessary information for production, pricing, and inventory decisions. Combining activity based accounting with Pareto analysis overcomes some of the key shortcomings of each process alone. According to Ronen and Spector (1992), in order to plan what will be a “good, reliable, and economic production line,” the planner must consider the cost of the resource, its location in the production chain, and its internal (demand) fluctuations.

Since the 1980s, many U.S. manufacturing firms have been forced to consider manufacturing as a way to gain a competitive advantage. In this way, inventory management systems, just-in-time supply (JIT), lean production, continuous product improvement (CPI), and similar programs are typical of efforts manufacturers have had to implement to improve productivity, become more efficient, and cut costs and reduce wastes (Azari-Rad, 2004). In addition to these concerns, designing and supporting an optimal mix of products has become a particularly pressing problem for firms that support a great variety of product offerings; product mix decisions may be most difficult when long product lines also require a wide variety of complex manufacturing processes. While marketing in such firms traditionally supports a wide spectrum of offerings to satisfy all customer demands, production managers often find it difficult to recover the costs associated with small or unique production runs. In many cases, true costs of manufacturing these special goods are difficult, if not impossible, to ascertain. Traditional cost accounting techniques are particularly weak in these instances.

The cost accounting techniques which evolved at the beginning of the last century as part of the scientific management movement work well for firms with few products that are manufactured in relatively simple processes. These methods focus on direct labor hours as the primary object of control and the most direct measure of efficiency (Kaplan, 1990). However, as product offerings multiplied and manufacturing processes became more complex, mechanized, and automated, traditional methods of cost accounting were found to be inadequate and unreliable. In particular, as overhead costs increased in amounts and complexity, their allocation to specific products and processes on the basis of direct labor became problematic. This led to cross-subsidization between products and processes (Johnson & Kaplan, 1987). The major problem was that, in plants where a wide variety of products are produced, more complex products are undercosted, while simple products tend to be overcosted (Banker, et al., 1990). In what is clearly a misguided decision, many simple products were purchased from outside sources at what *appeared* to be lower costs; outsourcing in this way often led to even higher unit production costs and even lower profits.

The solution for operations managers was to identify an accurate cost accounting system that captures production costs in conditions of product complexity. To address the problem, the management accounting profession developed the Activity Based Accounting approach, the goal of which is to more reliably capture variations in overhead resources for individual products and processes (Kaplan, 1990).

This paper presents an analytical model for disaggregating product mixes and production processes as a foundation for more effective production and inventory control management policies and decisions. The model sets inventory carrying costs against stockout costs. Because of the multiple factor design, we call this model Matrixed Pareto Analysis (MPA). The description of the method is followed by a report describing an application of MPA in a wood-products manufacturing company.

Pareto Analysis Theory

Simple Pareto Analysis (SPA) has long been used in operations, inventory control, and cost management as a means of organizing data for decisions purposes (Azari-Rad, 2001; Bonney Bradford & Sugrue, 1997; Chu & Chu, 1987; Rai & Allada, 2003; Wendell, 1987; Wharburton, 2003). The method is used in so many different ways that it seems appropriate to briefly review the process as used for inventory control. Historically, the method derives from the work of the Italian economist and sociologist Vilfredo Pareto who introduced the concept in his *Cours d'Economie Politique*, published in 1896-7. Pareto proposed his 80-20 rule as an explanation of the consistent pattern of the distribution of incomes and wealth in society; 80 percent of the wealth of a society is controlled by 20 percent of the people.

Pareto's method is simple and easy to understand when applied to inventory management. The distribution of inventory is aggregated into three large blocks according to their rank order of turnover; the groups of products are labeled A, B, and C. The A block usually includes from 10 to 15 percent of the number of items in inventory; together, these represent from 60 to 80 percent of the total inventory value.

The B block includes about 25 percent of the total number of items, and from 15 to 20 percent of the total value. The C items include the largest percentage of the total inventory (usually around 50 to 55 percent); these items represent only 15 percent of the total inventory value. While the break points between these blocks vary considerably in practice, the general relationship (that is, the shape of the curve) remains relatively constant in the overwhelming majority of applications.

Different inventory control approaches are applied to each block of items. One example has been proposed by a Fortune 500 firm (Wendell, 1987): A-items should be monitored daily and orders adjusted to reduce inventory holding costs. B-items should be controlled using a standard economic order quantity model. C-items, maintained as a minimum safety stock, might not be monitored at all, but simply reordered when the safety stock was opened. Thus, from 50 to 60 percent of the total inventory commanded little or no attention, while A-items received intensive attention. This practice illustrates the managerial value of Pareto analysis. If inventory costs and levels are to be effectively controlled, efforts must be focused on those items that constitute the greatest value of the total inventory (Wendell, 1987). The greatest strength of the

method lies in substituting objective counts for subjective “hunches” for performance measurement and control. There are, however, limitations to simple Pareto analysis.

Limitations of Simple Pareto Analysis

From a production planning viewpoint, the greatest limitation of Pareto Analysis is that it is unidimensional; categorization is typically based upon the aggregate value of product sales (stock turnover) alone. Thus, single high-value product category includes low-volume, high-cost items in the same group as low-cost, high-volume items. An argument can be advanced that these should be two different categories, each of which is managed differently. Control practices for high-volume, high-unit cost items should be different from control practices for high-volume, low-unit cost items. Equally, low-volume, high-cost items should be managed differently than low-volume, low-cost items.

A second limitation is that the analysis is unidirectional as well as one dimensional. A single parameter, turnover, is used to reflect all inventory costs, often neglecting those costs that are reduced by increasing inventory. The most important costs that counter inventory-carrying costs are stock-out costs-the costs associated with an inventory shortage or out-of-stock position. For example, if a product line includes high value-added items and commodity items, we would expect the losses from not selling the former to be high, while the stock-out costs of commodity items to be relatively low. Thus, different inventory management practices should be applied. However, once again, one-dimensional, simple Pareto analysis does not allow selectivity among such items.

To overcome the limitations of simple Pareto analysis with a more focused and selective approach to cost control strategies, we suggest using a matrixed Pareto analysis consisting of more than one parameter for defining categories.

Essential Criteria for a Production Decision Model

Kaplan (1990) identified the inability of traditional cost accounting systems to deal with the effects of changes that occur as a result of variation in production volume and product mix. Distortions in overhead cost allocations are introduced by shifts in product mix; simple summaries of per-unit costs become meaningless. Moreover, these distortions can become critical when a manufacturer fails to recognize the increasingly diverse nature of its output. Kaplan proposed a two-alternative solution to this problem: either develop product complexity indices, or entirely eliminate unit cost summaries. Neither of these suggestions has been found to be completely satisfactory.

The challenge of finding a useful means of disaggregating costs remains. Operations managers need a method of disaggregating costs that identifies intelligible cost drivers that are relevant to operational decisions. Several criteria for a useful method may be defined.

First, the method should be simple and intelligible. Second, it must deal effectively with the heterogeneity of products and the activities and processes required for their manufacture (Foster & Gupta, 1990). The method must be:

- Systematically accumulating,
- Control a large sum,
- Have diagnostic capability, and
- Be a vehicle for process cost management.

For cost management to improve the method must use multiple dimensions and include the ability to focus management attention as appropriate (Gronlund & Johnsson, 1990). In addition, the method should be possible to validate the cost categories and drivers used in the system. Finally, given that cost management is the goal, the method should be simple and economical in its application.

Goals for a New Production-Decisions Model

The primary goal of the Production-Decisions Model is to make it possible for management to quickly and effectively refine and interpret manufacturing and inventory data. Simple Pareto Analysis does this by creating useful subgroups based on Pareto distributions. But it does not go far enough. In principle, opposed costs associated with production and inventorying each "unique" product should be available for review in real time before every managerial decisions. In practice, however, when the firm's product mix reaches in the range of several hundred items such attention has been difficult if not impossible to achieve. Many firms in today's mature markets number their products in the thousands. Thus, a technique such as Matrixed Pareto Analysis (MPA) is needed to preserve the efficiency of simple Pareto classification into large subgroups while maintaining some capacity for refining these groups according to meaningful cost and contribution to margin measurement principles. If the groups that emerge are distinct, the difference-information should support better product and inventory decisions.

MPA appears remarkably robust with respect to the imprecision of data often found in manufacturing environments with an extensive variety of customer-selectable components and finishes, finished product designs and dimensions, and diverse product lines.

The MPA Model: Opposed Cost Parameters

MPA may be illustrated with a description in which a hypothetical simplified Pareto distribution is established for two measurement axes: inventory and gross margin. As suggested by Wendell (1987), inventory-carrying costs are proportional to the dollar value of annual usage and may be classified accordingly. Stock-out costs are more complex but can be simplified as the lost margin from missed sales. This enables the manager to consider two inventory costs concurrently: carrying costs and stock-out costs. The potential stock-out costs of an item may also be considered as being equal to, or at least proportional to, that item's annual contribution or gross margin¹ which, for simplicity, is labeled as Gross Margin in the following tables and figures.

¹ The firm in this case referred to the difference between direct labor and direct material costs and their discounted sales prices as "gross margin." This term suggests mark-ups and relates to marketing policies than the more accurate accounting concept of contribution. Whatever discrepancies these terms may signal are not relevant to the analysis.

Both measures should be considered over the same time frame. Simplification is achieved by breaking up the distribution into three groups labeled ABC and HML. The ABC categories refer to inventory carrying costs and the High-Medium-Low (HML) categories refer to the contribution margin, producing the nine-cell table shown in Table 1. The percentages are indicative of what might be expected from grouping a Pareto distribution. Sixty percent of the Gross Margin is contributed by the H group and 25 percent of the Sales Volume is from the B group. (Sales Volume serves as a surrogate representing the total amount of inventory that passed through the enterprise.) For clarity, we assign ABC to refer to undifferentiated sales groups and HML to undifferentiated Gross Margin groups. The cell, i.e. AH, refers to the Product Groups identified by distributing one group across the other.

Table 1: Two-Parameter Matrixed Pareto Analysis

Inventory Level	Gross Contribution to Margin		
	60% H Items	25% M Items	15% L Items
60% A Items	AH	AM	AL
25% B Items	BH	BM	BL
15% C Items	CH	CM	CL

Note: The cell labeling convention used in this paper is identical to that used in spreadsheets, i.e. row/column. For example, the lower left cell is Row C, Column H.

The descending diagonal (AH, BM, CL) is the expected outcome and yields no new information; those items that constitute 60 percent of inventory turnover should be expected to constitute a similar proportion of the contribution to gross margin contribution. If the other cells remained empty of items, the analysis will not yield useful results. However, three other cells are likely to contain important product groups. Cells AM and AL represent products with 'A' level inventory costs but only Medium- or Low-level contributions (gross margins). The AL group typically consists of commodity products with high demand but with low unit value; examples include milk in a supermarket or dimensional lumber at a lumberyard or building supply store. Given their lower contribution to gross margin, higher stock-out risks for AL items might be accepted. For example, a lumber wholesaler/retailer found that dimensional lumber (standard 2x4's etc.), represented a large part of sales to contractors yet delivered poor margins. The wholesaler considered a policy that allowed more stock-outs and authorized their outlets to make up shortages by buying from local competitors who also earned low margins.

Alternatively, the BH cell includes high value-added items; examples might include such items as decorative paneling or paint at the building supply store. Inventory management policies should be differentiated for these off-diagonal groups. Given their higher contribution to gross margin, management should consider higher safety stocks for BH items. Once these subgroups are established, other measures may be applied to further characterize each group. This will be demonstrated in the following case example.

An Application: Wood Products Company

Wood Products Company (WPC) is a locally owned West Coast manufacturing and assembling firm with a long history of operations in the specialty wood products industry. The firm produces more than 3,200 individual wood products and components. The firm's product lines vary from highly customized, albeit cataloged, parts and products to standardized high volume "commodity" items.

Following the logic of Rai and Allade (2003), the firm's product lines may be classified in two different ways: Single Product-type (with many variations) for all segments in the market, or Multiple Product-types (single product with a few variations) each of which is maintained for separate market segments. Product lines for stock-keeping records are predominantly finished products but also include parts and components that are fabricated or processed for internal and external applications.

For most of the firm's history it was generally assumed by management that the supply of special products gave the firm better access to dealers through whom the major part of their output is marketed. It was further believed that the highest profits were made on the higher value-added parts and products. However, when earnings failed to reach expectations several years ago, management became concerned about the impact on manufacturing costs, inventory costs, and market share that they suspected were the result of what appeared to be an accelerating and uncontrollable proliferation of product varieties. As product varieties increased, management found it difficult to establish consistent and effective cost management and pricing policies. A Matrixed Pareto Analysis was tested as a tool for improving product line depth and inventory decisions.

The next section describes these results (the data are systematically distorted to maintain proprietary confidentiality); the time period is indicated as annual but the actual data represent a different period). Furthermore, the data labels have been generalized somewhat to conceal their specific definitions. The adjustments made to Sales and Gross Margin reflect non-systematic price discounts granted by the firm during the time period. None of these changes undermine the conclusions.

Figure 1 is a simple Pareto Analysis distribution of WPC's annual sales volume. The classic Pareto pattern is exhibited for the 3,200 products. For this example, Pareto categories are labeled High, Medium, and Low rather than ABC. The vertical axis represents annual sales volume in units. H-category products constitute a higher proportion than found in a typical Pareto distribution, while the M and L products are also proportionately less.

Without further analysis, the simplest and most direct management interpretation of these distributions is that the H group clearly dominates in generating sales volumes and, therefore, similarly dominates in generating sales dollars and gross margins. Figure 1 should be replicated for Sales Dollars and Gross Margins, thus producing similar results.

Adjusted Sales vs. Adjusted Gross Margin

Greater assurance about the relative contribution for each category may emerge if the dimensions of sales dollars and contribution to gross margin are evaluated against

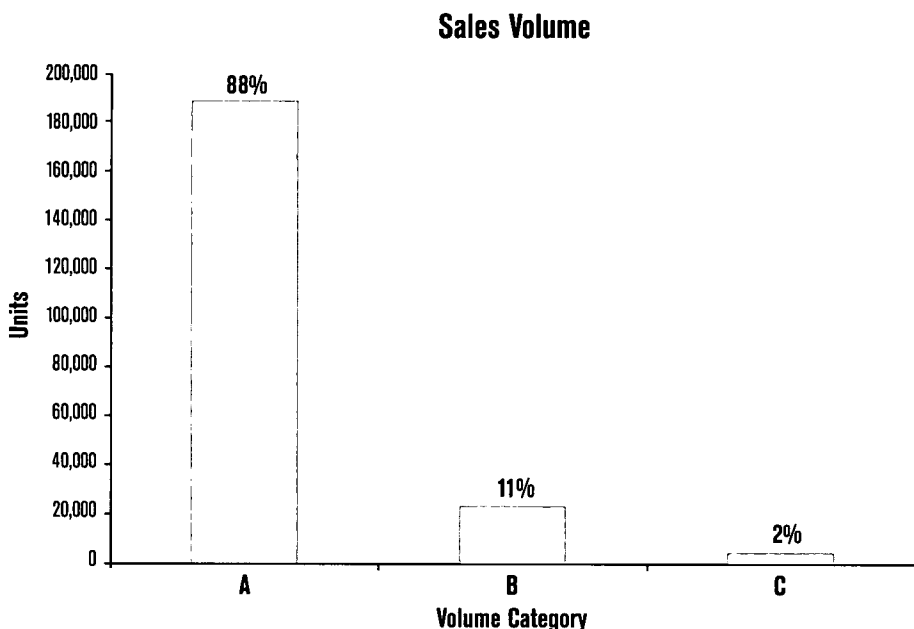


Figure 1: Pareto Distribution of Sales Volume for Wood Products Company

one another in a Matrixed Pareto Analysis. This analysis provides greater discriminatory precision by disaggregating the three traditional Pareto groups into nine separate cells, each representing a product group. For even greater precision, a fourth category of contribution to Gross Margin is included in the analysis, this raising the number of cells to 12. This additional category, N, applies to products that have negative gross margins.

Data for the 12 product subgroups are presented in Table 2. Cell entries represent sales and gross margin (all amounts are in thousands). Each sales group's data (A, B, and C) are distributed across four different levels of gross margin (H, M, L, and N).

Summing sales figures on the AH, BM, and CL diagonal produces a total of a little more than \$14.8 million, or only 55 percent of the company's annual sales of \$26.4 million. Thus, fully 45 percent of product sales do not conform to the expected relationship between sales and gross margins. This is the crux of the MPA approach: For accurate cost planning, management must disaggregate product populations into product groups with significantly different economic characteristics.

The value of disaggregation becomes immediately clear when the A-sales product group levels are examined. Product group AN (high volume, but with negative contribution to margin) corresponds to about 38 percent of all A-level sales. Moreover, it contributes a loss of \$651,000 to gross margin. Conversely, product group BH, while not a part of the A-Level sales group, contributes \$266,000 to gross margin. This is 12 percent of the gross margin for the entire operation. Each of the off-diagonal cells calls for different cost control and pricing strategies. Classification this way allows management to further explore the economic characteristics of its complete product line.

Table 2: Matrix Pareto Analysis: Adjusted Sales vs. Adjusted Gross Margin
 Cell Entries = Sales Dollars; Gross Margin (both in \$000)

Gross Margin (\$000)					
Sales \$	H	M	L	N	Totals
A	12,824	1,052	177	8,530	22,583
	2,152	19	1	-651	1,521
B	933	1,412	296	531	3,172
	266	272	11	-48	501
C		258	316	40	614
		102	81	-7	176
Totals	13,757	2,722	789	9,101	26,369
	2,418	393	93	-706	2,198

Contribution to Margin

It is now possible to examine the average contribution to gross margin for products in each product group. Table 3 contains the percentage of gross margin to sales for each group. The average contribution of 8 percent across all products conceals significant differences: Product groups vary from negative 18 percent to positive 40 percent contribution. Each of the product groups may be further analyzed to reveal anomalies in the cost and price management policies of WPC.

Table 3: Percent Gross Margin and Group Averages

Gross Margin Group				
Sales Group	H	M	L	N
A	17%	2%	1%	-8%
B	29%	19%	4%	-9%
C		40%	26%	-18%

WPC Average Gross Margin = 8%

Given the analysis and the available data, it is now possible to identify the cost characteristics of each product group including interesting ratios. For example, Table 4 displays the "M" level Contribution to Gross Margin Group distributed across three (A, B, and C) levels of Sales and other relevant data.

The differences between product groups are best seen in the ratios. The percent-Gross Margin varies from 2 to 40 percent. The former represent commodity mark ups while the latter appear to be healthy margins. However, product group CM's 40 percent contribution to Gross Margin invites suspicion once it is revealed that the average sales per product in this group are 1.5 per year. These products may be enjoying a subsidy from higher volume products if set-up costs are pooled in manufacturing overhead rather than assigned to each product (a common practice).

Table 4: Cost Characteristics of Product Groups

Sales Level Category

Metric			
Sales Group	A	B	C
Gross Margin Group	M	M	M
Cell:	AM	BM	CM
Data			
Products	51	247	826
Sales \$ (000)	\$1,052	\$1,412	\$258
Gross Margin \$ (000)	\$19	\$272	\$102
Volume - Units Sold	10,338	10,201	1245
Ratios			
% Gross Margin	2%	19%	40%
Sales \$/ Unit	\$102	\$138	\$207
Gross Margin \$/ Unit	\$2	\$27	\$82
Sales \$/ Product	\$20,627	\$5717	\$312
Gross Margin \$/ Product	\$1101	\$123	
Units Sold/year	203	41	1.5

Cell CM includes 826 products whose average annual contribution to Gross Margin is only \$123. These are custom ordered products that generate set-up, control, and tracking costs. These costs may easily consume the entire projected margin on the sale. Indeed, further analysis at WPC revealed many such outcomes.

Other than for the Gross Margins, all of the data in the cell analysis is reasonably hard; sales dollars and counts of units and products. The Gross Margin is an estimate of the mark-up over costs and, given the cell analysis, should be interpreted with care and skepticism. While the costs of materials and direct labor may be readily associated with each product, pooled overhead costs such as set-up costs, management, handling, design, tracking, etc., are expected to be absorbed by the Gross Margin.

The Matrixed Pareto analysis raised many questions, a result entirely consistent with its purpose, which is to focus management attention on opportunities for improved cost management. However, it may also serve to identify useful ways to disaggregate complex cost information. That is the agenda of Activity Based Costing.

MPA and Activity Based Costing

A core problem for management accounting in manufacturing operations such as WPC is the complexity of product offerings and manufacturing processes. The challenge is to disaggregate products and processes into meaningful subsets with reasonably homogeneous cost characteristics. Simply put, the goal of Activity Based Costing is to disaggregate overhead pools into cost components so that more refined

cost allocations can be made to particular products and manufacturing processes. Kaplan (1990) points out the inability of traditional systems to deal with the effects of changes in product volume and mix. "Distortions introduced by mix shifts occur when the organization fails to recognize the increasingly diverse nature of its output ... simple summaries of cost per unit are no longer meaningful." Kaplan's solution is to suggest either the development of "product complexity indices," or to eliminate unit cost summaries altogether.

Traditional cost management data is often problematic because it is not readily translated in ways relevant to operational decision challenges. Operations managers, often, must take the determinations of cost accountants on faith. The application of complexity indices can only exacerbate that situation. That may be one explanation for the systemic resistance to the substitution of these new cost drivers and performance measures for traditional measures. At least the old measures, if inaccurate and sometimes obscure, seemed more or less intelligible if only as a result of years of exposure. Thus, the challenge is to find useful means of disaggregating costs that identify intelligible cost drivers relevant to operational decisions.

Identifying Product Groups With MPA

As an example, suppose that WPC management wants to classify its products in terms of the kinds of overhead resources that they demand. Some of these resources are associated with the manufacture of parts and others with their assembly into final products. On average, WPC's final products are assembled from 10 to 30 components.

Much of the variety of the firm's 3,200 products is based on variations in one or more of these parts. Thus, this company may be dealing with 10,000 different part-combinations. Furthermore, a large variety of manufacturing operations are required to produce these basic components. Finished products use these components in different combinations. Required quantities vary greatly; they may involve production runs of several thousand or be limited to lot sizes of just one or two pieces. This is not an atypical level of complexity for many firms.

A first attempt at classification of parts and processes might utilize annual direct labor hours matched against part volume. Intuitively, it might be expected that those parts that accumulate the greatest portion of the total direct labor hours should also represent a similar portion of the total part volume. However, the Matrixed Pareto analysis suggests otherwise. These data are displayed in Table 5.

Table 5: Matrixed Pareto Analysis - Parts
(Direct Labor Hours vs. Part Volume)

Volume	Direct Labor Hours		
	H Parts	M Parts	L Parts
A Parts	AH	AM	AL
B Parts	BH	BM	BL
C Parts	CH	CM	CL

As noted above, the diagonal cells, [AH, BM, and CL] confirm intuitions and do not add information. Cells AM and AL represent high volumes with low direct labor hours. This is what we would expect from automated production processes and, accordingly, machine overhead costs might be more relevant for this subgroup. Alternatively, cells BH and CH represent labor intensive product groups. Each cell appears to represent a different resource consumption profile as a basis for cost allocations. The MPA enables accountants to remove part of one component of pooled overhead, machine overhead costs, and allocate it directly to off-diagonal subgroups defined by the analysis.

Identifying Machine Groups

A similar approach may be used to classify manufacturing processes and machines. Many different machines are used at WPC to manufacture the component parts. In many ways, the plant is organized like a job shop. How might the machines be classified from a cost management perspective? As displayed in Table 6, two potential metrics, among many, are the 1) volume and 2) variety of parts produced by a machine. Identical machines might be grouped and rank ordered in terms of the total number and variety of parts they produce. Assuming a full data set, the analysis should yield a useful classification.

Table 6: Matrixed Pareto Analysis –
Machines: Product Volume vs. Variety

Metric	Volume A Machines	Volume B Machines	Volume C Machines
Variety H Machines	HA	HB	HC
Variety M Machines	MA	MB	MC
Variety L Machines	LA	LB	LC

Consider the characteristics of machines in each of the corner cells. Cell LA represents highly specialized machines dedicated to producing a small variety of parts in high volumes. We would expect set up costs per part to be proportionately low in this cell. Cell HC represents general purpose machines that produce a large variety of parts in small lots. Set up time should be quite high as a proportion of total machine hours. Cell HA represents the ideal of flexible manufacturing systems and the production of high volumes of a large variety of parts. Capital costs may be particularly high. Cell LC represents machines with low utilization. They are machines infrequently used but for which there are no substitutes when needed. A primary cost may be their unused capacity and space utilization. Here, again, components of the pooled overhead may be more directly allocated to specific groups of machines.

Validity Testing

Both of the above analyses suggest useful subgroups for the allocation of overhead costs. However, the selection of metrics only exemplifies the many different ways to

classify parts, products, processes, or machines. For example, reject rates, rework required, or other quality measures might have been used. Some processes might better be classified by scrap rates.

The purpose of classification is to identify groups of parts or machines for which the distribution of indirect costs differs across the population of parts or machines. Consider the proportion of set up hours to total machine utilization. It might be expected that each of the corner cells in the above matrix is significantly different. This hypothesis can be tested using a Multi-Way Analysis of Variance (MANOVA.) First, sample each of the cells; then establish the average set up proportions and their standard deviations for each cell and for the entire population. Finally, test for significant differences. This may also be a useful way to test for subgroup validity.

The ideal outcome would be well-differentiated groups with little overlap in terms of their overhead costs. A more likely outcome is that cell boundaries will need to be shifted to create valid subgroups. In some instances, more or fewer subgroups will emerge. Finally, if there is considerable overlap between subgroups, we should conclude that the selected metrics are incorrect.

Validity must be understood in the context of the present challenges of cost accounting. An accountant in a large manufacturing corporation described the allocation of pooled overhead costs to direct labor as "spreading peanut butter thickly." The utility and validity of MPA for Activity Based Costing will be defined by the reduction in pooled "peanut butter" and the increased direct allocation of specific costs to parts and processes. MPA will not yield high levels of precision. However, given the present state of allocation methods, it should yield a considerable improvement.

Mapping Cross Subsidization

Matrixed Pareto analysis may also be used directly to test the usefulness of cost drivers by mapping cross subsidization between products. For example, management might test direct labor overhead allocations against set up frequency as representative of ordering costs (Table 7). The matrix may, or may not, produce meaningful cells. If few products appear in off-diagonal cells, it is possible to conclude that a cost driver based on set up costs will not meaningfully reallocate costs to products. If the off-diagonal cells are dense, there is evidence of cross-subsidization.

Table 7: Matrixed Pareto Analysis - Overhead Allocation
(Direct Labor vs. Set- Up Frequency)

Metric	Direct Labor H Products	Direct Labor M Products	Direct Labor L Products
Set Up Freq. H Products	HH	HM	HL
Set Up Freq. M Products	MH	MM	ML
Set Up Freq. L Products	LH	LM	LL

As before, the diagonal cells do not add any information. However Cells HM and HL represent subgroups with low direct labor and frequent set ups. We saw such products in the WPC case. They were low volume small lot products. The table suggests that if overhead is allocated on the basis of direct labor only, these subgroups enjoy a subsidy for their share of set up costs. Alternatively, cells MH and LH represent high volume items with infrequent set ups, i.e. larger lot sizes. Given direct labor as the driver of overhead allocations, these product subgroups are subsidizing other groups at least in terms of set up costs. A large variety of cost drivers may be tested in this manner to identify candidates for further study.

Validation of MPA

The purpose of MPA is to raise questions with respect to cost, inventory, sales or other business policies. The test of MPA's utility, therefore, is whether or not a MPA segregation of products or processes results in subgroups that merit differential policies. For example, in Table 2, the sales and inventory policies for high margin products should be different than for low margin or negative margins products. In principle, sophisticated techniques may be applied to the matrix to quantify the optimum differences in these policies as a function of Gross Margin. In practice, the assumptions governing such policies are more complex than can be optimized in a two dimensional matrix. The validity of MPA derives from the ability to identify subsets that merit consideration of differential policies.

Conclusion

The Wood Products Company case exemplifies the successful application of a Matrixed Pareto Analysis to operations and cost management. The method succeeded in highlighting a set of cost and operational problems and enabled management to focus their attention on product subgroups that were particularly problematic.

The application of Matrixed Pareto analyses at WPC initiated a management review of their entire product line. Close to 25 percent of the products were evaluated for potential elimination. An effort was made to associate set up costs with low volume products and pricing was reviewed accordingly. Much discussion was generated between marketing, manufacturing, and accounting about the merits of various product offerings, product costs, and the sales volumes necessary to justify product manufacturing. Many issues remain to be resolved but it appears evident that the traditional business practices of the firm have been challenged.

Few products were dropped by WPC. It was argued by Sales that their larger customers would not purchase their high volume products unless they could also get the low volume special products. One of the authors noted that that hypothesis could be tested using MPA. On one axis, we rank order customers by volume, against the products they purchased by volume. We reasoned that if the Sales argument was true, we would find high volume customers buying across the range of products. That seemed doubtful. More likely, they rarely bought the very low volume products. We suspected that particular customers were "cherry picking" the low volume products.

The MPA would have revealed the purchasing practices of high, medium, and low volume customers. The management chose not to proceed with the second analysis given the discussions that emerged from the prior analysis.

Matrixed Pareto Analysis is a low cost methodology for disaggregating products and processes into groups defined by opposing economic metrics. These groups permit differential analyses in support of more effective decision making. Research is required to validate the potential and actual utility of MPA in support of managerial and cost allocation decisions. The methodology may be further developed by the addition of a third dimension allowing for greater refinement of product or process groups.

The key is to apply Pareto Analyses based on opposed metrics. The disadvantages of single dimensional Pareto Analyses are overcome by disaggregating various subgroups. Moreover, Matrixed Pareto Analysis should be a useful method to discover useful product and process subgroups for the allocation of indirect costs and, in a simplified form, to identify suitable cost drivers. It also appears to be a relatively low cost methodology. However, its effectiveness can only be ascertained through actual research and application. It is hoped that Matrixed Pareto Analysis will prove a useful and effective addition to both management accounting and operations management practice and research.

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