The effects of high performance work systems on operational performance in different manufacturing environments: improving the "fit" of HRM practices in mass customization

Zachary Leffakis
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A Dissertation

Entitled

The Effects of High Performance Work Systems on Operational Performance in Different Manufacturing Environments: Improving the “Fit” of HRM Practices in Mass Customization

Submitted by

Zachary Leffakis

Submitted as partial fulfillment of the requirements for

the Doctor of Philosophy in Manufacturing and Technology Management

____________________________________
Advisor: Dr. Dale Dwyer

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College of Graduate Studies

The University of Toledo

August 2009
An Abstract of

The Effects of High Performance Work Systems on Operational Performance in Different Manufacturing Environments: Improving the “Fit” of HRM Practices in Mass Customization

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This dissertation presents a critical analysis and rigorous scientific investigation of Mass Customization Manufacturing (MCM) and High Performance Work Systems (HPWS). A resource-based theoretical framework is developed that logically and conceptually guides an in-depth empirical examination of their theoretical strategic integration. The content within this manuscript conceptually argues that distinct MCM approaches must be aligned with and functionally supported by explicit HPWS configurations that consist of different, but complementary sets of internally aligned Human Resource Management (HRM) practices. Notions of internally consistent sets of HRM practices in a conceptual model provide a basis for theoretically identifying different structures of HPWS configurations. The conceptual model suggests that different, holistic sets of internally consistent configurations of HRM practices support distinct types of MCM systems. A hierarchical multiple regression analysis will attempt to indicate that operational performance measures should significantly increase when a firm designs and implements a comprehensive HPWS structure to support an explicit MCM approach.
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CHAPTER ONE: INTRODUCTION

1.1 Research Background

In addition to fierce global competition, shorter product life cycles and an increased demand for product proliferation; advances in microprocessor-based production technologies have forced many manufacturing firms to reposition their competitive orientation in dynamic customer markets for consumer and industrial goods (Kotha, 1995; Appelbaum, Bailey, Berg, and Kalleberg, 2000). These competitive forces are creating pressures for speed, flexibility, quality and high performance at the corporate, functional, and individual levels. As a strategic response to these changing competitive conditions in the modern economic marketplace and to meet rising performance standards, Mass Customization Manufacturing (MCM) (Davis, 1987; Pine, 1993; Duray, 1997; Da Silveria, Borenstein, and Fogliatto, 2001) and High Performance Work Systems (HPWS) (Appelbaum et al., 2000; Becker, Huselid, and Ulrich, 2000; Kintana, Urtasun, and Olaverri, 2006) have emerged to the business forefront as new competitive mechanisms and unique sources of sustainable competitive advantage for many manufacturing organizations contesting in dynamic business environments.

Mass Customization Manufacturing (MCM) is a radical shift in operational processes and managerial practices integrating both the one-off craft production and
conventional mass production methods into one manufacturing system (Davis, 1987). It represents an innovative approach to the low cost design and manufacture of high volume individually customized consumer and industrial products that simultaneously emphasize a very high level of quality with fast and dependable delivery (Pine, 1993). At the center of this emerging industrialized approach to modern manufacturing (Milgrom and Roberts, 1995) are innovative flexible and cost-efficient programmable advanced technologies within adaptable manufacturing processes, the use of modular components, lean production systems, and total quality environments. In addition, Duray, Ward, Milligan, and Berry (2000) found that firms pursuing MCM characterized by the use of standard modules and modularity in the later stages of the production cycle have significantly higher levels of firm performance than those using modularity in the design and fabrication stages of the production cycle.

A human resource management HPWS model is characterized by the systematic combination of several complementary HRM practices into a comprehensive and consistent bundle (MacDuffie, 1995) that transforms the work system structure and is a fundamentally different industrial relations approach to manage the workforce (Huselid, 1995). This approach emphasizes an organic management style represented by the decentralization of decision making that stresses greater levels of employee skill development, flexibility, and motivation, coupled with their extensive involvement in day to day operations and enhanced empowerment to directly participate in managerial decision making (Pfeffer, 1998). This new form of work organization and emerging personnel management approach transfers power to the workforce and is significantly distinct from the traditional hierarchical mechanistic techniques associated with
Tayloristic/scientific methods in mass production systems that stresses control by vertical communication patterns with a rigid separation of conception, planning and execution of narrow job tasks (Arthur, 1992). As a result, there has been a sudden increase of studies demonstrating a positive association between HPWS and firm performance (Cappelli and Neumark, 2001; Appelbaum et al., 2000).

Consequently, the impact of HPWS on firm performance has become the dominant research issue in the Human Resource Management (HRM) discipline, whereas, MCM’s impact on operational and firm performance and customer perceived value has become the primary research focus in the operations and manufacturing management fields. Although researchers have recognized the value of investigating the HRM – operations management interface in a mass customization context (Liu, Shah, and Schroeder, 2006) there are limited studies that provide empirical examination of the combined implementation of HPWS and MCM approaches. Therefore, under the current competitive circumstances in intensive business environments and dynamic capital markets to maximize performance and gain a sustainable competitive advantage, MCM and HPWS assumes a significant importance to the business and academia communities requiring serious empirical research attention regarding their potential strategic integration. The goal of this dissertation is to identify the particular set of complementary HRM practices within a HPWS structure that supports a distinct MCM approach to maximize operational performance.
1.2 Limitations of Existing Research within the Mass Customization and HPWS Domains

Current academic literature reports the emergence of four distinct types of MCM approaches within discrete strategic orientations (Duray et al., 2000) and various Strategic Human Resource Management (SHRM) models of HPWS structures (Appelbaum and Batt, 1994; Author, 1992; Yount, Snell, Dean, and Lepak, 1996; MacDuffie, 1995; Lepak and Snell, 1999; Lepak and Snell, 2002) to counter the dynamic environmental forces that drive intense competition. However, contemporary researchers within these two separate functional disciplines have failed to systematically integrate these two sources of competition into a unified comprehensive framework that statistically analyzes their interaction and empirically validates the moderating effects their relationship may have on maximizing operational performance measures. The relationship between human resources and operations (manufacturing) is broadly described in the literature (Snell and Dean, 1992; Ahmad and Schroeder, 2003), but the specific nature of this relationship in different MCM approaches is limited.

To date, the academic literature has only exposed the surface of these new competitive paradigms independently and has just begun to explore their strategic relationship and the potential benefits of their integration. For example, Liu et al., (2006) empirically examined the relationship between nine innovative HRM work-design practices and mass customization ability based on data gathered from 185 plants of the High Performance Manufacturing research project conducted by Flynn, Schroeder, and Flynn (1999). The results of their MANOVA analysis indicate that firms with high mass customization ability use the HRM practices of feedback to shop-floor employees,
autonomous maintenance by shop-floor employees, cellular manufacturing set-up, multifunctional employees, high standards for recruiting, task-related training, differentiated reward and incentive systems, employee contribution willingness, and continuous improvement and learning to a greater extent than plants with low mass customization ability.

This dissertation differs significantly from the Liu et al., (2006) study based on two fundamental elements. First, their study analyzes the association of the nine HRM practices separately on mass customization ability and fails to analyze them as a comprehensive system and consistent set of HRM practices that theoretically defines a HPWS. Secondly, the study only address a firms ability to mass customize and fails to address the actual approaches and methods used to facilitate the manufacturing of mass customized products. To be considered a mass customizer, Duray (2000) emphasizes that a firm must have some degree of customer involvement and incorporate some form of product modularity in the production cycle. Without these two elements an organization is not considered a mass customizer and can be viewed as merely a flexible manufacturer that offers an extensive amount of product variety at a low cost very quickly without sacrificing quality. The Liu et al., (2006) study fails to meet the full criteria of MCM because it only address the degree respondents agree or disagree with their ability to add significant product variety without increasing cost and decreasing quality while maintaining high volume customization to customers quickly. Although their study shows a positive association between HRM practices and mass customization ability, it does not explore the roots of HPWS and MCM approaches. Mass customization ability can only be considered an outcome of a MCM approach. The Liu et al., (2006) study fails
to address the moderating circumstances that effect mass customization ability and the interaction effects these variables have with HPWS on operational performance. Therefore, I argue that MCM plants are more likely to combine a unique complementarily set of HRM practices into a specific HPWS based on the particular degree of customer involvement and modularity in the product cycle to enhance operational performance.

Thus, recent academic and practitioner literature has failed to provide adequate scientific evidence and practical knowledge that substantially details the strategic and competitive issues involved in MCM approaches and HPWS integration. In particular, the impact of hidden technical and social changes created by MCM approaches on the organization of work, HRM practices and HPWS structures has not been explored. To illustrate, researchers within the mass customization field (Kotha, 1995; Pine, 1993; Duray, 1997; Tu, Vonderembse, Ragu-Nathan, 2001; Tu, Vonderembse, Ragu-Nathan, Ragu-Nathan, 2004; Liu et al., 2006) agree that advances in flexible manufacturing technologies, JIT management systems, time-based manufacturing practices, modularity-based manufacturing practices, and information systems have facilitated mass customization capabilities for many manufacturing organizations; however, they have failed to address the importance of transforming the work system and including the workforce, job design, and innovative industrial relations practices systematically combined in a HPWS structure to make MCM a reality.

Additionally, researchers within the HPWS literature have not specifically defined structures of workforce attributes associated with MCM organizations nor provided detailed employee capabilities and behaviors that make mass customizers distinct from
conventional or flexible manufacturers. For example, the notion of HRM and HPWS described in the literature discusses the integrated and advanced manufacturing (Snell and Dean, 1992; Milgrom and Roberts, 1995), lean production (MacDuffie, 1995), flexible manufacturing (Arthur, 1992), and manufacturing strategy (Yount et al., 1996; Jayaram, Droge, and Vickery, 1999) implications of HPWS design, but has failed to discuss how the manufacturing approaches used to achieve a mass customization capability impact the design of HPWS structures and implementation of innovative HRM practices.

Also, advocates of HPWS proclaim that the effectiveness of this approach to manage the workforce is maximized only when a comprehensive set of innovative HRM practices and policies are strategically combined into a comprehensive structure to support advanced manufacturing systems. However, this assertion ignores the possibility that conventional HRM practices and policies may continue to be effective if appropriately bundled into a comprehensive structure that supports repetitive manufacturing systems for standardized component and modules. A thorough review of the relevant HPWS literature indicates that researchers have dismissed the use of conventional HRM practices and have discounted the benefits of utilizing them in moderate standardized manufacturing systems.

Therefore, from a dynamic business perspective to maximize operational performance in modern free market global economic systems, this dissertation presents the following academic argument; to achieve a mass customization manufacturing capability that maximizes operational performance, mass customizing organizations must understand the strategic alignment between the mass customization manufacturing
approach and the specific bundles of workforce management system policies and practices that support it. A higher level of operational performance can be expected when a unique set of complementary HRM practices are bundled into a comprehensive HPWS structure that supports a distinct mass customization manufacturing approach.

Interestingly, a good deal of scientific evidence and empirical data suggests that changes in manufacturing systems characterized by advanced technology often are not accompanied by complementary changes in manufacturing infrastructure (Boyer, Leong, Ward, Krajewski, 1997), HRM approaches (Snell and Dean, 1992), workforce development activities (Waldeck and Leffakis, 2007) and the organization of work systems (Appelbaum and Batt, 1994). Hence, based on an extensive review of the relevant literature, past experiences, and a comprehensive case analysis; the basic premise of this dissertation is that MCM firms often fail to transform the work system, under-invest in workforce development activities and inappropriately manage their employees; and just as important, transform improperly and invest incorrectly. It is relatively clear that many MCM firms seem to be unaware of the consequences of their investment decisions involving the recruitment, development, and management of the workforce and the strategic decision to transform the work system.

Thus, within the content of this dissertation, it will be scientifically argued that the human resource function and the social dimension of an organization should also be included as a functional capability that appropriately transforms the work system and manages human capital by theoretically and empirically identifying the appropriate bundles of HRM practices and policies required to facilitate distinct MCM approaches that maximizes operational performance for these types of firms.
1.3 Research Questions

The realization of mass customization by contemporary advocates might have been based on a faulty assumption that the resources needed to facilitate MCM capabilities reside in the sole use of individual HRM practices separately, marketing, manufacturing and engineering resources (Liu et al., 2006; Duray, 1997). However, previous research has failed to integrate complementary sets of HRM practices to examine the relationship between HPWS and operational performance in distinct mass customization approaches. Hence, the two broad primary research questions in this dissertation focus on addressing these integrative issues. They are:

1. Are HRM practices uniquely bundled into distinct HPWS based on the particular approach used to manufacture mass customized products?

2. Do organizations with distinct mass customization manufacturing approaches that are supported by a particular HPWS structure have higher operational performance than organizations that do not?

1.4 Research Contribution to the Mass Customization and HPWS Bodies of Knowledge

This paper first presents a critical analysis of previous research on MCM and HPWS. After which, a resource-based conceptual framework is developed to guide a thorough empirical examination of the operational performance effects associated with
their integration. Then, this analysis postulates that specific HPWS configurations must be intentionally developed to complement and support the unique manufacturing approaches of two distinct strategic types of mass customizers. The explicit HPWS structure required to support each MCM approach is conceptually argued to be significantly different from any other SHRM configurations.

The intention of this scientific research is to provide a thorough and comprehensive empirical examination of the anticipated positive relationship and interaction effects between HPWS structures and MCM approaches on operational performance for each strategic type of mass customizer. The goal is to anchor this study firmly in a deep understanding of mass customization dynamics associated with specific manufacturing approaches and the role that plant level work system changes could play in maximizing operational performance in a particular mass customization strategic setting. At the same time, this dissertation moves beyond the idiosyncrasies of any particular modern manufacturing approach to understand the dynamic relationships between emerging workplace personnel practices in diverse MCM environments.

Empirical studies and critical examinations that scientifically investigate the proposed strategic integrated relationship between HPWS and MCM are not readily available and represent an important missing link in both manufacturing management and HRM research. In response to this academic limitation, this research theoretically develops discrete typologies of HPWS structures and specifies the explicit coherent set of complementary HRM policies and practices needed to support the distinct configurations of HPWS for the different types of MCM approaches. Therefore, based on the statistical results of this empirical analysis, it is anticipated that the scientific knowledge created
will provide a set of rational recommendations of HPWS design principles and prescriptions to help guide practitioners to effectively implement a HPWS structure and manage the workforce in various MCM settings. It further expands the knowledge and broadens the understanding of HPWS structures to include different configurational types within diverse MCM systems.

This study establishes a new paradigm of HPWS that presents a concise representation of many intricate and interconnected characteristics of work system organization and personnel management practices within complex MCM systems. The archetypes provide a method for identification and classification of HPWS structures that has not been previously considered in the HRM literature. Once classified, the typologies provide a method to determine the appropriate holistic set of complementary HRM policies and practices for the successful implementation of each distinct HPWS configuration to support an explicit MCM approach. Managers should be able to identify their respective MCM approach or degree of product customization and determine if existing set of HRM practices associated with the work system match and support the required MCM system attributes. Organizations that fail to strategically combine their HRM practices into a coherent HPWS structure are unlikely to develop and manage the workforce required to undertake a mass customization initiative successfully.
CHAPTER TWO: LITERATURE REVIEW & THEORETICAL FOUNDATION

2.1 Scope of Mass Customization – HPWS Strategic Integration

2.1.1 Overview

The fundamental decision every organization must make is the strategic investment and allocation of its structural (technical) and human (social) capital resources required to support their business strategy and achieve a sustainable competitive advantage (Murphy and Zandvakili, 2000). The specific strategic posture an organization takes toward the external competitive environment should have capital resource investment and allocation implications for each internal functional department within a firm. In particular, different organizational strategic postures emphasize unique capital demands on both the manufacturing systems (Hayes and Wheelwright, 1984; MacDuffie, 1995) and the work systems (Arthur, 1992; Snell, Yount, and Wright, 1996; Ferris et al., 1999; Huselid, 1995; Delery and Doty, 1996; MacDuffie, 1995); further requiring the appropriate investment and allocation decision of technical and human capital resources to be competitive.

Researchers have proposed an explicit link between different business strategic postures and the functional approaches related to manufacturing infrastructure attributes
and structural process technologies (Skinner, 1969; Wheelwright and Hayes, 1984) and HRM practices and policies (Arthur, 1992; Wright and McMahan, 1992; Jackson and Schuler, 1995). Hence, the conceptual and empirical work relevant to these interrelationships and strategic linkages has progressed far enough to suggest that the mutual role of HRM and operations management as strategic partners can be vital to an organization’s competitive and economic success when considered concurrently (Yount et al., 1996; Guthrie, 2001; Ichniowski, Shaw, Prennushi, 1997; Jayaram, Droge, and Vickery, 1999; Ahmad and Schroeder, 2003). Where strategic goal congruence decreases, the potential for conflict between the two functions increases, which may lead to poor performance and a decline in competitiveness.

To illustrate, researchers within the SHRM (Ferris et al., 1999; Jackson and Schuler, 1995; Becker, Huselid, and Ulrich, 2001; Sell and Dean, 1992; Yount et al., 1996) and manufacturing management disciplines (Skinner, 1969; Hayes and Wheelwright, 1984) have stressed the importance of including these two departmental functions as critical strategic partners in business strategy formulation to competitively guide the organization and make accurate resource investment and allocation decisions. Jayram, Droge, and Vickery (1999) developed a HRM framework to empirically analyze the relationship between numerous individual HRM practices and specific manufacturing competitive dimensions and, in addition, HRM-factors or “bundles” and manufacturing performance. The authors found that the HRM practices; namely, top management commitment, communication of goals, training, cross functional teams, and other general practices can be grouped according to the manufacturing strategic dimensions of cost, quality, flexibility, and time. In addition, there was significant empirical support for a
positive relationship between each strategy-specific HRM-factor or “bundle” and various manufacturing performance measures of overall cost, quality, flexibility, and time. The implication of these findings suggests that HRM activities should be coordinated and linked to the competitive goals and strategic priorities of manufacturing.

Snell and Dean (1992) found several significant positive direct and interactive relationships between various dimensions of integrated manufacturing; namely advanced manufacturing technology, just-in-time inventory control, and total quality management, to several human resource practices such as selectiveness of staffing, comprehensiveness of training, developmental use of performance appraisals, externally equitable rewards, and individually equitable rewards. As a result of their findings, Snell and Dean (1992) suggest that managers should not perceive the work system and technical systems as separate units, but instead manage them in concert.

These finding reverberate the SHRM-manufacturing management strategic relationship argument, suggesting that the HRM and the operations management function must move from a reactive perspective emphasizing compliance to a proactive perspective emphasizing the cross-functional involvement in business strategy formulation and the corresponding resource implementation and deployment. The literature base described in the following sections provides the foundation to illustrate the predominant hierarchical model of business and functional strategies depicted in Fig. 2.1. The model suggests that mass customization can be considered from a general strategic perspective consisting of two specific competitive postures for a firm requiring an appropriate MCM approach and supportive HPWS.
Although the principal hierarchical model of business and functional strategies suggests that the employed competitive strategic posture influences each functional area of a firm, this dissertation will only focus on the manufacturing and HRM disciplines as well as the individual components of these functional strategies and how their congruent integration may influence the maximization of operational performance. The scope of this empirical research centers on mass customization as a competitive strategic option and how the manufacturing and work system interact to influence operational performance. Therefore, the outcomes of the corresponding MCM approach and HPWS will be used to determine the relationship with the identified mass customization strategy. Due to the notion of research parsimony, the choice of other functional strategies as well as their individual facets will not be included within this manuscript, further providing more accurate and valid results regarding the HPWS – MCM integration effects on operational performance. The subsequent literature review explores the intricate details of the primary mass customization strategic model as illustrated in Fig. 2.1 with respect to MCM and SHRM approaches.
2.1.2 Competitive Business Strategy

In general, a strategy is a future focused action plan which encompasses a comprehensive competitive framework that dictates how organizational policies and practices are coordinated, framed and executed to effectively allocate, structure and manage scarce organizational resources to achieve predestined goals and create profitability for a firm now and in the future. Ultimately, it facilitates the ability of an organization to compete in dynamic, intense, and competitive marketplaces by providing a clear strategic direction.
In particular, a firm formulates a competitive business strategy to identify the general response or broad organizational approach on which it intends to compete against other firms in a customer defined specific marketplace. The business strategy signifies the distinct coordinated pattern of strategic investments and tactical allocation of a firm’s scarce structural and infrastructural resources to successfully compete in diverse business environments and dynamic markets (Arthur, 1992). It further determines how they will differentiate themselves from the competition (Krajewski and Ritzman, 2002) by defining the range of value adding activities for the business and setting competitive priorities so that it accomplishes overall financial goals and objectives of the firm (Finch, 2005). Furthermore, the business strategy provides the foundation for how the firm intends to manage and interact with their external and internal environments.

From an external environmental perspective, the business strategy is a well-conceived tactical plan based on the firms’ vision, mission, beliefs, and values that attempt to attract and retain a certain target set of potential customers in a particular market in which the firm decides to compete (Gephart and Van Buren, 1996). It must be consistent with its business environment and assist in distinguishing the firm and its products and services from the competition; dictating how the enterprise will meet and exceed customers’ value expectations through appropriate patterns of structural and infrastructural resource investments and allocations.

From an internal environmental perspective, the business strategy can be seen as a collection of organizational and functional attributes and resources that establishes its competitive position in an industry (Duray, 1997). A competitive business strategy provides the focus for individual internal functional departments to make coordinated
resource investments and allocation decisions that create and satisfy customer value in efficient and effective ways. In addition, the business strategy indicates how the corresponding pattern of organizational resource investments should be allocated by each functional department to provide congruence and support between each of them. This is accomplished by coordinating the firm’s overall strategic goals with its scarce functional resources and core competencies, further indicating which customers the firm will serve and which products and services it will produce. The execution of the business strategy will require investments, synchronization, and allocation of scarce resources, managing those resources, and following organizational policies to guide and control them.

Porter (1980) has successfully classified organizations by their strategic posture used to achieve a sustainable competitive advantage over other firms in a given industry. These groups have been categorized into three broad strategic types; Cost Leadership, Differentiation, and Focus. Firms undertaking a Cost Leadership strategy compete in a mature market segment of an industry and focus on becoming the lowest cost producer of standardized products or services through high volume economies of scale production. Within the same industry, a firm may choose to compete in an emerging market segment and implement a Differentiation Strategy which focuses on some basis other than low cost that is perceived by the customer as being unique and more valuable; and which they are willing to pay a premium price for. Alternatively, a Focus strategic posture is intended to focus products or services at a small segment of the market, whether it is to provide low costs, high quality, timeliness of delivery, or some form of product customization and variety. The concept of focus dictates that a firm can only provide a
limited amount of resource attention to a small group of customer needs, but does so extremely well.

2.1.2.1 Mass Customization: An Emerging Competitive Strategic Concept

However, a new strategic posture or competitive concept, Mass Customization, is quickly emerging that simultaneously emphasizes the calculated combination of all three traditional strategies of Porter (Davis, 1987). It is an intentional combination of multiple competitive criteria associated with Differentiation, Cost Leadership, and Focus principles that provide the basis of mass customization as a business strategy. At the heart of these combined principles are increasingly individualized customer requirements at low costs. More recently, researchers are referring to the concept of mass customization as a competitive business strategy that stresses low-cost, high quality, large volume delivery of individually customized products and services (Pine, 1993; Duray, 1997). Tu, Vonderembse, Ragu-Nathan (2001) describe the foundation of mass customization as the ability to achieve customer responsiveness, cost efficiency, and high volume production simultaneously. From this perspective, mass customization can be regarded as mostly a low-cost process focused differentiation strategy within both emerging and mature markets. Furthermore, Duray (1997) illustrates that mass customization should be considered a strategic posture by arguing that “The choice of mass customization as a business strategy fit well within the new models of business strategy that views the firm’s competitive position as a collection of company attributes” (p. 19). In addition, Ferris et al., (1999) highlight the fact that the generic categorizations of Porter (1980) and Miles
and Snow’s (1978) firm strategy typologies are not consistent with the realities of the current competitive environment that organizations compete in and suggest that researchers adopt a more relevant strategic perspective that takes into account the dynamic aspects of the current competitive pressures organizations are facing in the global marketplace.

The ability to execute mass customization is more important than the strategic concept itself. The idea of mass customization has evolved from a marketing perspective (Kotler, 1989), to the incorporation of the production and operations management arena (Pine, 1993; Duray, 1997). However, including the HRM function and workforce element may hold the key to maximized mass customization operational performance in different manufacturing environments and processes (Kakati, 2002). The preceding notion regarding workforce development and management motivates this study to view mass customization as a business strategy that must be supported by appropriate manufacturing approaches and sustainable HRM work systems.

2.1.2.2 Mass Customization Strategy Defined

The coordinated fit of business strategic policies and manufacturing and human resource imperatives is critical to the operational performance and sustained competitive advantage of a firm competing in mass customization environments (Venkatraman, 1989). In mass customization strategic environments, the fit is required to match competitive market initiatives, manufacturing system characteristics, workforce attributes and behaviors, and supportive structures of HRM policies and practices. Therefore, this
study broadly defines mass customization strategy as a collective pattern of interrelated and coordinated manufacturing choices that collectively support the strategic objectives sought by the firm and assist in maximizing operational performance. Furthermore, it is regarded as the collective pattern of coordinated strategic decisions and tactical plans that acts upon the deployment of customer involvement and component modularity in the production cycle that directly relates to the design, fabrication, assembly, and delivery of customized products to enhance operational performance. The following sections provide a more detailed description of the conceptualization of mass customization.

2.2 The Foundation of Two Mass Customization Strategies

The revolutionary and evolutionary development of mass customization as a strategic source of competition by both researchers and manufacturers indicates that obtaining a competitive advantage in the dynamic and competitive post-industrial environment (Doll and Vonderembse, 1991) will center on the organizations ability to provide customized products at mass production prices in a timely manner with high quality attributes (Pine, 1993). The sources for modifying the manufacturing function include technology advancements, the modularization of both product design and process layout, and new managerial initiatives such as JIT, lean systems and time-based practices. These transformational sources have led to the identification of various forms of mass customization strategic postures.

Duray et al., (2000) establish a two dimensional conceptual model to unambiguously classify four fundamental, mutually exclusive types of mass customizers
according to the way manufacturers achieve mass customization through the use of modularity and the point of customer involvement in the production cycle. To classify these four categories accurately, the points in the production stages are defined as design, fabrication, assembly, and use/delivery (Lampel and Mintzberg, 1996). The combination point of customer involvement and product modularity at these production stages determines the degree of uniqueness of the end product. Figure 2.2 illustrates the conceptual model empirically validated by Duray et al., (2000).

### Mass Customization

<table>
<thead>
<tr>
<th>Modularity Type</th>
<th>Point of Customer Involvement</th>
<th>Design</th>
<th>Fabrication</th>
<th>Assembly</th>
<th>Delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>Designers</td>
<td></td>
<td></td>
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<tr>
<td>Fabrication</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Assembly Use</td>
<td>Involvers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use</td>
<td>Modularizers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure: 2.2 Conceptual Model of Mass Customizers (Duray et al., 2000)

The authors empirically categorize mass customizers as Designers, Assemblers, Involvers and Modularizers based on the factor scores corresponding to the specific combination at the point in the production stage where the end-user customer participates in specifying the product design and the type of product modularity used in the customized design of the product. Classification results suggest that Designers include...
both the customer involvement in product design and product modularity during the design and fabrication stages, *Involvers* include the involvement of customers in product design during the design and fabrication stages but integrate product modularity during the assembly and use/delivery stages, *Modularizers* use customer involvement in product design at the assembly and use/delivery stages but incorporate product modularity in the design and fabrication stages, and *Assemblers* contain both the customer involvement in product design and product modularity during the assembly and use/delivery stages.

After the mass customizers were clearly identified based on the classification scheme, the four mass customization groups were empirically examined to explore the different manufacturing approaches used to achieve a mass customization capability using manufacturing system decision variables that strongly resonates with mass customization characteristics. These manufacturing contextual decision variables are represented by the specific structural and infrastructural categorical choices identified by Hayes and Wheelwright (1984). Results from an One-way ANOVA with Scheffe’s test indicates that significant differences exists between each group for the structural decisions of process choice and technology, and the infrastructural decision of production planning techniques. The findings suggest that each group has a distinct manufacturing system that facilitates different types and scale of mass customized products. The authors concluded that there are significant distinctions in the manufacturing system implementation of mass customization between groups.

Furthermore, Duray (2002) suggests that the four types of mass customizers can be compared to the traditional manufacturing practices of customization (or “craft” production) and mass production because each type effectively implements different
manufacturing systems (represented by process, technology, and production control manufacturing decision variables) to achieve mass customization capabilities based on the base product production. The author illustrates that Designers and Involvers both involve the customer in the design stage of the production cycle which represents the true nature of customization characterized by specially made products. Assemblers and Modularizers involve the customer in the later stages of the production cycle which represents the true nature of mass production characterized by partially tailor-made products. For the purposes of this dissertation, this paper will continue with this logic and classify Designers and Involvers as “Fabricators” and Assemblers and Modularizers as “Assemblers”. Therefore, Fig. 2.2 can be simplified to represent two distinct types of mass customizers and their corresponding MCM approach. The following discussion will illustrate that the two types of mass customizers use different operational approaches to mass customization.
The author explains that *Fabricators* closely resemble traditional custom product producers because this group incorporates customer involvement in product design during the design and fabrication stages, exhibits a significantly higher level of usage of job shop processes in the manufacturing of component parts, has the highest usage of Make-to-Order production planning control systems and CAD and FMS manufacturing technology. In the *Fabricator* group, customers have the ability to specifically design an unlimited amount of custom features and components around common modules and indicate how the product should be assembled to meet their needs. “Modules can altered or additional components can be fabricated to supplement the standard modules.
providing for the unique requirements of the customer (Duray, 2002).” Thus, there is an infinite range of product proliferation for the customer.

In addition, the author indicates that *Assemblers* are very much similar to standard product producers that utilize mass production methods because this group involves the customer in product design during the assembly and use/delivery stages, has a significant level of line process usage, has the highest usage of Make-to-Stock production planning control systems, incorporates MRP administrative technology and extensively utilizes robotics manufacturing technology. In this group, customers can only customize the product by specifying the exact assembly configuration of pre-designed and manufactured component modules to create unique end products. Product customization is only realized when high volume standardized parts and modules are assembled into different end product configurations according to customer preferences at later stages in the production cycle. In this MCM approach, the customer may not design or alter common component modules, which provide the means to produce standard parts in high volumes. Customers are not permitted to specify the exact design of the customized product, but may only be involved in dictating how the finished product may be assembled from a large, but predetermined envelop of product options. Thus, there is a limited variety of component options but a greater range of end products. “*Assemblers differ from mass producers in that the products have been designed so that the customer can be involved in specifying the product (Duray, 2002).”* This characteristic gives the customer the perception that the product is customized.

Although Duray (2002) implies that both the Fabricators and Assemblers are considered mass customization strategic types and suggests that each implements a
distinctive manufacturing system, the author fails to explicitly label the corresponding manufacturing approaches. Therefore, as Fig. 2.3 suggests, the Fabricator’s manufacturing approach will be identified as using an Infinite Mass Customization Manufacturing (IMCM) approach and the Assembler’s manufacturing approach will be identified as using a Finite Mass Customization Manufacturing (FMCM) approach. The IMCM approach can receive this label because ideally these manufacturers have the capability to produce an unlimited amount of unique component modules to customer specifications and assemble them according to their particular application needs. Subsequently, the FMCM approach can receive this label because these manufacturers only have the ability to assemble a restricted range of end-products from standardized modules to meet customer requirements. The following sections descriptively discuss the technical and social characteristics associated with each MCM approach.

2.2.1 Technical and Social Characteristics of Mass Customization Manufacturing Approaches

This dissertation argues that an important distinction between the Assembler and Fabricator mass customizers is their corresponding manufacturing system’s approach to product customization and the associated organization of work system’s attributes, characteristics and features. Furthermore, this dissertation suggests that for Assemblers and Fabricators to maximize operational performance, both the MCM approach and the workforce must be uniquely designed and managed to support each other. The course of mass customization approaches for each type of mass customizer has forced radical
changes in the way work is designed, organized and employees managed – from employee involvement to autonomous work groups. Figure 2.4 summarizes the work system characteristics for each MCM approach.

2.2.1.1 Assemblers – Finite Mass Customization Manufacturing (FMCM)

The Assembler approach utilizes a FMCM system that incorporates the customer in the final stages of the production cycle and permits them to choose among a pre-determined list of modules and features that can be assembled and delivered to meet customer requirements. Duary et al., (2000) argue that modular design facilitates volume repetitiveness and product variety simultaneously in the production process or enables the “mass” in mass customization. Product modularity in the later stages of the production cycle (assembly and use) permits the FMCM system to achieve economies of scale and low cost by producing high volumes of common component parts while providing customization of end products. This approach can be viewed as a traditional high volume production system that produces a limited range of homogeneous component parts and modules characterized by low costs, consistent quality and quick reliable delivery.

FMCM systems are inclined to implement a line or continuous flow processes with robotic technology as the manufacturing method to produce high volumes of low variety standardized component parts and modules. In regards to standard product producers, Duray (1997) illustrates the following, “Since modules are not unique and can be reproduced, modules can be produced in a batch or line environment.” Line production processes are characterized by a high investment in dedicated, inflexible
automated machinery that are designed to duplicate the same operations, activities, and tasks continuously. This form of manufacturing produces long runs of large lot sizes to realize economies of scale and high resource efficiency and utilization. Therefore, product modularity employed in the design of the product customization can be used to achieve high manufacturing scale efficiencies that approximate those of standard mass produced products. However, to assemble these types of mass customized products plants will need to incorporate more flexible resources (manufacturing technology, processes and people) to adapt to the large amount of possible end-product configurations dictated by the customer.

To optimize a FMCM system for the production of standardized components and modules and assembly of customer specified end-products, the organization of the work system is based on applying some limited aspects of a Taylorist approach that focuses on a semi-mechanistic model of organizational effectiveness. This approach is characterized by limited hierarchical management structures that implements scientific management principles with the purpose of creating a limited amount of multi-tasking, teamwork, job rotation and production related decision-making. Such management structures represent a moderate centralized control of semi-narrowly defined and fragmented tasks that requires some monitoring by supervision.

In the FMCM systems, shop-floor workers are considered to be semi-skilled (as apposed to low skilled) with a reasonable ability to provide suggestions for production process improvements and solving quality problems. The organization of work is designed to be semi-rigid with some functional flexibility so any moderately skilled worker could learn routine, simple repetitive tasks on dedicated machinery and
equipment for standardized components and modules, but flexible enough to assemble
unique end-product configurations to customer specifications. Such tasks encompass a
tapered (as opposed to narrow) range of specialized to broad work related activities that
leads to more efficient processes, less formal training, faster work pace and lower costs.

Workers performing work related activities in the fabrication of standardized
component parts are expected to work individually on their work tasks while rotating
between similar job assignments only within their immediate work area. Workers may
set-up, operate, and perform simple routine maintenance on several different machines,
but only within the primary work area. Also, they are responsible for direct inspection of
their work and are encouraged to consult with their immediate supervisor and other co-
workers within the immediate work area to resolve quality issues. Workers performing
these types of component fabrication tasks are not expected to make significant changes
in the production process or work in self-managing work teams as management enforces
the repetitive nature and execution in the standardized production system. However, they
are encouraged to participate in management controlled improvement teams that meet
off-line to focus on production and quality improvements and address poor work-related
activities within the repetitive production process. Individually or as members of
improvement teams, workers are expected to provide input and suggestions to
management for production and quality decision-making purposes, but are not permitted
to make work related decisions on their own.

Workers performing work related activities in the assembly area for a large
amount of possible end product configurations are expected to be more flexible, multi-
skilled and work in semi-autonomous work teams. These teams are not fully autonomous,
but have limited responsibility to make immediate process and quality related decisions regarding workflow and assembly methods design. This ensures that the time needed to make production and quality related decisions are minimized and facilitates fast assembly cycle time with acceptable quality standards. Since all customers’ end-product configuration can be significantly different from each other within a certain range, the complex demands placed on the assembly processes requires that the assembly methods and product flow be redesigned and adapted for each new customer order. This requires the workers to consult with customers about configuration issues, supplier about material problems and other functional experts outside of their immediate work area when engineering or delivery problems arise. Also, to gain a better understanding of the assembly process, workers should be more flexible with multiple skills and be able to rotate between job tasks and teams in the assembly area. This provides the workers with the overall knowledge of the assembly process so that work related problems can be solved earlier in the process and long production delays prevented.

2.2.1.2 Fabricators – Infinite Mass Customization Manufacturing (IMCM)

The Fabricator approach utilizes an IMCM system that incorporates the customer in the beginning stages of the production cycle and permits them to uniquely design or alter components and modules that can be assembled and delivered in any configuration to meet customer requirements and specifications. IMCM systems are inclined to implement flexible manufacturing systems to produce an unlimited range of low cost heterogeneous products very quickly which are characterized by both high performance
design and consistent quality. The IMCM system implements manufacturing cells or
group technology production processes as the manufacturing method to produce large
volumes of highly customized components, modules and assemble individualized end
products. Such production processes are characterized by a high investment in advanced
manufacturing technologies that are configured within flexible manufacturing systems to
perform many different operations utilizing the same re-programmable machine tools and
flexible equipment through management information systems. Duray (1997) stresses that
flexible manufacturing technologies are the foundation of mass customization abilities in
environments similar to that of the Fabricator. This form of flexible manufacturing
produces many different short runs of small lot sizes to achieve economies of scope
through the reduction in changeover times between multiple products.

To technically optimize an IMCM system, the organization of work is based on
cooperative and supportive management principles that directly involve shop floor
employees to have a more essential decision making role closely associated with the
flexible production system. Such management principles promote the decentralization of
production responsibilities through open communication and flatter hierarchical
structures that considers labor as an asset to provide a competitive advantage. The
organization of work is designed to be more participatory and flexible which provides
broader job classifications within self-managing work teams that lead to more task
variety, challenging work, and the opportunity to learn new skills.

The expansion of job duties in the IMCM system requires a fully cross-trained
multi-skilled workforce that is highly motivated to perform both production and assembly
related tasks and make tactical operating decisions. These highly skilled and fully flexible
workers must react quickly to rapidly changing customer demands for component parts, modules and assembly configurations. The adaptability of the workers are needed as production and quality problems arise due to the unique specifications of component parts and requirements of assembly configurations by the customer. Employees are expected to have a conceptual grasp of the design, fabrication and assembly of the highly complex customized products manufactured in a flexible production system.

To accommodate severe product complexity, workers in the IMCM system should function within self-managing work teams who directly work together on-line, that manage themselves and jointly have complete day-to-day responsibility and discretion over many production and administrative decisions. These workers should rotate between numerous job tasks both within and outside their primary work teams and within and between the fabrication and assembly areas. They will perform multiple work tasks in the area of machine set-up, programming and maintenance, component design and fabrication, end-product design and assembly, inspection and testing, and material handling throughout the manufacturing process. The self-managing team will have full responsibility to make production and quality related decisions in both the fabrication of components and assembly of end products. To facilitate the decision making process, these workers will consult with engineers, marketing, supervisor and other employees both within and outside their primary work area, directly with customer, and suppliers.

In addition, self-managing teams will be responsible for making administrative decisions such as setting production goals, scheduling the production of components and assemblies, and assign work tasks to workers. Also, these teams will manage themselves by providing feedback about individual and group performance, schedule vacations,
tracking absences, and performing performance appraisals. In some instances they may be involved in strategic decisions such as redesign of a plant, implementation of new technology and future investment plans. Finally, since the customer can uniquely specify module components, workers may have to select and certify suppliers for specialty materials and participate in the purchasing decisions of new machinery, technology, and equipment.

The high complexity associated with IMCM products suggests that workers in this manufacturing system have exceptional knowledge and skills throughout the production cycle. All workers will need to be directly involved in the design, fabrication and assembly of highly customized products. It is imperative that they understand the customers requirements and be directly involved in the production processes because they are responsible for the fabrication and assembly of their products.
<table>
<thead>
<tr>
<th>Work System Characteristics</th>
<th>FMCM Approach</th>
<th>IMCM Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teamwork</td>
<td>Management controlled improvement teams for component and module production</td>
<td>Self-managing work groups and improvement teams for component and module production and final assembly of end-products</td>
</tr>
<tr>
<td></td>
<td>Semi-Autonomous work groups for final assembly of end-products</td>
<td></td>
</tr>
<tr>
<td>Skills and Abilities</td>
<td>Tapered multi-tasking</td>
<td>Unlimited multi-tasking</td>
</tr>
<tr>
<td></td>
<td>Partial flexibility</td>
<td>Full flexibility</td>
</tr>
<tr>
<td></td>
<td>Rotate within work area and team</td>
<td>Rotate within and between work area and teams</td>
</tr>
<tr>
<td></td>
<td>Focuses on following production procedures</td>
<td>Focuses on developing new production procedures</td>
</tr>
<tr>
<td></td>
<td>Consult with immediate supervisors and other employees within work area</td>
<td>Consult with immediate supervisor, other employees within and outside work area, customer, and suppliers</td>
</tr>
<tr>
<td>Decision Making</td>
<td>Provides input and suggestions individually or as a ad hoc improvement team to management for component part production</td>
<td>Makes production process and quality related decisions as a management/labor committee or as a self-managing work team for component part production and end product assembly</td>
</tr>
<tr>
<td></td>
<td>Makes assembly related decisions as a management/labor committee</td>
<td></td>
</tr>
</tbody>
</table>

Figure 2.4: Summary of work system characteristics in the FMCM and IMCM approaches
2.3 The Foundation of Strategic Human Resource Management

A thorough review of the extant strategic human resource management (SHRM) literature has indicated a major transformation in both the form and function of the human resource management task responsibilities (Jackson and Schuler, 1995; Snell, Yount, and Wright, 1996; Ferris, Hochwarter, Buckley, Harrell-Cook, and Frink, 1999). This shift signifies the evolution from a maintenance function of administrative record keeping into a cross functional strategic partner that expands the HR role beyond the traditional functional tasks of selection, training, compensation, and performance appraisal. As Figure 2.1 illustrates, the emerging SHRM paradigm attempts to align HRM functions and activities with the principal strategic goals of the organization to maximize organizational performance and provide a sustainable competitive advantage (Ferris et al., 1999). In the need to develop a conceptual foundation for SHRM and distinguish it from the traditional perspective and initiatives of HRM, Wright and McMahan (1992) define SHRM as “the pattern of planned human resource deployments and activities intended to enable an organization to achieve its goals” (p.298). This definition extends the HRM function beyond the traditional micro-level functional activities and facilitates its identification as an important partner in the strategic orientation of manufacturing firms (Snell and Dean, 1992; Jayaram et al., 1999). Furthermore, its influence on the strategic direction of the firm highlights the functions role in facilitating a sustainable competitive advantage and a key driver of value creation.

Researchers within the SHRM field (Huselid, 1995; Wright and McMahan, 1992; Becker and Gerhart, 1996; Delery and Doty, 1996; Becker, Huselid, Ulrich, 2000) have
argued that, to maximize firm performance and gain a sustainable competitive advantage, organizations should shift their focus from managing individual employees discretely at a micro-level to managing the workforce as a whole from a broader firm-level macro-level strategic perspective (Lepak and Snell, 2002). From a macro-level strategic perspective, HRM researchers have proposed a HPWS as the appropriate administrative method to manage the workforce as a whole. The fundamental elements of a HPWS are the congruent implementation of numerous HRM policies and innovative practices into a coherent bundle to recruit, select, compensate, train, communicate, and assign job tasks to the workforce. Numerous SHRM researchers have empirically corroborated and provided substantial support for the notion that human capital, and the way employees are managed through innovative HRM best-practices (Pfeffer, 1995) or systematic bundles of congruent practices in a HPWS (MacDuffie, 1995), have a significant positive impact on a variety of firm performance measures and competitiveness (Wright, McCormick, Sherman, and McMahan, 1999; Huselid, 1995; Arthur, 1994; Ichniowski, et al., 1994; Yount, et al., 1996). Farias and Varma (1998) support this notion that “The people emphasis inherent in the HPWS design makes this a superior intervention, especially with regard to the preservation of human capital” (P. 53).

In regards to SHRM in MCM strategic environments, the strategic role of human resources can be crucial to the maximization of organizational, operational and economic performance given the importance and complexities of achieving strategic fit between the firm’s mass customization strategic objectives and the corresponding HPWS policies, practices, and activities. Thus, from the SHRM perspective of Figure 2.1, the essential concern for HPWS success is achieving two primary dimensions of fit or alignment,
vertical and horizontal, to maximize firm performance and create a sustainable competitive advantage for an organization (Huselid, 1995; Wright and McMahan, 1992; Becker and Gerhart, 1996; Delery and Doty, 1996; Guest, 1997;).

2.3.1 High Performance Work Systems Overview

From a SHRM perspective, a HPWS is a complex set of distinct, but interrelated HRM policies and innovative workplace practices that are combined into a congruent “bundle” (MacDuffie, 1995) and utilized as a coherent system to select, develop, motivate, and retain a qualified and competent workforce to obtain organizational strategic goals and objectives (Way, 2002). This complementary “bundle” of innovative managerial practices attempts to manage, involve and empower the workforce to achieve synergy between employees and their work environments in such a way that employees are committed so that organizations can experience superior performance and achieve a sustainable a competitive advantage (Huselid, 1995). In particular, HPWS structures are perceived as social labor management systems that have a significant effect on intangible employee characteristics such as their social and leadership skills, knowledge, motivation, commitment, behaviors, values and attitudes. Furthermore, the congruent set of complementary HRM workplace practices improves employees’ orientations to work, which makes them more productive and strengthens a firms’ manufacturing system and competitive position (Kintana et al., 2006). Ultimately, a manufacturing plant that has adopted a cluster of different, but supportive HRM workplace policies and practices that provides workers with incentives, the skills, and above all the opportunity to participate
in substantive decisions that result in intangible, unique, firm specific organizational capabilities that are not easily replicated by other organizations has established a HPWS (Becker, Huselid, Pickus & Spratt, 1997).

The development and implementation of HPWS structures represents a significant strategic investment in human capital (must create economic value for the firm, (Snell and Dean, 1992)) and a radical transformation of how work is structured and the workforce is managed (Appelbaum and Batt, 1994; Becker and Huselid, 1998). This innovative form of work organization is based on the idea of comprehensive development, high motivation and involvement, and extensive participation in decision-making and problem solving by human and social resources at the operational level to meet the particular strategic imperatives of the firm (Lawler, 1992). In a HPWS, employees are at the center of attention and their creative abilities and skills, extensive knowledge, discretionary motivation, and participation in managerial decision making are perceived as valuable, critical, and vital assets to the competitiveness and economic success of an organization (Boxall and Purcell, 2000).

In modern competitive organizations, a HPWS is the primary means to develop a workforce that possesses all the competencies, motivation, and empowerment necessary to find and contribute new ways of working efficiently and effectively with new technology (Wright, et al., 1999). It is from this perspective that HPWS structures develop and motivate employees and teams to work to their full potential and toward the same goals and vision of the organization through increased involvement and participation (Pfeffer, 1994). By clearly defining their vision, mission, and strategic goals, organizations that utilize HPWS structures motivate employees, both extrinsically
and intrinsically, to apply their discretionary effort so that the outcomes of work related activities and tasks would be optimal and superior (Appelbaum et al., 2000). In addition, HPWS structures consistently provide opportunities for front-line workers to participate in substantive decisions that alter operational and organizational routines (Appelbaum et al., 2000). A HPWS maximizes the performance of a firm’s employees (Becker and Gephart, 1996) by providing workers with fundamental intangible elements such as business and customer information, technical and analytical skills, motivational incentives, and increased responsibility and involvement in the day-to-day operational activities. After receiving these elements, employees are then encouraged to apply their discretionary effort so they can participate in substantive operational and organizational decisions that contribute to value creation, innovations, quality improvements, and a rapid response to customer change (MacDuffie, 1995).

In a HPWS, jobs are designed and work is structured, organized and managed in such a way that employees determine what work is to be preformed and how it gets accomplished, are responsible for improving work methods and procedures, solving operational problems on the job and expected to operate without a controlling supervisor (Lawler, 1992). The development and implementation of an HPWS often signifies a significant organizational shift in emphasis toward employee commitment, increased involvement, empowerment, and responsibility and away from employee control (Becker and Huselid, 1998). This shift will enable employees to work more efficiently because they possess comprehensive knowledge and operational experience regarding work tasks and work processes and often have access to information that higher management lacks, especially about how to make their jobs more efficient and effective. Thus, from a post-
industrial perspective, the concept of HPWS structures represents a paradigm shift from more traditional, bureaucratic management approaches based on top-down control to one that explicitly involves all employees through open communication and autonomous decision-making (Agarwala, 2003). Incidentally, HPWS structures require greater commitment to employees to get greater commitment from employees.

A well-designed HPWS is likely to create a subtle and pervasive work environment that shapes workers’ capability and expertise to pursue new ideas and solutions to both customer and production problems in MCM environments. In MCM approaches, a HPWS becomes a valuable, indispensable internal resource and capability of an organization by increasing their ability to develop and retain a capable and committed workforce. The HPWS approach is based on the idea that all employees must actively participate in the business functioning of the organization and must be given access to power, information, knowledge and rewards (Lawler, 1996). However, this notion of HPWS may not be necessary in all types of MCM environments because each MCM approach, the IMCM and FIMCM systems are characterized by different technical and social attributes (Duray, 1997). These diverse manufacturing attributes may require different levels of HRM investments in the work system and shop floor employee attributes to effectively compete in both types of MCM approaches. Snell and Dean (1992) corroborate this premise by stating, “Human resource management practices are the primary means by which firms invest in their employees. By extension, different characteristics of HRM practices reflect different levels of investment in human capital” (p. 473). Furthermore, this premise can be extended to demonstrate that the difference in the level of human capital and work system investment is indicated by the specific
strategic posture of a firm and requires that these HRM investments must be vertically aligned and “fit” with a particular business strategy.

2.3.1.1 Vertical Alignment of a HPWS

The first dimension of SHRM fit centers on strategically aligning the HR function and properly linking a firm’s human resource policies and innovative workplace practices (recruiting and selection, incentive compensation plans, teamwork, flexible job assignment, skills training, and labor management communication) with its competitive business strategy posture to maximize organizational performance and create a sustainable competitive advantage (Arthur, 1992; Jackson and Schuler, 1995; Becker et al., 2000; Ferris et al., 1999; Huselid, 1995; Becker and Gerhart, 1996). From a strategic alignment perspective, the HRM approach implemented to develop the work system and manage the workforce is embedded within the context of a larger macro-view associated with the firm’s business strategy development process and implementation (Wright and Boswell, 2002). This type of macro-level strategic fit is commonly referred to as vertical alignment or external fit and seeks to achieve a high degree of congruence and coordination between the firm’s numerous departmental functions (HRM) and the strategic imperatives of the firm to maximize performance and gain a sustainable competitive advantage in a particular economic marketplace. For the purposes of this dissertation, vertical alignment focuses on satisfying unique customer requirements for product customization by creating value in two different postures of mass customization.
strategic environments through the coordination between the HRM department and the MCM strategic approach.

Based on the SHRM perspective, vertical alignment signifies a strategic approach to the resource investments in work system organization and human capital development, motivation, and utilization for customer value enhancement and organizational competitiveness. In particular, I argue that the HRM role in MCM environments is to design a HPWS that strategically develops and guides employee capabilities, behaviors, and attitudes toward the support of appropriate manufacturing systems for each strategic type of mass customizers. In each of the Assembler and Fabricator MCM approaches, emerging competitive potential hinges on the increasingly central role of intangible human resource assets and intellectual capital embedded within the manufacturing system. Overall, this dissertation will demonstrate that a firm’s HR function and corresponding HPWS structure must be externally aligned with the complex technical requirements and unique social demands of a specific mass customization strategic posture and provide support for the explicit MCM approach to maximize operational performance. In other words, the explicit HPWS structure and corresponding HRM policies and practices are contingent on the specific MCM approach.

2.3.1.1.1 Contingency Perspective of a HPWS

From the context of vertical alignment, the contingency perspective of post-industrial SHRM and work organization suggests that the HR function’s initiatives, activities, and subsequent HRM policies and innovative practices must be consistent with
an organization’s specific strategic posture and tailored to their competitive situation (Arthur, 1992; Yount et al., 1996; Delery and Doty, 1996; Wright and Boswell, 2002; Khatri, 2000). Given that there are numerous strategic postures a firm may choose as their competitive initiative (Porter, 1980; Miles and Snow, 1984; Mintzberg, 1983; Duray, 1997); Yount et al., (1996) strengthens the SHRM contingency perspective by positing “that an organization’s strategic posture either augments or diminishes the impact of HR practices on performance” (p.837). Delery and Doty (1996) add further support by noting, “Contingency theorists argue that, in order to be effective, an organization’s HR policies must be consistent with other aspects of the organization. For example, contingency theorists have attempted to show how a number of HR practices are consistent with different strategic positions and how these practices relate to firm performance” (p. 803). Therefore, based on the notion of strategic contingency and SHRM consistency, it can be interpreted that HRM consistency indicates that there is a conditional cause and effects unidirectional relationship that exists between the design and implementation of an innovative HPWS and the strategic position of the firm (Schuler and Jackson, 1987).

The SHRM contingency interpretation implies that external contingencies (such as the mass customization strategy a firm implements to compete in a dynamic marketplace) and internal HRM work systems attributes are often linked by linear cause and effect relationships involving unidirectional causation (Meyer, Tsui, and Hinings, 1993). In other words, the relationship between the levels of cause and effect variables is determined by a situational context. For the purposes of this dissertation, internal system attributes are an organization’s innovative HRM workplace policies and practices that are
embedded within a particular HPWS structure, which is contingent on a specific mass customization strategic posture (an external contingency) and must achieve a high degree of vertical alignment to be competitively effective and maximize performance. Delery and Doty (1996) advance this interpretation by indicating from a SHRM perspective of vertical alignment that “The variations in HR practices across organizations should be explained by the organizations’ strategies, and organizations that have greater congruence between their HR practices and their strategies should enjoy superior performance” (p.803). Furthermore, Jackson and Schuler (1995) support the basic premise underlying the SHRM contingency perspective by noting “Studies clearly support the assertion that strategy is a contextual factor with important implications for HRM” (p.248).

There is some empirical and anecdotal support for the strategic contextual contingency debate within the SHRM and manufacturing discipline; Arthur (1992) demonstrated that organizations following different competitive business strategies utilize different industrial relation systems and associated HR practices. Arthur (1992) found that firms following a Cost Leadership strategy, as advocated by Porter, had a significant association with an industrial relations system emphasizing “Cost Reduction”. The Cost Reduction workplace industrial relations system is characterized by narrowly defined job tasks with very little communication and employee influence over management decisions. This type of work system emphasized low skill requirements and wages, limited training and benefits, and intense supervision and control. In addition, Arthur (1992) concluded that firms following a Differentiation strategy, as advocated by Porter, had a significant association with an industrial relations system that focused on “Commitment Maximizing”. The Commitment Maximizing workplace industrial
relations system is characterized by broadly defined jobs with high levels of employee participation and involvement in management decision-making. This type of work system had self-managing teams with a high percentage of skilled workers that was exposed to regularly shared business and economic information. Employees within this system received more extensive skills training and benefits, relatively higher wages and stock ownership options.

Yount et al., (1996) empirically analyzed the moderating relationship between human resource systems (“Administrative” and “Human-Capital-Enhancing”) and three forms of manufacturing strategy (Cost, quality, and flexibility manufacturing strategy) to determine the interaction effects on various measures of operational performance. The authors found that a low cost manufacturing strategy interacts with an “Administrative” HR system to predict equipment efficiency. In addition, there was significant support to indicate that the interaction between a quality manufacturing strategy and the “Human-Capital-Enhancing” HR system predicted customer alignment, employee productivity, and equipment efficiency. The authors concluded that, “Maximizing performance appears to depend on properly aligning HR systems with manufacturing strategy” (p.853).

Furthermore, Jackson and Schuler (1995) conceptually relate Miles and Snow (1984) and Porters (1985) typologies for characterizing business strategy to describe the possible HRM implications for each strategic type. Jackson and Schuler argue that a specific strategic posture adopted by a firm should have important implications for the HRM function and the way the workforce is recruited, developed, evaluated, and provided a sense of employment security but provide not empirical evidence to validate this assertion. Therefore based on the previous discussion regarding the situational
application of cause and effect variables in a strategic context, it can be argued that the primary concern associated with SHRM is the contingency relationship between the HR function and business strategy posture; and the corresponding implicit issue of “fit” associated with superior economic performance and sustainable competitive advantage. Murphy and Zandvakili (2000) reinforce this contingency relationship argument by noting that “HRM must understand and constantly evaluate the linkage between its practices and the overall business strategy and must measure its contribution to the enhancement of sales and profits” (p. 94-95). The authors further argue that, “Making HRM an integral part of the overall business strategy is vital for today’s employers” (p. 95).

Although achieving a high degree of vertical alignment or fit with the business strategy may result in superior economic performance and a sustained competitive advantage, the SHRM perspective also requires a corresponding dimension of fit that is associated with horizontal linkages among the various HRM policies and practices within the HR work system to ensure successful economic and competitive outcomes (Becker and Gehart (1996). Jackson and Schuler (1995) cautions researchers and stresses that “Our understanding of vertical linkages between HRM and contexts (business strategy) cannot proceed without attending to the horizontal interdependencies that exist among human resource policies and practices” (p.255) Therefore, following the SHRM perspective, maximizing performance and obtaining a sustainable competitive advantage requires both vertical and horizontal alignment.
2.3.1.2 Horizontal Alignment of a HPWS

The second dimension of SHRM alignment centers on the approach firms implement to transform the organization of work and manage of the workforce to achieve a high degree of internal fit or consistency among numerous discrete innovative workplace policies and practices (Huselid, 1995; Huselid, Jackson, Schuler, 1997). Post-industrial work reform requires the development of a coherent system of multiple organizational and innovative HRM policies and practices that achieves horizontal alignment or internal fit between them. Horizontal alignment is commonly expressed as the extent of how well several individual HRM practices consistently work together in concert rather than in conflict with one another (Wright and Sherman, 1998). Within the SHRM boundaries, the horizontal alignment perspective is referred to as the “systems approach” to work organization in which an internal congruent fit among the various, but diverse, components and innovative HRM practices of the work system is needed to maximize individual, operational and organizational economic performance (Appelbaum et al., 2000). The “systems approach” focuses on developing a cluster or “bundle” (MacDuffie, 1995) of multiple complementary and mutually reinforcing HRM workplace and personnel practices that support each other and leads to improved performance and a sustainable competitive advantage in a variety of ways. MacDuffie (1995) found that bundling human resource practices and integrating them within a lean production system and overall business strategy led to higher levels of economic performance.

The systems approach is generally associated with an organizations attempt to achieve horizontal alignment or internal fit because the consistent coherent set of
innovative personnel management practices provides complementarities or synergies between numerous distinct HRM workplace policies and practices within a HPWS structure or architecture (Becker and Gehart 1996). Huselid (1995) advocates the synergies perspective by arguing, “Conceptually, the potential for synergies among High Performance Work Practices should increase when these practices have been consistently implemented throughout the firm” (p.). Thus, the effectiveness of any one individual HRM practices depends upon how it is combined with some other HR or management practices into a coherent and internally consistent system of complementary practices (Wright, et al., 1999).

The systems view of a HPWS suggests that organizations implementing a complementary set of high performance workplace practices in conjunction with one another would perform better than organizations adopting individual HRM practices independently on a piece meal manner. Pil and MacDuffie (1996) promote this assertion noting “Practices are complementary when using them together results in greater performance than the sum of the performance resulting from using each practice separately” (p.) In other words, organizations realize higher performance by adopting an entire complement or interaction of innovative HRM policies and practices rather than making marginal changes in any individual HRM practice or by implementing just a select few (Way, 2002). These considerations suggest that there may be synergies among the work system organization and HRM practices that lead to positive interaction effects on performance when they are adopted together (Delery et al., 1997). According to this proposition, the greatest gains in plant performance occur when manufacturing plants implement an innovative cluster, bundle, or set of coherent, complementary, supportive
and mutually reinforcing HRM workplace practices that have the potential for synergies and a high degree of internal consistency (Huselid, 1995).

The implementation of a system of complementary HRM workplace practices is frequently referred to as the holistic nature of HPWS structures. Ledford and Lawler (1994) argue that there are different levels of participation, and only those that involve holistic change are related to positive improvements in performance. Furthermore, Farias and Varma (1997) endorse the holistic perspective stressing, “The overwhelming emphasis on the holistic nature of the HPWS design makes it clear that the implementation of individual high performance practices (without the systems approach) cannot be termed an HPWS” (p.53-54). In addition, Kling (1995) provides further support by concluding; “The existing evidence suggests that it is the use of comprehensive systems of work practices in firms that is most closely associated with stronger firm performance” (p.29). Such support for the importance of the complementary nature of high performance workplace practices once again confirms that HPWS design features should be viewed from a holistic complementary perspective, and not as a number of individual HRM design features.

2.3.1.2.1 The Holistic Systems Approach

Fundamental to the holistic systems approach is the assumption that firms design and implement a coherent set of internally consistent and horizontally aligned HRM workplace policies and practices that are mutually reinforcing and are expected to complement and provide synergies with each other. This congruent system increases
employee competencies, provides more relevant business information, motivates workers to exert their discretionary effort in their job tasks, and encourages employees to actively participate in substantive decision-making through decentralization of responsibility that alters operational and organizational routines. The development and implementation of such a comprehensive system of work practices should lead to an increase in individual, plant, and business performance (Appelbaum et al., 2000; MacDuffie, 1995). Gephart and Van Buren (1996) explain the holistic systems approach as follows, “Synergy comes from more than just putting all the pieces of a system in place; a HPWS achieves synergy when it produces two outcomes simultaneously. First, all its parts are aligned and fit together. Second, people in the company are deeply committed, energized, and impassioned about their work” (p.23). The authors further note that, “The synergy achieved through overlapping work and human resource practices is the heart of what makes a high performance system effective” (p.26).

The holistic system fit is considered essential for competitive firms to respond to the unique customer requirements and environmental dictates in MCM environments. Thinking systemically emphasizes the interrelationship of the various HPWS components and the strategic link between the HR function, HRM practices and policies, and MCM approaches. A holistic system of complementary HRM workplace practices facilitates varying degrees of mass customization by appropriately selecting, developing, motivating and retaining a qualified and proficient workforce that can quickly and cheaply manufacture high quality customized products that meet specific and unique customer needs. This innovative system of work organization ensures a capable and committed
workforce, the development of essential employee competencies, and a training system that assist the workforce to learn faster than competitor’s employees (Becker et al., 2001).

2.3.1.2.2 Configurational Perspective of a HPWS

Parallel to the holistic systems or synthesis approach to the organization of work is the configurational theoretical perspective to view a HPWS (Wright and Boswell, 2002), which is based on developing discrete ideal theoretical typologies that address the reciprocal relationship of interrelated attributes (Meyer, Tsui, and Hinings, 1993). The configurational perspective is appropriate in situations where the reciprocal relationships between mutually dependent attributes should be considered as a whole and require extreme modification to all attributes to have a significant strategic impact (Duray, 1997). The collections of different interdependent attributes that are identified in a specific archetype provide the foundation for configurations to function as a classification system and theoretical model to specify a HPWS approach.

Based on the configurational perspective, this dissertation conceptualizes a HPWS as a coherent work system that possesses a high degree of horizontal alignment among a holistic set or bundled pattern of multiple innovative HRM practices and HR activities. Meyer, Tsui, and Hinings, (1993) describe it as “This patterning occurs because attributes are in fact interdependent and often can change only discretely or intermittently” (p.1176). From a SHRM perspective of configurations, each HPWS is a collection of interdependent attributes that when taken together specify a SHRM approach to workforce management. Such attributes can be seen as innovative managerial workplace
practices that are distinct, but complementary, resources that must be combined into an internally coherent incentive system aligning existing or newly developed manufacturing system features with operating and strategic objectives to produce superior performance and a sustainable competitive advantage (Becker and Gerhart, 1996). Doty, Glick, and Huber (1993) provide additional insight on the configurational-performance link, “Configurational theories typically posit higher effectiveness for organizations that resemble one of the ideal types defined in the theory. The increased effectiveness is attributed to the internal consistency, or fit, among patterns of relevant contextual, structural, and strategic factors” (p.1231) Wright et al., (1999) provide substantial support for the configurational-performance link by empirically examining the impact of various HRM practices on the financial performance of US petro-chemical refineries. The results from their study conclusively indicate that when selection, compensation, and appraisal HR practices interacted with highly employee participative management systems to form a configurational bundle, these combined personnel management practices have a significantly strong positive relationship to financial performance. The authors concluded that “These results indicate that the most effective approaches to managing human resource in petro-chemical refineries are either to invest simultaneously in both HR practices and participation programs or to invest in neither; the lowest financial performance is observed when managers invest in only one or the other” (p.565).

For the purposes of this dissertation, the configurational perspective will provide the foundation to focus on developing of a holistic synthesis of reciprocal and nonlinear interactions (Meyer, Tsui and Hinings, 1993) of multiple HRM practices to restrict the range of viable HPWS forms or types that are strategically aligned (externally) with
distinct MCM approaches to maximize operational performance. Classifications may be used to support a central tenet of SHRM, namely, that there are different patterns of HRM practices associated with different configurations of innovative work systems and that many aspects of work organization are related to work system types (Delery and Doty, 1996). Underlying classification schemes is the attempt to understand work system diversity through theoretical typologies and empirical taxonomies. Tiryakian (1968) states “A typology goes beyond sheer description by simplifying the ordering of the elements of a population, and the known relevant traits of that population, into distinct groupings; in this capacity a typological classification creates order out of the potential chaos of discrete, discontinuous, or heterogeneous observations. But in so codifying phenomena, it also permits the observer to seek and predict relationships between phenomena that do not seem to be connected in any obvious way. This is because a good typology is not a collection of undifferentiated entities but is composed of a cluster of traits which do in reality hang together” (p.178).

Typologies within configurational approaches generally follow the logic of ideal archetypes, accentuating key characteristics and attributes to draw a priori distinctions between work systems. This assertion can be extended to include a holistic horizontal perspective. Delery and Doty (1996) forward this contention “Configurational theories are concerned with how the pattern of multiple independent variables is related to a dependent variable rather than with how individual independent variables are related to the dependent variable. An ideal configuration would be one with the highest degree of horizontal fit” (p.804). Meyer, Tsui, and Hinings (1993) further promotes this disputation suggesting that “Configurational inquiry represents a holistic stance, an assertion that the
parts of a social entity take their meaning from the whole and cannot be understood in isolation” (p.1178). Thus, following a holistic horizontal perspective, configurational arguments are theoretically formulated by categorizing individual HRM workplace practices into ideal groups of work systems that are posited to enhance and maximize performance only from a system as a whole and “represent nonlinear synergistic effects and higher order interactions that cannot be represented with traditional bivariate contingencies” (p.808, Delery and Doty, 1996).

2.3.1.3 SHRM Perspectives: Configurational and Contingency vs. Universalistic

The SHRM configurational and contingency perspectives of innovative work system management directly contrast the “best practices” or “universalistic” HRM approach which assumes that the greater use of some innovative HR practices will always result in improved firm performance (Pfeffer, 1994). Delery and Doty (1996) describe this approach to be “the relationship between a given independent variable and a dependent variable is universal across the population of organizations” (p.805). To positively impact firm level performance, the universalistic approach focuses on the degree a limited number of best HRM practices, utilized in isolation, are consistently used in all contextual situations and across different types of firms competing in different competitive environments (Lepak and Snell, 1999; Delery and Doty, 1996), regardless of the strategic imperatives of these firm (Ferris, et al., 1999). In addition, the universalistic SHRM approach to the HRM-performance relationship has been conceptualized by some researchers as being micro-analytical in nature (Wright and Boswell, 2002; Khatri, 2000)
and based on the perspective that individual innovative HRM practices have a significant
direct and positive main effect on organizational outcomes that contributes to increased
financial performance, ceteris paribus, independent of any other HR or managerial
practices that may exist. This notion suggests that innovative best workplace practices are
often studied in a vacuum to empirically analyze the isolating effects of individual
practices on firm level performance irrespective of the internal and external contextual
factors facing an organization, including business strategy (Jayaram, Droge, and Vickery,
1999).

Under the SHRM universalistic perspective, best practices are considered
strategic because they are related to firm performance and have often been labeled, and
the terms used interchangeably, as high commitment (Pfeffer, 1995; Arthur, 1994), high
involvement (Lawler, 1992; Inchniowski, Shaw, and Prennushi, 1997; Pil and
MacDuffie, 1996), high performance (Huselid, 1995; Cappelli and Newmark, 2001;
Osterman, 2000), progressive (Delany and Hudelid, 1996), alternative (Godard, 2001),
and innovative (MacDuffie, 1995; Guthrie, 2001) HRM practices. It is important to note
that the precise definition and operation of these best practices varies from researcher to
researcher, but they are all grounded in the fundamental assumption that each are
innovative HRM practices and activities to manage the workforce and will have a
positive impact on performance.

Lepak and Snell (1999) note that advocates of the “best practices” perspective
(Becker and Gerhart, 1996; Delery and Doty, 1996, Pfeffer, 1994; Lawler, 1992;
Osterman, 2000) assume that these practices are context gerneralizable, suggesting that
all organizations should implement these best innovative HRM practices in isolation
because they are universally effective across all firm contexts and more superior to the others. However, “despite the practical appeal and theoretical parsimony of the ‘one-size-fits-all’ approach” (Lepak and Snell, 1999; p. 42) contemporary SHRM researchers are suggesting a shift in the approach to study the HPWS-performance relationship from searching for the “one best way” to investigating the fundamental features that characterize the many possible ways to design and maintain effective work systems because there has been little consensus on what these best HRM practices are and which practices should be included in a best practices system (Jackson and Schuler, 1995; Guest, 1997; Ferris, et al., 1999). One of the most important arguments in the SHRM discipline is that HRM-performance studies that embrace the universalistic perspective have the profound possibility that empirical conclusions could potentially result in the underestimation of the impact HRM practices on firm-level performance measures and competitiveness.

The best practice approach may not be appropriate in all organizational settings because it ignores the possible existence of different workforce management practices for different MCM approaches and the strategic posture a firm adopts. It may be inappropriate to simplify the nature of workforce management and suggest that there exists a single optimal HRM system and an ideal set of innovative practices for managing all type of mass customization employees. Even if all types of mass customization manufacturers were to adopt the same HRM architecture philosophy and implement a single set of best HRM practices and activities, these are expected to be differentially interpreted and manifest themselves in different practices across the IMCM and FMCM systems because of the diverse strategic issues associated with each manufacturing
approach. Guest (1997) recognizes that there are theoretical difficulties of viewing HRM form the “one best way” approach because “it focuses predominantly on the internal characteristics of HRM at the expense of broader strategic issues” (p.265). Cappelli and Croker-Hefter (1996) conducted several intra-industry case studies regarding the universalistic approach determining that each firm possessed a unique HR system that represented distinctive intangible competencies for that particular company and concluded that their analyses failed to indicate the universal use of best HRM practices among these firms.

Consequently, this dissertation is fueled by the belief that the most appropriate SHRM approach to transform the organization of work and manage the workforce will vary for and be contingent on different types of MCM approaches and possess a unique horizontal alignment among multiple innovative HRM practices as advocated by the configurational perspective which implies that HPWS effectiveness is dependent on finding an appropriate combination of HRM practices. Realizing the full effectiveness and potential positive impact of HPWS structures on operational performance requires an internally consistent bundle of multiple HRM practices that goes beyond the imitation of other firms’ best innovative HRM practices (Tomer, 2001). HRM practices that are bundled together to provide synergy among one another and are consistent with the MCM approach are more effective than those that do not. Therefore, it is conceptualized that HPWS can only exist and have a positive impact on operational performance and when high commitment, high involvement, high performance, or innovative HRM practices are bundled into a comprehensive and coherent system that ensures complementarities and synergies between multiple workplace practices that fits a firms
particular mass customization strategic posture and supports the corresponding MCM approach. While for some researchers HPWS is synonymous with high commitment, high involvement, high performance, or innovative practices or systems; I conceptualize it to reflect a broader SHRM notion that is characterized by a complementary holistic set of multiple HRM practices that are interdependent and combined into a coherent system that maximizes performance and provides a sustainable competitive advantage for a firm. The SHRM configurational-contingency model has a great deal of intuitive appeal and has the potential to theoretically explain why the underlying concept of HPWS structures is differentiated in particular mass customization strategic contexts.

2.3.1.4 Integrating the Configurational and Contingency Perspectives of a HPWS

Although on the surface the SHRM configurational and contingency perspectives may appear to be opposing, I argue the two theoretical perspectives based within a HRM-MCM context are not mutually exclusive, but rather they can be complementary and supportive in an attempt to investigate the integrative nature of HPWS and MCM approaches on operational performance. In order for the configurational perspective to be more effective in examining the impact HPWS structures have on the operational performance outcomes of organizations in various mass customization marketplaces, the internally consistent and holistically coherent configuration of innovative HRM workplace practices must maximize both horizontal and vertical alignment (Huselid, 1995; Delery and Doty, 1996; Ferris et al., 1999; Becker and Gerhart, 1996). This notion is expected given that researchers within the SHRM discipline have long asserted that
organizational performance and competitiveness is greatly influenced by the method in which the workforce is managed (Lawler, 1994). Delery and Doty (1996) synthesize this SHRM integrative theoretical perspective summarizing that “Configurational theorists working in SHRM must theoretically derive internally consistent configurations of HR practices, or employment systems, that maximize horizontal fit, and then link these employment systems to alternative strategic configurations to maximize vertical fit” (p.809). The authors further articulate, “Configurational ideas are incorporated in empirical SHRM studies when researchers attempt to identify configurations of HR practices that predict superior performance when used in association with each other, or the correct strategy, or both” (p.804). In addition, Huselid (1995) highlights the importance of integrating the configurational-contingency SHRM perspective to analyze the impact of HRM practices on turnover, productivity and corporate performance suggesting that, “The presumption is that more effective systems of HRM practices, which simultaneously exploit the potential for complementarities or synergies among such practices and help to implement a firm’s competitive strategy, are sources of sustained competitive advantage” (p.636).

Thus, this dissertation is fueled by the conviction that although the possible combinations of innovative HR work system practices and attributes may be infinite, only a finite number of coherent holistic configurations are prevalent in each distinct mass customization strategic environment and its corresponding MCM approach. This is in direct contrast to the study conducted by Duray (1997) who utilizes the configurational perspective, but does not include the contingency perspective because the complex relationship between customer involvement and modularity types are posited to be
reciprocal in nature and do not necessarily possess a linear situational relationship that changes incrementally in response to the context, which is essential in the characterization of the contingency perspective (Meyer, Tsui, and Hinings, 1993). Rather, Duray (1997) only incorporates the configurational perspective to conceptualize the connection between these two mass customization infrastructural attributes because their interrelated relationship may not be directly linked as cause and effect in nature and possess a more reciprocal disposition. One possible explanation for Duray’s (1997) isolated utilization of the configurational perspective is that the author applies the interrelated pattern of structural and infrastructural manufacturing decisions embedded in manufacturing strategy decision making to test the mass customization theory. On the surface, this approach appears to be reasonable since the author is analyzing the interrelated relationship among structural and infrastructural manufacturing strategy attributes from a manufacturing perspective to explore the theoretical intrinsic relationships in the mass customization paradigm. However, the present analysis differs as it attempts to identify the theoretical reciprocal relationships among innovative HRM practices that are inherent in HPWS configurations and how these archetypes respond to situational mass customization strategic context, and for that reason, provide a rigid basis to integrate the separated SHRM and mass customization paradigms. Accordingly, it would only be appropriate to include both the configurational and contingency perspectives in this study because such an approach will assume that each MCM approach contains a unique set of embedded holistic patterns of innovative HRM practices and policies that are present in each specific archetype.
The preceding discussion implies that to maximize operational performance in mass customization strategic environments, a firm’s HPWS structure must achieve both horizontal and vertical alignment. In other words, a firm’s HPWS structure must possess reciprocal and nonlinear relationships among numerous HRM workplace practices (horizontal alignment) as advocated by a configurational perspective while simultaneously adopting a unidirectional and linear relationship with the firm’s mass customization strategic orientation (vertical alignment) advocated by the contingency perspective. Thus, both the configurational and contingency perspectives are mutually interrelated SHRM and mass customization perspectives that are embedded in appropriate patterns of organizational strategic processes, MCM approaches, and work system structures. Both theoretical perspectives’ criteria can be satisfied for their integration, therefore, the decision to empirically analyze their conceptual impact on the HPWS-mass customization relationship to maximize operational performance is strongly supported.

This mutual interrelationship between the configurational and contingency theoretical perspectives suggests internal alignment follows from external alignment. Huselid (1995) conducted his empirical analysis to “test the prediction that the impact of High Performance Work Practices on firm performance is contingent on both the degree of complementarity, or internal fit, among these practices and the degree of alignment, or external fit, between a firm’s system of such practices and its competitive strategy” (p. 636). The author further states, “In fact, the internal and external fit hypotheses may not be altogether inconsistent: All else being equal, the use of High Performance Work Practices and good internal fit should lead to positive outcomes for all types of firms.
However, at the margin, firms that tailor their work practices to their particular strategic and environmental contingencies should be able to realize additional performance gains” (p.644). Lepak and Snell (1999) adopt the contingent/configurational view and argue that not all HR systems are appropriate for all conditions; suggesting that different HR configurations have different importance to the workforce and encourage different behaviors.

Therefore, I conceptually argue that a firm strategically competing in a distinct mass customization environment should design the innovative HRM work system only after careful analyze of the manufacturing system to provide a high degree of both internal and external fit between the unique HPWS and corresponding MCM approach. In the remainder of this dissertation, I focus on theoretically developing a priori and empirically indicating that different holistic configurations of innovative HRM policies and practices must have high levels of external and internal fit to maximize operational performance. By doing this, the analysis creates a kind of strategic fabric that weaves the competitive situations (dimensions) of HPWS and MCM systems together. Jackson and Schuler (1995) address the need for an extension of research in the integration of the configurational-contigency SHRM perspective indicating that “Research that simply identifies and describes the most common configurations of prescribed HRM systems and the most common forms of received HRM should serve as the foundation for future investigations of HRM in Context” (p. 257). The authors note that one contextual factor is business strategy and in which I have extended to be conceptualized as two distinct and novel mass customization strategic postures.
Furthermore, Ferris et al. (1999) suggest the need to integrate interdisciplinary work with the practice of SHRM to better understand the dynamic relationships associated with HRM activities and other organizational influences. Following these SHRM suggestions, this dissertation proposes that the strategic dimensions of mass customization manufacturing (Duray, 1997) must be vertically aligned and supported by an effective internally aligned HPWS configuration to enhance operational performance. This study views the dimensions and characteristics of each mass customization strategic posture as a specific competitive business strategy that must be supported by the appropriate MCM approach and corresponding HPWS.

2.4 Theoretical Foundation

As a meaningful extension of Arthur’s (1992) and Yount, Snell, Dean, and Lepak’s, (1996) HRM system-strategy integration work, this dissertation contributes to the comprehensive development of the SHRM field by including the emerging mass customization strategic posture and manufacturing approaches. However, an extensive theoretical foundation that logically combines concepts from human resource and manufacturing management is essential to provide a logical expectation that an appropriate link and strong fit exist between specific HPWS configurations and the distinct strategic dimensions of each MCM approach. Scholars from diverse disciplines have suggested various conceptual frameworks as explanations for the adoption of HPWS structures and HRM practices in complex environments to study the potential role of human resources in the determination of organizational outcomes and sustainable
competitive advantage (Delany and Huselid, 1996). These have included general systems
theory (Von Bertalanffy, 1950), role behavior theory (Katz and Kahn, 1978), institutional
theory (Meyer and Rowan, 1997), resource dependency theory (Pfeffer and Cohen,
1984), human capital theory (Becker, 1964), transaction cost economics (Williamson,
1979), agency theory (Jenson and Meckling, 1976), and the resource-based theory of the
firm (Barney, 1991). For purposes of this dissertation, I will incorporate the resource-
based view as a broad theoretical foundation that encompasses both the SHRM
configurational and contingency perspectives because this theoretical view provides an
apparent understanding of how bundles or systems of HRM practices impact
organizational performance and employee outcomes as apposed to the firm-level impact
of universally best innovative HRM practices individually. The following section will
attempt to rationally explicate the conceptual relevance of this framework and explain
why it is the most logical and appropriate theoretical perspective to apply for this analysis
and empirical investigation. Essentially, it will be argued that the SHRM configurational
and contingency perspectives follow more directly from the resource-based view than the
universalistic best practice approach to maximize organizational outcomes and achieve a
sustainable competitive advantage. Becker and Gerhart (1996) provide further insight
suggesting, “that although best practices are consistent with institutional theory and
efforts to strive for parity, contingency models follow more directly from resource-based
approaches and efforts to achieve a sustained competitive advantage” (p. 787).

The resource-based view of a firm (Barney, 1991) has an explicit theoretical
relevance concerning different patterns and configurations of HPWS practices to support
distinct strategic dimensions of MCM system attributes. A resource-based theoretical
framework is provided to depict the contextual strategic relationship among mass customization and the corresponding manufacturing and human resource configurational approaches. From a resource-based perspective of competitive strategy, Figure 2.1 illustrates the innovative fit of HPWS and MCM approaches into the fundamental hierarchical framework of business and functional strategies. It is suggested that the resource-based conceptual framework will provide the basis to study the potential positive impact of HPWS configurational practices on operational performance and attempt to explain the associated contextual link between HPWS structures and firm-level outcomes in different MCM approaches.

A resource-based view offers a cross-functional strategic lens to critically analyze the integration effects of HPWS configurations and MCM system attributes on operational performance. Furthermore, a cross-functional strategic lens provides the conceptual perspective to fundamentally understand how different strategic dimensions of mass customization firms may assist the human resources function in transforming the work system and managing the workforce to achieve a sustainable competitive advantage and maximize performance. Mass customization and HPWS strategic capabilities can be considered simultaneously from the general perspective of the resource based theory because the strategic combination of their functional capabilities cannot be easily imitated or reproduced by other mass customization competitors, therefore, leading to a sustained competitive advantage in the market. Jackson and Schuler (1995) urge the use of multiple theoretical perspectives to identify possible explanations for the empirical relationships between strategic contexts and HRM. Furthermore, the authors suggest that researchers translate and adapt theories to understand HRM in context. The subsequent
section attempts to translate and adapt the resource-based theory into a domain that incorporates the SHRM configurational-contingency perspective with the mass customization strategic paradigm.

2.4.1 A Resource-Based View of HPWS-Mass Customization Integration

This dissertation exploits the resource-based view of a firm to facilitate the integration of HPWS and Mass Customization, and link it more broadly to strategy and operational performance. The resource-based view provides a conceptual lens for the theoretical argument that HRM activities, attributes, and practices combined into a comprehensive bundled system, can strategically contribute to firms’ mass customization capabilities and competitive success by making significant and accurate investments in the workforce and transforming the work system in order to support the degree of product customization embedded in the corresponding manufacturing system. Theoretical developments in the resource based view relating to the strategic dimensions of MCM have important implications for the way SHRM is perceived, and particularly, the competitive advantage based on workforce capabilities and HPWS approaches.

A fundamental strategic assumption of the resource-based view is that physical, human, and organizational internal resources cannot be easily imitated or obtained by competitors because there are no ready substitutes available to competing firms (Barney, 1991; Jackson and Schuler, 1995). Jackson and Schuler (1995) suggest that physical resources are associated with facilities, technology and equipment, and geographic location conditions; human resources are associated with the condition of employees’
experience and knowledge; and organizational resources are associated with conditions concerning structure, systems for planning, monitoring, and controlling activities, social relations within the organization and between the organization and external constituencies.

Following Jackson and Schuler (1995) suggestion, both SHRM and mass customization functions and activities greatly influences the conditions associated with all three internal resources required to gain a competitive advantage. Mass customization establishes the need to develop immobile facilities and process technologies that are unique and facilitate the strategic manufacturing capability to produce varying degrees of customized products. HRM establishes the need to develop firm specific employee skills, behaviors, knowledge, and capabilities for which there are no ready substitutes available to competitors. In combination, both the mass customization and SHRM capabilities establish the need to develop organizational resources that create systems for planning, monitoring, and controlling manufacturing and workforce activities associated with the relationships between the technical manufacturing and the social work system. By integrating HPWS and MCM systems, complexities associated with these internal resources cannot be reversed engineered or easily teased out (Ferris et al., 1999) because they adequately meet the criteria for a source of sustained competitive advantage advocated by the resource based view of the firm. The integrated resource complexity argument logically focuses this dissertation on the competitive imperatives of mass customization to strategically develop and manage workforce capabilities in MCM systems.
Presumably, the extent to which HRM activities and workforce capabilities can be used to gain a sustainable competitive advantage in mass customization strategic environments are determined by the unique technical and social capabilities associated with the manufacturing system in which the workforce operates and functions. A mass customization firm is expected to accumulate unique resources of specialized technical knowledge and market experience from distinct customer demands. These unique manufacturing resources must be strategically translated to manage the workforce and develop a particular configuration of HRM practices that can generate valuable, rare, non-imitable and non-substitutable work systems and human capital (Takeuchi, Wakabayashi, and Chen, 2003). The nuances of MCM and HPWS integration are extremely complex, suggesting that it would be nearly impossible for competitors to imitate because they are path dependent and causally ambiguous (Barney, 1991).

The resource-based view of the firm provides an appropriate investigative lens to establish the theoretical foundation for the exploration of the proposed relationship between mass customization and HPWS configurations because each discipline, in isolation, has exploited this theoretical perspective to understand how firms can enhance performance and gain and sustain a competitive advantage (Duray, 1997; Lepak and Snell, 1999). Grounded in the SHRM perspective, the resource-based view of the firm focuses primarily on the relationship among the strategic relevance of a holistic system of HRM practices and the unique firm specific competencies, skills and abilities of the workforce that provides a direct link to achieving and sustaining a competitive advantage for a firm (Jackson and Schuler, 1995; Lepak and Snell, 1999). The resource-based view is reflected in the SHRM literature by Jackson and Schuler (1995) who note that
employees’ experience, knowledge, and capabilities are consider valuable organizational resources to create and sustain a competitive advantage because a firm’s HRM system can greatly influence the development of their workforce that cannot be easily copied by competitors and for which there are no ready substitutes in the labor market. From a resource-based perspective of the SHRM initiative, a firm should focus on implementing a HPWS that develops workforce competencies and capabilities that are considered valuable, specialized, rare, inimitable, firm-specific and nontransferable (Barney, 1991; Wernerfelt, 1984; Lepak and Snell, 1999).

Grounded in the strategic perspective of mass customization, Duray (1997) argues that mass customization can be recognized as a strategic competitive capability because it is not easily imitated by competitors and the process of achieving mass customization provides a unique resource of customer information. Duray (1997) subjects mass customization to Collins and Montgomery (1995) five-step test of the value of a resource which includes: imitability, durability, appropriability, substitutability, and competitive superiority. The author concluded that mass customization appears to adequately pass the test of Collins and Montgomery (1995) and can be considered a sustainable, durable, unique, and valuable resource; qualifying it as a competitive capability. Furthermore, Ettlie and Ward (1997) provide additional support for viewing mass customization from the resource-based perspective by stating “Mass customization – providing products that are created to the customers’ specification at a price close to that of similar products that are mass produced – illustrates the resource-based view” (p.56).

For the purposes of this dissertation, the resource-based view is primarily concerned with how heterogeneous capabilities of MCM, HPWS configurations, and
workforce competencies, behaviors, attitudes and motivation are interrelated to be considered valuable, rare, non-imitable, and nontransferable across competitors. A resource-based view provides the broad theoretical foundation to integrate MCM and HPWS configurations that links workforce capabilities with enhanced operational performance for both the Fabricator and Assembler firms. For example, in the Fabricator firms, the production workers would function in self-managing teams and rotate jobs within a complex manufacturing process, learning from the unique application of advanced design and flexible manufacturing technologies. Workers would then be encouraged to apply this innovative knowledge to the new and distinct design demands of customers for customized products in all four stage of the production cycle. This exclusive workforce knowledge of innovative design, fabrication, and assembly capabilities would be firm specific and not easily duplicated by competitors because of a first-mover advantage in identifying unique customer information and appropriately utilizing a complex manufacturing system. Fabricator firms can develop and sustain firm specific bundles of manufacturing and human resource capabilities that their competitors cannot acquire or imperfectly duplicate.

Both the HRM and the mass customization disciplines have recognized that they can contribute to gaining and maintaining a competitive advantage for a firm by developing rare, valuable, imperfectly imitable, and non-substitutable physical, human, and organizational internal resources and capabilities. By conceptually combining the SHRM configurational-contingency and mass customization perspectives through the resource based view of the firm, a more complete strategic perspective and understanding of how HPWS configurations integrate with the strategic dimensions in each MCM
approach maximize performance will emerge. The resource based view fits well with the concepts of mass customization and SHRM articulated by many academic researchers, motivating this dissertation to incorporate the resource based view theory because of its clear strategic focus and relevance to this research inquiry. The resource based view assists in the attempt to empirically explain how distinct HPWS configurations can be used to facilitate varying degrees and strategic dimensions of MCM capabilities.

I argue from the resource based view that a mass customization firm can gain a sustainable competitive advantage and maximize performance by developing valuable, rare, firm specific employee competencies, experiences, and knowledge through HPWS configurations that cannot be easily copied or obtained (immobile) by competitors. This notion is supported by Lepak and Snell (1999) suggesting that “The resource based perspective encourages a shift in emphasis toward the inherent characteristics of employee skills and their relative contribution to value creation” (p.34). This statement echoes the argument of this dissertation suggesting that mass customization capabilities are critically dependent on the workforce and core employee skills and competencies; further highlighting the importance of developing the workforce through HPWS configurations to achieve a sustainable competitive advantage and maximize performance in both types of MCM systems.

By insisting on the application of MCM characteristics into the design and implementation of its HPWS practices, HRM will facilitate results that are integrated with the overall mass customization business strategy dimensions. Employees and their capabilities are argued to be the most important link between any organization and its unique customers in MCM environments. Thus, the integration of workforce and
manufacturing characteristics are essential to the improvement of organizational success for various mass customization strategic dimensions. This requires organizations to assess its HRM activities and practices for each MCM approach in order to be successful. Accordingly, the MCM system should be the center of HPWS policies and practices. The mass customization strategy and the accompanying manufacturing process attributes can help drive many aspects of the HPWS – its mission, structure, function, and the behavior and capabilities of its employees.

To illustrate, the two MCM approach have brought complex changes in the demands that jobs place on workers – in thinking, acting, learning, and doing – in each group. Many mass customization firms seem to be unaware of the consequences of their investment decisions involving the integration of the workforce with the corresponding manufacturing system (Kakati, 2002; Brown and Bessant, 2003). To be successful, organizations attempting different strategic dimensions of MCM must develop an appropriate work system that facilitates the simultaneous achievement of low production costs, high production volumes, and short delivery times, while delivering customized products that meet unique customer needs. These unique innovative work systems are inseparable components of MCM approaches. Firms that match innovative work systems with MCM systems maximize overall individual, operational and economic performance by aligning the skills, responsibilities and efforts of the workforce with the degree of customer demanded product customization.

The HR function must take a more strategic perspective regarding their role in mass customization strategic environments. HRM facilitates the creation of customer value in mass customization firms by:
• Linking its selection and promotion decisions to mass customization manufacturing systems
• Providing timely and effective support for the skills demanded and required by the corresponding manufacturing system
• Enacting a complementary holistic system of HRM workplace practices that attracts, retains, and motivates a high performance workforce.

These items seem obvious; however, they are vital steps in improving employee skills, commitment, motivation, and providing more opportunities to participate in decision making throughout IMCM and FMCM systems. Mass customization realities are putting organizational pressures on the HR function to shift its focus from the administration and maintenance role it has traditionally played to a broader cross-functional strategic role. The resource-based view accepts the SHRM configurational-contingency approach in that human capital is necessary to achieve mass customization capabilities because the true strategic advantage of mass customization lies in the unique and innovative knowledge and capabilities of a committed and motivated workforce. Exploiting employee commitment and applying unique workforce knowledge and capabilities can yield a sustainable competitive advantage that is valuable and maintainable because it is rare as well as hard to imitate. Thus, mass customization capability building through HPWS configurations makes theoretical as well as practical sense.

In the two MCM approaches, the overall competitive fit is also required to match internally aligned HPWS configurations with the IMCM and FMCM systems; requiring the contingency perspective of external fit to be supported by the configurational
perspective of internal fit. To better understand mass customization strategy and SHRM dimensions, the ability to integrate the contingency and configurational perspectives from a resource-based view are essential because they are closely related perspectives within the SHRM and mass customization bodies of work. By combining both perspectives through the resource-based view, it can be argued that the issue of organizational fit associated with holistic patterns of HR practices and competitive strategy is a critical factor in the HRM-mass customization performance relationship and determination of sustained competitive advantage.
3.1 Model Development Overview

HPWS structures may be an effective organizational mechanism to transform the way work is done in mass customization strategic environments by implementing properly designed employee management initiatives with high involvement and commitment from all members of the organization. By making better use of unique employee capabilities, skills and knowledge, a HPWS is intended to assist mass customization firms to become lean, cost efficient, flexible, and more responsive to changing customer needs and advanced technologies by motivating individuals through incentives and involving them in managerial and problem-solving decision making. HRM activities can significantly contribute to the financial performance and organizational strategic outcomes of the firm when the holistic coherent set or pattern of HRM practices and policies are congruent with the critical strategic dimensions of each MCM approach.

Rather than attempting to force fit the workforce into the existing technological structure of each MCM system, HPWS structures aim to find the best strategic fit between a holistic system of complementary HRM practices and the appropriate MCM approach for the explicit mass customization strategic dimensions. In this regard, HPWS design optimizes the social needs of the workforce as well as the technical demands of
each distinct MCM approach. This strategic fit leads to optimal utilization of all organizational resources and capabilities with a constant eye on the customer and other internal and external environmental requirements. Therefore, HPWS structures create a mutually reinforcing internal working environment that supports the customers’ unique needs and expectations for customized products while maximizing operational performance for the organization.

However, despite the development and implementation of these complex and innovative systems of HRM practices and policies, HPWS programs have contributed limited competitive success for countless manufacturing firms (Appelbaum and Batt, 1994; Brown and Bessant, 2003). These failures to produce maximized performance can be extended into the mass customization arena. This may be attributed to the failure of many manufacturing organizations to recognize the innovative demands MCM systems have brought about on the workforce and the lack of HRM strategic fit. Brown and Bessant (2003) conducted a longitudinal case study of three large firms in the auto industry and three large firms in the computer industry to indicate the strategic blockers in pursuing mass customization capabilities. The authors determined that a lack of strategy formulation, internal processes, external linkages, and human resources were among the significant reasons why a firm may fail to implement a mass customization strategy and execute mass customization capabilities. In particular, their analysis highlighted that the underachieving firms had poor training, lack of strong leadership, and an unawareness of what skills were required in mass customization orientations. The authors concluded that these inadequacies lead to the failure to develop a flexible and multi-skilled workforce, creating a culture that prevented initiative, creativity, and
supportiveness. This paper argues that the production system complexities embedded within the both MCM approaches must fit and be supported by appropriate coherent patterns of HRM policies and practices to create a culture of high firm performance, operational excellence and sustained competitive advantage.

As a result of extreme global competitive pressures and the development of advanced technologies confronting many manufacturing organizations, there appears to be no universal best-practice approach to creating and executing a HPWS in any manufacturing environment. Numerous failures of HPWS structures have illustrated that caution must be exercised when implementing a universalistic set of innovative HRM practices within complex manufacturing environments. I argue that a HPWS can be extended into manufacturing environments characterized by a more standardized manufacturing systems that emphasizes standardization, routinization, and formalization of job tasks (Mintzberg, 1983). This analysis focuses on the tangible and intangible factors that influence how MCM firms design and implement HPWS structures in various types of mass customization strategic environments and manufacturing approaches. The fundamental difference between the FMCM approach and IMCM approach concerns how work is organized and shop floor employees are managed in front-line operational positions. Firms following the FMCM approach assumes that the organization of work should be simplified, standardized, and specialized within the manufacturing system where individuals performance routine tasks efficiently under semi-controlling supervision. Conversely, firms following an IMCM approach assume that the organization of work should be structured so that shop floor employees coordinate their work with team members and perform multiple job tasks without a controlling
supervisor. These employees are exposed to extensive training that increases their knowledge and skill level and are motivated by incentives and encouraged through empowerment to participate in managerial decisions such as on the job problem solving and improving work methods and procedures.

This dissertation theoretically argues from a resource-based view that to effectively manage the distinct manufacturing systems of the two strategic types of mass customizers in the workplace, the coherent holistic set of innovative HRM workplace practices must consider the degree of product customization, desired employee attributes and capabilities, level of motivation, extensiveness of involvement and participation, and the working environment confronting the organization. Thus, to identify an effective complementary system of innovative human resource practices and activities, organizations must have some understanding of how employees interact and operate within unique MCM systems as well as the techniques organizations have implemented to manage these interaction. Ultimately, this analysis will specify a set of recommendations of HPWS design principles to assist managers and researchers in effectively developing and implementing a HPWS in distinct MCM environments. This dissertation provides an understanding of how diverse mass customization firms adopt particular HPWS structures while maintaining the delicate but necessary balance between economic goals, competitiveness, and human development.

With the exception of Snell and Dean (1992), Arthur, (1994), Yount et al. (1996), Wright, et al. (1999), MacDuffie (1995), and Inchiowski et al., (1997), literature on innovative HRM practices and HPWS structures has focused mainly on the direct performance results of these innovative work systems, not on the interaction and
integration with different manufacturing systems in which these innovative work systems are embedded and the performance effects of matching production system requirements with unique bundles or configurations of complementary HRM workplace practices (Appelbaum et al., 2000). When the complementary and coherent holistic configurational set of specific HRM innovative workplace practices within the structure of a HPWS supports the appropriate mass customization manufacturing system, it is proposed that these firms should realize higher individual, manufacturing and financial performance and achieve a sustained competitive advantage over competitors.

The main emphasis is on the unique design of an explicit HPWS configuration, which should focus on the creation of “fit” both within and between the organizational work system, manufacturing system, and the workforce. Individuals and teams may do high performance work, but the organization will not have a competitive advantage unless the whole comprehensive system of HRM workplace practices are vertically coordinated and strategically aligned with the technical and social characteristics of the manufacturing system within the corresponding mass customizing strategic environments. The emphasis is on modifying the coherent holistic set of HRM innovative practices to achieve horizontal fit among the comprehensive configuration of workplace practices with a strong external customer orientation in mass customization strategic environments. The basic principle is that all HRM practices are interrelated with each other and combined into a synergistic nexus to generate higher levels of performance and provide a sustainable competitive advantage. Farias and Varma (1997) champions this notion demonstrating that, “The attainment of fit between the organization and its external business environment and among its design features must be a key objective of
the design” (p. 52-53). From the overall perspective of this dissertation, the general notion of “fit” suggests that each mass customization manufacturing system’s success is largely a matter of the unique way the firm attempts to manage the work force by strategically configuring the complementarity variations of innovative HRM practice into a comprehensive interrelated pattern that is consistent with its specific strategic posture (Ferris et al., 1999).

Newly conceptualized HRM systems of organizational work approaches are needed in each MCM approach to maximize operational performance of the manufacturing system, the competitiveness of the company, and the well-being and employability of the workforce. Because of the explicit functional differences between technical attributes, characteristics, and features of each manufacturing system previously identified, the organization of work and personnel practices should be designed to match and support the explicit technical and social requirements for each distinct MCM approach. Each MCM approach can affect the corresponding work system design, the nature and function of work itself, the way the workforce is managed, and the demands placed on employees differently. This rationale indicates or suggests that designing the work system to manage the workforce should focus on identifying a specific holistic bundle or configuration of complementary and supportive HRM innovative workplace practices for each MCM system. In other words, the basic premise is that the structure and content of work differs or is contingent on the context of technical characteristics in each mass customization manufacturing system, thus, requiring a unique workforce and personnel management system.
3.2 Configurational-Contingency Approach for Designing HPWS Configurations for MCM System

The integrated configurational-contingency SHRM theoretical approach for designing holistic HPWS configurations in distinct MCM environments suggests that there must be a vertical link between the horizontally coherent pattern of complementary HRM policies and practices to specific organizational competitive strategies. Researchers within the SHRM discipline have argued that complementary sets of horizontally aligned HRM practices must be synergistic and consistent with organizational strategy to be considered competitively effective (Arthur, 1992; Yount et al., 1996; Schuler and Jackson; Ferris et al., 1999; Delery and Doty, 1996). This dissertation offers conceptual typologies distinguishing horizontally aligned HRM practices on the basis of the explicit MCM approach utilized to achieve an explicit mass customization strategy. It extends the studies conducted by Author (1992) and Yount, Snell, Dean, and Lepak (1996) to include the two new emerging strategic dimensions of mass customization advocated by Duray (1997). It is argued that employees in the FMCM and IMCM systems possess capabilities, knowledge, skills, motivation, and decision making opportunities that are not of equal strategic importance. This interpretation suggests that holistic configuration of horizontally aligned individual HRM practices are contingent on the strategic dimensions of the FMCM or IMCM approach.

Fundamental to the HPWS paradigm is the supposition that its effectiveness and positive impact on performance is influenced by the aptitude and attitude of employees to
intentionally apply their discretionary effort in their multiple work roles and on complex job tasks. To illustrate, the conceptualizations of HPWS identified earlier assumes that members of the workforce (shop floor employees) should be exposed to higher levels of skill development, greater levels of motivation and commitment, and increased amounts of work-related involvement and extensive opportunities to actively participate in managerial decision making of day-to-day governance of the workplace (Wright, McCormick, Sherman, and McMahan, 1999). These are the primary mechanisms through which a HPWS functions and are fundamental requirements for full system effectiveness. These essential mechanisms are the key underlying concepts that govern the HPWS paradigm and are the central notion behind the HPWS-performance relationship. Through these critical HPWS mechanisms, it is suggested that employees will be more eager to learn new skills, have greater motivation to apply their discretionary behaviors to offer new ideas and suggestions based on their knowledge, and the empowerment and autonomy to actively participate in managerial decision making processes that impact how, when, and why work tasks is accomplished. Many of the intended HR policies and implemented HRM practices within a HPWS structure revolve around and function best when the firm realizes these HPWS mechanisms.

MacDuffie (1995) argues that innovative HRM practices are most effective and positively impact firm performance only when three conditions are met: “when employees possess knowledge and skills that managers lack; when employees are motivated to apply this skill and knowledge through discretionary effort; and when the firm’s business or production strategy can only be achieved when employees contribute such discretionary effort” (p.199). However, I argue that a particular Assemblers can
have an effective HPWS structure and not have a high emphasize or greater levels of skill
development, motivation to apply discretionary effort, and involvement and participation
in decision-making to have a positive impact on performance. To demonstrate, a FMCM
approach stresses centralized decision-making that emphasizes job formalization and
work tasks that are standardized, semi-narrow, and routine to achieve high levels of
efficiency. As a result, developing multiple skills and providing extensive motivation to
apply discretionary effort in the active participate in the managerial decision making
processes of shop floor employees is not encouraged. This does not suggest that this type
of mass customizer should not invest in training to develop the appropriate skills, provide
performance appraisals and incentives to motivate and enhance commitment, and
communicate relevant information and implement team work practices to facilitate
involvement and participation; rather, the particular HRM practices associated with
recruiting and selection, incentive compensation plans, teamwork, flexible job
assignment, skills training, and labor management communication activities will be
uniquely combined to provide synergy between all other work system and industrial
relation practices to support the MCM approach for mass standardized products.

Furthermore, HPWS structures have been positively associated with other
manufacturing management methods such as Lean Production, Integrative
Manufacturing, and Flexible Manufacturing; but it is conceptually plausible that a
properly design innovative work system configuration can enhance the effectiveness and
maximize the operational performance of a more standardized production system similar
to that of the FMCM system identified by Duray (1997) too. Applebaum et al. (2000)
develop a framework to examine the influence HPWS structures have on plant
performance. The authors argue that effective HPWS require three basic components: opportunity for substantive participation in decisions, appropriate incentive, and training and selection policies that guarantee an appropriately skilled workforce. Their model suggests that an effective HPWS will motivate workers to exert their discretionary effort, which should lead to an increase in plant performance. I agree with their model; however, it can be rationally and theoretically argued that the design and implementation of a HPWS is contingent on the distinct manufacturing system characteristics within the mass customization strategic environments because the authors explicitly state: “Variations among plants in the use of specific practices arise from several sources. At the plant level, managers may adopt different workplace practices because they confront differences in such contingencies as the availability of modern technology, the characteristics of the local labor force, the complexity of the product mix produced, or the value that customers place on on-time delivery. While a particular combination of practices and contingencies may provide the best horizontal fit among practices and contingencies, plants, vary in the contingencies that face and their ability to introduce practices. The result is variation in the spread of particular combinations or bundles of practices” (p.11).

I further argue that, managers may adopt a particular holistic system of different HRM workplace practices because they confront differences in such contingencies as the manufacturing approach implemented to produce varying degrees of mass customized products. Within these different manufacturing approaches, the complexity of the product is contingent upon the point of customer involvement in the design of the product and the type of modularity used by the organization. In addition, the value customers place on the
degree of product customization will result in variations of particular combinations or bundles of work system practices within each MCM system.

A firm’s explicit HPWS configuration must provide the appropriate skills and knowledge (competencies), motivation, opportunity to participate, and work structure to support the technical and social demands of each MCM approach through the implementation of proper HRM practices. This dissertation argues that FMCM producers adopt innovative sets of horizontally aligned HRM workplace practices very differently than those adopted by IMCM producers. This adoption difference suggests that HPWS configurations do not entail greater levels of motivation, involvement, empowerment, participation in decision-making, and skill development for all employees, regardless of their function or level in the organization. Rather, the level of autonomy, involvement, participation, motivation, and skill development is contingent upon the technical and social characteristics of the particular MCM approach. In other words, the design of an explicit HPWS configuration must complement and support the specific manufacturing system characteristics and objectives embedded within a distinct MCM environment. To illustrate, the IMCM approach requires greater levels of involvement and participation in decision-making than the FMCM approach because job tasks are undefined (less structured, standardized and routine) given that employees are constantly faced with numerous dynamic changes to product design by customers. However, both manufacturing systems must implement an explicit HPWS configuration that serves to enhance the commitment, motivation, knowledge and competencies of the workforce to maximize operational performance.
Testing the holistic systems perspective first requires categorizing each MCM approach into a meaningful typology of HRM work system configuration. Underlying the use of these typologies is the proposition that mass customization firms differ in their basic strategic approaches or objectives to manage the workforce. These strategic objectives related to desired employee characteristics, attitudes, and behaviors should be derived from a firm’s manufacturing approach to achieve various degrees of product customization. It would be a great discord for academia to assume that a HPWS’ effectiveness would be universal and equally valuable in all type of MCM environments.

For the purposes of this dissertation, a HPWS is conceptualized to include two different configurations of work system structures that contain different, but mutually reinforcing innovative HRM practices based on the contingent manufacturing system approach adopted to achieve a mass customization strategy. Each HPWS configuration type will be theoretically developed a priori for the IMCM and FMCM systems. These two independent work systems represent two distinct managerial approaches to shaping employee skills, capabilities, motivation, behaviors and attitudes in their work roles. To illustrate, the technical and social characteristics of the IMCM and FMCM systems will dictate the specific holistic complementary set of HRM workplace practices to be included within each explicit HPWS configuration type. The organization of the work system is based on the configurational approach and is contingent upon which manufacturing system is implemented to achieve a distinct mass customization strategy.
3.2.1 HPWS policies and Practices

The fact that all individual HRM practices can consist of varying degrees and there has been little consistency among researchers and practitioners in regards to which innovative HRM practices constitutes a HPWS, previous research suggests developing broad categories of HR policies in which various specific HR workplace practices can be grouped and classified (Way, 2002). An extensive review of the literature by Way, (2002) resulted in identifying six broad HRM policies of workforce and personnel management where a group of specific innovative HRM workplace practices is hypothesized to produce higher levels of individual, manufacturing and firm performance when they are aligned with and complement a firm’s explicit manufacturing system. As illustrated in Tables 3.1 and 3.2, these broad HRM policies include: (1) recruiting and selection, (2) incentive compensation plans, (3) teamwork, (4) job assignment, (5) skills training, and (6) labor management communication (Way, 2002). Within each of these broad workforce management policies identified above, the specific HRM innovative work practices to be included within this analysis’s two HPWS configurations will be conceptualized based upon the unique technical and social characteristics, attributes and features embedded within each distinct mass customization manufacturing systems.

For the purposes of this dissertation, a HPWS is an umbrella term that encompasses (a) six broad categories of HRM policies: recruiting and selection, incentive compensation plans, teamwork, flexible job assignment, skills training, and labor management communication as advocated by Way (2002); and (b) the specific innovative HRM practices embedded within each HRM policy. Each explicit HPWS configuration
type will consist of the same six HR policies (recruitment and selection, compensation, training, teamwork, job assignment and communication), but will have a completely different coherent set of interrelated and horizontally aligned HRM practices within each holistic configuration. Each explicit internally aligned HPWS configuration will possess multiple complementary HRM practices that provide synergy between them and are vertically aligned to fit with the corresponding mass customization strategic posture and manufacturing approach.

Recently, Wright and Boswell (2002) have suggested that researchers should recognize the distinction between HR policies and HRM practices when attempting to study the SHRM impact of HRM systems on firm-level outcomes. The authors define this distinction as “HR policies representing the firm or business unit’s stated intention about the kinds of HR programs, processes, and techniques that should be carried out in the organization. HR practices consist of the actual programs, processes, and techniques that actually get operationalized in the unit” (p. 263-264). Wright, et al. (1999) define HRM practices as “the organizational activities directed at managing the pool of human capital and ensuring that the capital is employed towards the fulfillment of organizational goals” (p.552) Jackson and Schuler (1995) conceptualize the HR policy-practice distinction by describing HR policies as providing a formal direction that partially constrains the development and implementation of specific HRM practices such as recruitment, selection, training, and compensation.

Making this distinction enables researchers to emphasize the operational reality that the workforce responds and reacts to tangible and practical HRM practices that are implemented rather than the intended HR policies of executive managers. This reaction
of employees to technically specific HRM practices permits researchers to demonstrate an empirical relationship between the real HRM system and corresponding practices and firm-level outcomes. Together, intended HRM policies and implemented HR practices comprise a workforce management system that attracts, develops, motivates, and retains employees to ensure a positive impact on firm performance and provide a sustainable competitive advantage. Thus, to thoroughly comprehend how HRM practices and policies can positively impact firm performance and competitiveness this dissertation views the implementation and alignment of many different HRM practices as being rationally determined by six proactive, strategically intended HR policies embedded in a broader HPWS structure to fit a particular mass customization strategic posture and support the explicit MCM approach.

Researchers have stressed that HRM practices can take many different forms, but they are all grounded in the belief that the workforce are a critical competitive asset (Gehart and Van Buren, 1996). In both types of MCM systems, the complementary coherent set of innovative HRM practices are intended to enhance employee skills, capabilities, knowledge and motivation, and must function as a holistic configurational system to achieve the financial and strategic performance goals of the organization and sustain a competitive advantage. This can be interpreted to mean that both HPWS configurations can have drastically different recruitment and selection, compensation, training, teamwork, job assignment, and communication HRM practices, but quit similar HPWS structures because they each possess the same six HR policies (Becker and Gerhart, 1996). For example, although both HPWS structures consists of training and compensation HR policies, the difference is that both link the executed compensation
practices to desired behaviors and performance outcomes and both effectively implement training practices to develop employee skills that fit the corresponding work and manufacturing systems requirements. Becker et al. (2001) summarize this notion; “A key distinguishing characteristic of a HPWS is not just the adoption of appropriate HR policies and practices such as employee acquisition, development, compensation, and performance management, but also the way in which these practices are deployed. In a HPWS, the firm’s HR policies and practices show a strong alignment with the firm’s competitive strategy and operational goals. Moreover, each HPWS will be different. No single best example exists; each organization must customize its system to meet its own unique strengths and needs” (p.19). Gephart and Van Buren (1996) further support this view arguing, “In practice, not two HPWSs are exactly alike. The exact components depend on the setting and the needs of the organization. Two organizations rarely take the same approach to high performance. The goal in each case should be to use practices that overlap and contribute to common outcomes. Exactly which combinations work best, and under what conditions, needs further exploration” (p.22-23).

From an integrated contingency and configurational SHRM perspective, HPWS structures are complex workplace systems with six different intended HR policies that must be vertically and horizontally aligned to produce superior performance and obtain a sustainable competitive advantage. The components and HRM practices within the HPWS must fit together (internal alignment) as well as be aligned with and support the mass customization manufacturing system strategic dimensions (external alignment). Misalignment can decrease performance and expunge a competitive advantage. From a SHRM configurational perspective of the work system, horizontal alignment means that
the internal horizontally aligned holistic set of HRM practices within the six different HR policies complement one another. Hence, a HPWS cannot be recognized by prioritizing HRM policies at the expense of other practices and policies, for example, recruiting and selection at the expense of training. Vertical alignment is recognized when the holistic configurational set of internally consisted and mutually reinforcing HRM practices support the appropriate MCM approach. Effective horizontal and vertical alignment is a precondition for an organization to maximize operational performance in all mass customization strategic environments.

With their work and manufacturing systems strategically aligned, high performing mass customization firms achieve substantial gains in productivity, cycle time, flexibility, quality, and significantly reduce costs and delivery times through the contribution of the workforce. A holistic systems perspective is a prerequisite for cultivating internal and external alignment of the work and manufacturing systems and thus for generating a true competitive advantage in all mass customization strategic environments. Together, both types of alignment produce a focused workforce, which drives superior performance.

“Systemic perspective is essential for figuring out how to change the system in order to improve alignment.”

3.3 Two Conceptual HPWS Models: Fundamental High Performance Work System (FHPWS) and the Innovative High Performance Work System (IHPWS)

Based on a rigorous review of the relevant literature and conceptual logic, this dissertation theoretically argues that the two MCM approaches are differentiated by a
unique personnel management and industrial relations philosophy that incorporates a precise holistic configurational set of innovative HRM workplace practices. It is clear that much attention needs to be given to both the human/social and technical requirements of the two distinct MCM systems in the design considerations of HPWS configurations – not only in designing the new system but also in gaining acceptance for changes. HPWS configurations are expected to enhance the competencies, capabilities, motivation, and commitment of shop floor employees in both MCM systems by organizing work systems and managing the workforce through the combination of six broad categories of HR policies in the areas of selection, training, communication, compensation, job assignment, and teamwork (Way, 2000). However, the specific investments of HRM practices firms implement within each broad category of HR policies to select, develop, motivate, and retain a capable and committed workforce will be tailored to (or contingent on) an organization’s explicit MCM approach to achieve customer demanded product customization. In regards to Schuler and Jackson’s (1987) proposal of HRM practice unlimited choice, Wright and Snell (1998) state “Firms have at their disposal a ‘menu’ of HRM practices; different strategies require different role behaviors from employees, and thus, firms choose HRM practices based on their ability to elicit the behaviors required to implement a chosen strategy” (p. 758). Although not explicitly stated, Wright and Snell’s (1998) and Schuler and Jackson’s (1987) conceptualization of different strategic postures requiring different innovative HRM practices to elicit appropriate behaviors parallels that of the contingency fit perspective within the SHRM field (Becker and Gerhart, 1996; Lepak and Snell, 2002).
Following Wright and Snell’s (1998) and Schuler and Jackson’s (1987) conceptualization of contingency fit in SHRM, it is proposed that each explicit holistic configuration of the HPWS is theoretically designed to maximize the overall effectiveness of the workforce, enhance performance, and achieve a sustainable competitive advantage in both MCM systems and strategic environments. In other words, each policy of the HPWS is designed to maximize the overall effectiveness of the workforce in both MCM approaches. Tables 3.1 and 3.2 at the end of this section provide a conceptual model of the specific HRM personnel management practices as internally supportive activities and components within the six broad categories of HR policies for each of the HPWS configurations associated with the FMCM and IMCM systems. The HPWS configuration that is congruent and supports the FMCM system is labeled a Fundamental High Performance Work System (FHPWS). The HPWS configuration that is congruent and supports the IFMCM system is labeled an Innovative High Performance Work System (AHPWS). I view both HPWS configurations as being determined by proactive, strategically intended HRM decisions to align the effort of the workforce with the degree of mass customization. The conceptualization of the specific HRM innovative industrial relations practices within the six HR policies for each HPWS configuration are based on extensive field work that revealed which personnel management practices differentiated mass standard product and mass custom product manufacturing systems most clearly.
3.3.1 Recruiting and Selection Practices in FHPWS

In FMCM approach, organizations do not depend directly on employee skills, capabilities, and competencies to mass produce standardized components and assemble simple end-product configurations, but instead, simplify and routinize job tasks by designing and programming fixed automation technology to incorporate the desired human skillfulness into machines and equipment. This type of work organization is more appropriate for high volume standardized component and modules in which the workforce produces continuously and has no creative input regarding the design, production, and assembly of the finished customized product. To maximize performance, the workforce is required to follow standard operating procedures and work instructions determined by advanced engineering methods. Furthermore, employees should not be permitted to alter operational routines, nor the freedom to change or alter standardized job tasks.

These types of mass customization organizations should use less rigorous recruiting and selecting techniques to identify and hire potential employees from outside the firm because of low skill requirements and ease of operating programmable automation and machinery in the mass standardized manufacturing system. Recruiting and selection efforts should be simple and informal that focuses on filling current job openings while giving little consideration to hiring for potential or promotability. Managers should make hiring decisions on the basis of resume screening and in-person interviews; they should not use formally validated selection tests because of the high associated administrative costs and substitutability of semi-skilled employees.
Firms FMCM approaches should focus on recruiting individuals at the entry level who have a narrow job focus with general technical knowledge and skills that demonstrate the ability to carry out routine manufacturing functions and standardized job tasks repeatedly. Rather than invest in developing generic skills through extensive training, FMCM firms are more likely to recruit and select individuals who already possess common manufacturing skills such as machine operation and simple mechanical assembly. Given that these individuals may depart, recruiting and selecting should then focus on implementing low cost practices such as the use of temporary workers, on-site applications, and seat of the pants hiring to facilitate more rapid replacement and maintain minimum administrative costs. These organizations would not waste valuable and scarce organizational resources to recruit a large pool of potential applicants from which to select since there is limited continuity and loyalty from employees in this manufacturing environment. In addition, potential applicants should only be required to go through one round of interviews before being hired to reduce recruiting and selection costs.

3.3.2 Recruiting and Selection Practices in IHPWS

Workers in the IMCM system need extensive basic, technical, and occupationally specific skills, along with leadership and social work group competencies. One way IMCM organizations can acquire and secure a more competent workforce is by being more rigorous and selective in their recruiting and selecting procedures for better-educated, higher skilled workers who have the ability to learn complex job tasks and the
capability to perform multiple job activities on a rotational format. Firms should recruit and select workers who can integrate their idiosyncratic characteristics of advanced knowledge, specialized skills, creativity, problem solving abilities, and technical experience into a complex and flexible IMCM system to continuously solve unique and unexpected operational and customer problems.

Since customers are involved earlier in the production cycle and have the ability to uniquely design their own modules and specify end-item configurations, novel and complex design and operational problem continuously surface. These unpredictable and unexpected types of problems force Fabricators to recruit and select potential employees with a pioneering spirit who are willing to take a risk with new flexible technology, accept increased task responsibility, agree to an open labor-management relationship, and cooperate and collaborate with other employees within autonomous work teams. This ensures a work environment based on egalitarianism and trust to solve customer induced problems in the plant.

Fabricators should use information gathered from several rigorous and comprehensive selection and recruitment techniques to evaluate potential job candidates. Such techniques may consist of pre-hire screening devices, providing realistic job previews, multiple rounds of structured interviewing, use of different recruiting sources, involving existing employees in the hiring process of future team members, and aptitude and personality testing. These sophisticated staffing techniques should be more extensive, take longer, involve more people, and increase selection ratios to select better-qualified workers with more advanced knowledge and specialized skills and abilities. Staffing practices that increase selection ratios, take longer, and use objective criteria from these
methods can screen out all the very best talented employees that possess superior skills and multiple abilities. Extensiveness of sophisticated staffing can determine if potential employees have the ability to do well in training extensive environments, work in autonomous teams, and learn firm specific technical knowledge. As the importance of a workers ability to apply their discretionary effort to participate in shop-floor decisions and problem solving increases, sophisticated staffing decisions are likely to focus on aptitude, potential, and cognitive ability rather than accomplishment (Lepak and Snell, 2002).

In addition, IMCM approaches should focus on hiring or promoting within existing operations due to the potential lack of firm specific skills and technical knowledge in the labor market that is required to function in such complex and flexible production systems. Organizations may use flyers within existing plants to advertise for new jobs. Employees hired within existing plants tend to possess more talent and experience with increased skill levels in mass customization production systems.

Recruitment and selection procedures (staffing) in IMCM approaches should use more selective staffing practices to locate the best and brightest workers because more advanced or specialized skills are required to satisfy unique and constantly changing customer requests. Snell and Dean (1992) found partial support for the positive relationship between the use of selective staffing practices for operations and quality employees and integrated manufacturing environments characterized by advanced manufacturing technologies, Just-in-Time, and total quality management. Because integrated manufacturing environments are similar to IMCM approaches, it is suggested that there should be more active recruiting and consideration of applicants for each job
position in order to increase selection ratios. Also the selection process should take longer and involve input from more people in self-managed work teams.

Huselid (1995) maintains that “Recruiting procedures that provide a large pool of qualified applicants, paired with a reliable and valid selection regimen, will have a substantial influence over the quality and type of skills new employees possess” (p. 637). Therefore, it is conceptually argued that using the identified sophisticated staffing practices in the recruiting and selection process may effectively help Fabricators to obtain and retain highly skilled and knowledgeable employees. Mass customization manufacturing organizations that are dedicated to maximizing overall performance and competitiveness must pay a great deal of attention on how they recruit, select and hire new personnel.

3.3.3 Incentive Compensation Practices in FHPWS

In FMCM approaches, workers are paid to do specific pre-defined job tasks that maximize individual efficiency and productivity, not to think or be creative. Compensation is position or seniority focused and would most likely be based on a market determined hourly wage and the accomplishment of specific work tasks. In addition, compensation is generally not contingent on individual, work group or firm performance. Any pay increases go proportionally to all workers. As a general rule Assemblers should not differentiate pay between the lowest and highest performing workers in any given job. Also, individual incentives such as rewards and bonuses should be used to focus on short-term efficiency and productivity goals, bringing problems and
opportunity to the attention of management, and ensuring worker compliance to standards with pre-determined production procedures and processes. Such individual incentives may be based on meeting:

- volume quotas
- productivity, efficiency and utilization standards
- production within cost budget
- delivery requirements
- conformance to quality standards and goals

Furthermore, to evaluate employee performance and the level of compliance to specified rules, procedures, and standards, performance appraisals should be process oriented and based on employee work-related outcomes and the specific organizational results associated with those outcomes. These conditions enable performance appraisals to focus on auditing employee performance and correcting any procedural problems that may exist; further aligning employee interests with those of the firm to reduce costs and increase efficiency (Snell and Yount, 1995). Snell and Dean (1992) commenting on the use of performance appraisals in traditional mass production environments where differences in employee performance have a marginal impact to the bottom line concludes, “Performance appraisal is thus frequently carried out in a pro forma, non-participative manner and is intended simply as an administrative device” (p.474).
Wage incentive compensation schemes in IMCM approaches are designed to increase the motivation of the workforce to expand extra effort on developing and enhancing their job skills and to apply their discretionary effort to participate in substantive shop-floor decisions and problem solving because it is difficult for managers to specify or monitor. In particular, group-based wage incentives should be outcome-oriented on group performance that focus on rewarding team members for tangible improvements of the production process, high customer service, and the achievement and attainment of extra skills (Yount et al., 1996). Group-based wage incentives that focus on group performance intend to align the interest of all employees with organizational goals by structuring wages and the type and quantity of rewards to performance of the work group and/or the firm. Pil and MacDuffie (1996) stresses the benefits of implementing group-based wage incentives to manage the transfer of “best practice” at Japanese auto plants in North America maintaining that “A firm that makes compensation contingent on performance at the group or organizational level will have workers that are more likely to engage in mutual monitoring, and are more motivated to participate in activities that improve the organization’s overall performance” (p.429). Similarly, this comment suggests that group wage incentives and bonuses/rewards based on performance should be designed to encourage and reward cooperation, collaboration, and information sharing among one another.

In order for wage incentive compensation schemes to be effect, they should be tightly linked and used in conjunction with formal developmental performance appraisals that
objectively assess individual and work group performance and focus on strengthening employee skills, expertise, and capabilities. To be highly effective, employees must participate in performance appraisal criteria and goal setting. By combining wage incentive compensation and high quality developmental performance appraisal systems that are outcome-oriented and administered on a routine basis from more than one source, organizations are able to recognize employee merit and reward the workforce based on their work-related behaviors that contribute to the firm's strategic objectives and enhancing competitiveness in IMCM systems (Huselid 1995). Snell and Yount (1995) emphasizes the importance of this performance enhancing approach, “By linking personal interests with the achievement of organizational targets, such an approach to HRM gives individuals discretion over the processes they use, but still provides incentives for outcomes that benefit the firm” (p.714).

In addition, internal promotion systems present a strong incentive for employees to perform well when combined with appropriate formal developmental performance appraisal systems that provide continuous feedback on performance, coaching, and identify training needs to enhance skill level (Snell and Dean, 1992). Internal promotion criteria can consist of merit or performance rating alone, seniority only if merit is equal, and seniority among employees who meet a minimum merit requirement (Huselid, 1995). To further emphasize the importance for employees to continuously enhance their competency level for internal promotion considerations, performance appraisals should be focused on development and feedback of quantifiable results.

Similarly, organizations may offer employees with superior skills higher wages to motivate them to contribute discretionary effort in participating effectively in substantive
decisions within the complex production system. In addition, offering high wages increases the size and quality of potential applicants during the recruiting and selection process. Compensation packages based on salary as apposed to an hourly rate should be used to attract potential candidates who possess superior skills and multiple abilities and promote egalitarianism among peers within work groups (Yount et al., 1996).

3.3.5 Teamwork Practices in FHPWS

In a FMCM approach, top management determines what problems and tasks teams will work on. Improvement teams within FMCM environments are characterized by tight supervision and rigid job classifications that followed strict work roles. Such rigidity helps management to ensure stability and predictability of the production process. Under this framework, management and employees work to ensure that the production process is not stopped and operates continuously to produce high volumes of standardized components and modules.

These types of improvement teams are formed by management based on particular problems occurring within the production process and teams do not have the authority to choose which problems to solve. Workers participate in improvement activities directed to solve quality and production problems, but they have little discretion over how tasks shall be accomplished. Workers are encouraged to apply their discretionary effort only to work harder on pre-defined problem solving tasks.

Quality circles, improvement committees or tasks forces should be developed as managerial practices that focus on meeting standards in production and assembly.
processes, improve quality and production problem solving without providing workers with the opportunities to participate in substantive decisions. These practices are designed so improvement teams are not directly involved with the production process and are designed to meet off-line and solve particular problems pre-defined by management. Workers’ ideas and suggestions could only be incorporated into the problem at hand and not for any other operational improvements or innovations.

3.3.6 Teamwork Practices in IHPWS

From the context of adopting high involvement work practices as part of a system of complementary HR practices, Pil and MacDuffie (1996) argues the position, “When switching to a team based environment, production workers and managers face great uncertainty. They have to learn new roles, new ways of interacting, and develop a new degree of trust in the new system and one another” (p.432). This argument can be applied to IMCM approaches suggesting that giving teams more autonomy and permitting them to be self-managed can reduce these uncertainties. Thus, self-managing work teams that are given the autonomy to make effective decisions for the entire production process, from start to finish are essential work system elements necessary for the attainment of high levels of performance within IMCM systems. Autonomous work teams are the basic building block of HPWS configurations in IMCM approaches, where individuals within teams are treated equally and ensured there will be greater levels of job security. Team members are given much more autonomy to make on-line decisions during work tasks than their counterparts are in traditional mass standard product systems because of the
high amount of uncertainty, unpredictability, and complexity administered by the customer.

IMCM approaches revolve around well-trained, cooperative teams that work closely with management, experts, customers, and vendors. Teams cooperate more effectively when they are given improved means to communicate internally and externally. As a result, team members contribute discretionary effort to continually innovate and solve production and customer problems. These types of teams are self-directed and rely on group consensus to arrive at substantive decisions regarding which particular customer, quality and production problems to solve and how to do so. The implementation of autonomous teams promotes team members to pool ideas resulting in more innovative solutions. Team members can also counsel with one another with respect to absenteeism and other problems affecting their work with external resources (engineers and vendors) consulted as needed.

By being directly involved in the production process, self-managed teams are closer to the level at which responsibility for work takes place. These teams work without a controlling line supervisor and are responsible for tasks and processes traditionally reserved for management. Team members are crossed-trained in a variety of tasks, learn new skills, take on much more responsibility, and do work outside of standard job descriptions. Teams are organized to give shop-floor workers more scope and opportunity so they can apply their discretionary effort and participate in substantive decisions that alter existing production system routines. Some of the duties autonomous work teams perform in mass custom product environments may include:
• Planning and scheduling the work

• Coordinating activities within and outside of the team

• Producing a quality product to schedule
  
  o Monitor data on quality, cost, and productivity

• Performing within budget

• Make job assignments within teams – assigning multiple work tasks

• Maintaining equipment – routine preventive tasks

• Controlling and monitoring inventories and scrap

• Ensuring compliance with safety and health standards and improvement in such standards

• Obtaining tools and supplies

• Keeping records

• Assist in new product development

• Training

• Determining working environment and quality of work life

• Determine who to purchase supplies from, how to stock them, what sizes, what inventory levels are.

• Dealing with absences

• Technical skills
  
  o SPC and quality inspections
FMCM approaches rely on managerial and technical expertise supported by centralized coordination and decision-making for optimal performance. Jobs are tightly defined and work tasks are designed to be routine, uniform, stable and specialized with an emphasis on formalization and standardization to eliminate uncertainty and increase the predictability of individual and operational efficiency performance. Workers should follow directions and have few opportunities to directly solve problems or make decisions.

Management assigns jobs based on explicit functions of the production system and the general, but limited basic skills of the workforce. Employees work on jobs that are fragmented into simple repetitive tasks that are deeply embedded in the production process for standardized components and modules. Management enforces specific provisions regarding standard operating work procedures in which employees know the content of their jobs exactly that ensures conformance to fixed production and quality standards.

In the FMCM approach, shop floor employees clearly understand what is expected of them, and they are trained to work in accordance with those expectations. Jobs are limited in scope and assigned so workers can master easily learned tasks that prevent them from using their creativity skills and applying their discretionary effort in an innovative way. When problems arise, technical experts effectively implement well-known scientific solutions; preventing workers from performing duties that are not considered part of the job and limiting their participation to the boundaries of their job
description. By shaping work duties through well-defined job descriptions, workers cannot conceptualize the relationship between what they are doing and the goals of the organization. Workers do not have autonomy and control over methods of work through all stages of the production cycle because the components and modules are designed to be standardized for high volume, low cost production. In addition, workers must follow standard work instructions and operate dedicated pre-programmed technology. These workers do not have to think or be innovative because components and modules never change; work is less challenging. Also, these workers should not have the opportunity to participate in decision-making at all four stages of the production cycle because of the component and module standardization required for FMCM systems. Assembly is simple and predictable because customer configurations always are the same. Workers will be familiar with different assembly request and will not be exposed to configuration that will require them to think.

3.3.8 Job Assignment Practices in IHPWS

Job assignments in IMCM approaches are designed to be more flexible and interesting which should encourage and motivate workers to apply their discretionary effort to participate in problem solving and managerial decision making. Flexible job assignments are designed to utilize individuals’ unique skills, knowledge, and superior abilities in employee assisted defined work roles; further exploiting their expert knowledge to maximize their contribution in flexible IMCM systems. In particular, flexible job assignments are intended to provide workers with greater autonomy so they
can apply their discretionary effort in substantive shop-floor decisions that alter work related job tasks and the complex production process to meet continuously changing and unpredictable customer requirements. Employees will be more intrinsically satisfied when they are directly involved in designing their work through decentralization and have the authority and are empowered to participate in decisions that affect their behaviors, work related tasks and processes (Appelbaum et al., 2001).

Employees who participate in flexible job assignments possess the capability to effectively solve unexpected operational problems (design, fabrication, and assembly) that are critical to achieving many of the strategic goals associated with IMCM approaches. Workers must master a greater variety of more complex job tasks in order to produce highly customized products without sacrificing cost, quality, delivery, and customization performance. Participation in job enrichment and job rotation are two innovative HRM practices that broaden workers skills and abilities that enable them to apply their discretionary effort in an innovative way to gain more experience as job task responsibility and difficulty increases. These innovative HRM practices require employees to participate in cross-functional work teams that are self-directed. Participating in cross functional work teams facilitates rapid and effective changeovers between the many unique and unpredictable customized products because workers are more readily involved and experienced in making incremental process changes, given that minor modification changes in the software programs for advanced manufacturing technologies may be executed by shop floor employees.

The work requirements in IMCM approaches involve a broader scope of responsibility for decision making, problem solving, and process improvement requiring
employees to perform jobs that permit them to routinely make changes in the way they perform their jobs (Lepak and Snell, 2002). Therefore, Fabricators are more likely to loosely define jobs and structure work around individual skills by assigning a wide variety tasks to allow for job flexibility, change, and adaptation to unpredictability of customer requirements.

3.3.9 Skills Training Practices in FHPWS

In the FMCM approach, the entire work process is split into a sequence of functionally specialized operations reducing the need for broad skill base and innovation training. Training should be extensive but, focus on basic operational skills and statistical process control quality analysis so the production process continuously produces high volumes of standardized components and modules; achieving economies of scale and minimizing down time. Employees should only be concerned about informing management when product components and modules do not conform to specifications.

In addition, individual on-the-job training that is informal and unstructured should focus mainly on developing general organizational skills for jobs that are fragmented into standardized, routine and repetitive tasks that emphasizes high levels of individual and operational efficiency. Informal, unstructured, on-the-job training ensures workers follow the dictates of innovative and scientific engineering and is one fundamental reason why these work systems can lead to such dramatic improvements in productivity and efficiency. Workers should receive minimal specialized skills training and have little discretion concerning how to do their jobs suggesting that training should be provided to
make sure workers behaviors conform to organizational policies, systems and procedures. From the context of production systems competing with a low cost strategy, Youndt et al. (1996) state “Training efforts would only need to focus on general information, such as company policies and procedures, or be used as a remedial activity aimed at correcting skill deficiencies, not as a method for driving superior performance” (p.842). This suggests that to make sure workers act in accordance with organizational policies, systems and procedures; Assemblers will focus their training efforts on enforcing rules and regulations, maintaining work procedures, and ensuring conformance to predetermined work standards (Lepak and Snell, 2002).

3.3.10 Skills Training Practices in IHPWS

From a “technological upgrading” view of IMCM approaches, the utilization of advanced flexible technologies will require a more highly skilled workforce that will need high levels of extensive training (Adler, 1986, Snell and Dean, 1992). Workers in the IMCM system require an “upskilling” of technical, conceptual, analytical, problem solving and team-building skills to do their jobs successfully because common component parts and inventory buffers are reduced, exposing multiple design and operational problems. Raising the visibility of these problems forces Fabricators to expand firm specific workforce problem solving skills and capabilities to effectively deal with these problem conditions and improve the flexible production system. When employee idiosyncratic skills are used in exceptional circumstances that are firm specific,
they tend to require more comprehensive training because firms are not likely to locate these firm-specific skills in the open labor market.

“Upgrading” workforce capabilities through comprehensive skills training that is formal and ongoing represents an investment in people, and ensures that required knowledge, skills and capabilities are present to adapt to a complex flexible production system and enhances their understanding of the entire production system to facilitate fast product changes (Snell and Dean, 1992). MacDuffie and Kochan (1995) argue that firms using flexible production systems require that the workforce should possess more skill and motivation than those using traditional mass production systems. In order to make workers discretionary effort significant in IMCM approaches, Fabricators should have more formal and comprehensive developmental programs that facilitate advanced knowledge and understanding about how the organization and manufacturing system operates before starting work. This suggests that IMCM increases the firm-specific skills required of the workforce, the amount of discretion they must be given, and the influence they have on production processes because they have a greater impact on the design, fabrication, and assembly of the finished product.

Formal training practices such as cross training, classroom training, safety training, and structured on-the-job training should focus on developing a variety of specialized workforce skills and abilities that will enable employees to exert discretionary effort to participate in operational decision-making and problem solving associated with the numerous unpredictable product changes in the IMCM system. In addition, these formal developmental programs centers on enhancing different types of workers skills for multiple job assignments through which they are given the opportunity to participate in
substantive decisions regarding which jobs to work on and what problems to solve. MacDuffie and Kochan (1995) suggests that complex problem solving in flexible production systems requires high levels of competency in reading, math, reasoning and communication skills. A more skilled workforce effectively participates in reducing the time to solve shop floor and customer problems.

Extensive formal training practices facilitates developing firm-specific skills of the workforce that focus on increasing their knowledge of products and processes and relationships with suppliers and customers to create and sustain a competitive advantage. In addition, workers are expected to develop a close working relationship with customers and have the ability to apply discretionary effort to meet unpredictable customers’ needs and solve their unique product design, fabrication, and assembly problems. Formal training practices should be more frequent, extensive, structured, and involve all members of the workforce to encourage mutual trust, ensure cooperation and buy-in, and enhance team building skills to adapt to customer uncertainty and frequent product changes. “To complement training, organization might sponsor career development and mentoring programs to encourage employees to build idiosyncratic knowledge that is more valuable to the firm than to competitors” (Lepak and Snell 1999, p. 37).

3.3.11 Labor Management Communication Practices in FHPWS

In FMCM approaches, information flows in hierarchical interactions (vertical) that minimize the need for coordination and communication between management and employees and among employees themselves. Information is only provided to the
workforce about production schedule requirements and personal and production goal performance. Managers make operational decisions based on information gathered and processed from shop-floor employees. Once decisions have been made, only production related information (schedules, scrap, and rework reports, etc.) and instructions are relayed to the shop-floor workers who carry them out.

3.3.12 Labor Management Communication Practices in IHPWS

A formal communication process that emphasizes open and consistent information sharing between management and self-directed work teams about business performance and customer preferences is expected to enhance employee motivation to apply their discretionary effort in their work related activities and improve performance in IMCM systems. This production system emphasizes the decentralization of information flows through minimum layers of management and open-ended exchanges to encourage the workforce to actively participate in problem solving and substantive decision-making. Self-directed work teams with problem solving and decision-making responsibilities will need open-ended communication exchanges to share information with workers outside their own work group, managers other than their own, suppliers, customers and engineering experts. These work teams need to develop trust with other constituents and be able to communicate proposed solutions to problems they have identified. Open and consistent information sharing are the most important factors establishing a high level of trust.
Communication procedures and mechanisms that permit workers to express their view concerning work related issues facilitate open and consistent information between management and the workforce in IMCM systems. Such communication procedures that provide formal information sharing include formal grievance and/or complaint resolution procedures and suggestion programs that focus on obtaining employee input regarding design and process performance improvement issues. In addition, communication mechanisms should include formal meetings such as employee-management committees that meet on a regular basis off-line in small groups to discuss production or quality related problems (Arthur, 1992) and issues related to performance (manufacturing, organizational, and financial) and quality goals. Also mentoring relationships should be established to reduce of status barriers between management and the workforce and facilitate an open and consistent exchange of information and knowledge sharing for joint decision-making.

To encourage open and consistent communication and commitment to the organization’s long-term success, Fabricators should communicate a considerable degree of employment security, publish timely newsletters and post them on accessible communication boards. In addition, Fabricators should develop quality of life programs and conduct attitude surveys on a regular basis to identify and correct employee morale problems.
3.4 FHPWS and IHPWS Configurations in MCM Approaches

From the SHRM and mass customization integrative perspective, this dissertation presents the theoretical argument that when the previously identified holistic sets of innovative HRM practices within each conceptually unique Fundamental and Innovative HPWS are utilized as a coherent and comprehensive system, the overall result is an explicit HPWS configuration that complements and supports a specific MCM approach to maximize operational performance. This approach suggests that if one of the components of the explicit HPWS is not present, performance will not be as high and competitiveness will decline. Indeed, these human resource components and the corresponding innovative workplace practices are interdependent and strategically contingent on a firms’ mass customization orientation and their corresponding manufacturing system. The HRM system is embedded within the larger system of the firm’s mass customization strategy implementation. I have conceptualized that different HPWS configurations should be designed and implemented to manage the workforce in different MCM approaches and strategic postures to maximize performance. An empirical examination will attempt to determine (demonstrate) and scientifically illustrate that the form of HR investment varies to strategically manage different types of human capital for different forms of MCM.
Table 3.1

The HR policies and practices of a FHPWS for FMCM Approaches

**Recruitment and Selection**
- Use less rigorous and extensive recruiting and selecting techniques
  - Temporary workers
  - On-site applications and one round interviews
  - Seat of the pants hiring

**Incentive Compensation Plans**
- Based on an hourly market-based wage
- Based on the accomplishment of specific work tasks and auditing of performance
  - Detect errors and correct deviations from standard operating procedures
  - Use of formal results-based performance appraisals
- Individual incentives are used to focus on short term efficiency and productivity goals
- Result-based performance appraisal
  - Error reduction and process standardization to reduce costs and enhance efficiency

**Skills and Behavioral Training**
- Minimal on-the-job training that is informal and unstructured
- Basic skills
- Focuses on compliance with rules, regulations, policies and procedures
  - Ensure conformance to preset standards
- Seeks to increase short term individual and operational productivity and efficiency

**Job Assignment**
- Based on explicit functions of the production system and the general, but limited skills of the workforce
- Job descriptions are clearly defined and limited in scope by the organization

**Labor Management Communication**
- Hierarchical interactions – vertical communication patterns
  - Centralized decision making

**Teamwork**
- Improvement teams are formed by management
  - Quality circles, committees or tasks forces
Table 3.2

The HR policies and practices of a IHPWS for IMCM Approaches

### Recruitment and Selection
- Use more rigorous and comprehensive selection and recruitment techniques
  - Sophisticated pre-hire screening devices
  - Realistic job previews
  - Multiple rounds of structured interviewing
  - Involving existing employees in the hiring process
  - Aptitude, skills, personality, and drug testing
  - Hiring or promoting within existing operations
    - Internal promotions based on performance
  - High selection ratios per position
    - Selective staffing
  - Extensive use of different recruiting sources
    - Agencies and universities

### Incentive Compensation Plans
- Offering high wages
  - Salary
- Pay is based on a skill or knowledge based system (versus a job-based system); ie., pay is primarily determined by a person’s skill or knowledge level as opposed to the particular job that they hold
- Group-base pay and incentives
  - Extensive use of company incentive plans, profit-sharing plans, and/or gain-sharing plans
- Use of formal performance appraisals to assess individual and work group performance on a routine basis
  - Employee participation in performance appraisal and goal setting
- Use of formal performance appraisals to develop individuals
  - Provide feedback, coaching and identify training needs
- Use of formal performance appraisals to determine workforce compensation
  - Contingent on business and plant performance
  - Contingent on skills acquired and knowledge gained
- Use of formal performance appraisals to assess individual and work group performance on a routine basis from more than one source
- Internal promotions
  - Promotion decision rules
    - Merit or performance rating alone
    - Seniority only if merit is equal
    - Seniority among employees who meet a minimum merit requirement
Skills and Behavioral Training

- Formal classroom training to develop and enhance a wide range of specialized and advanced skills, knowledge, and capabilities
  - Firm-specific skills
  - Variety of jobs or skills to routinely perform more than one job task
    - Cross-training
- Safety training
- Role change training
- Group production and quality problem solving
  - People skills training - communication
- Coaching and mentoring
- Formal seminars, educational programs
- More frequent, structured, extensive, and comprehensive on-the-job training

Job Assignment

- Flexible
- Design own work roles and how jobs tasks are performed
- Job enrichment
- Job rotation
  - Within and across work teams and across departments
- Broad job classification
  - Number of job classifications

Labor Management Communication

- Open and consistent information sharing between management and self-directed work teams
  - Lateral communication patterns
  - Labor-management teams and committees
    - Meet off-line to discuss issues of concern, including issues related to performance and quality goals
      - Provide operating performance information
      - Provide financial performance information
      - Provide information on strategic plans
  - Newsletters
  - Extensive use of quality of work life programs
  - Extensive use of attitude surveys on a regular basis
    - To identify and correct employee morale problems
  - Extensive use of a formal grievance and/or complaint resolution system
  - Intensive provision of job security
  - Reduction of status barriers between management and the workforce
- Extensive use of formal employee participation programs to elicit employee input
  - Production process and quality improvement related

Teamwork

- Autonomous work teams
  - Self-managed and self-directed teams
    - Decentralized decision making
CHAPTER FOUR: RESEARCH HYPOTHESES

The basic premise underlying the FHPWS and IHPS configurations is based on the notions that the theoretically identified HRM practices for each of the six broad HR policies must be interrelated, mutually supportive, and congruently configured into a coherent holistic system to strategically support and fit a particular mass customization manufacturing system. The conceptualization of the FHPWS and IHPS is consistent with the resource-based view of SHRM configurational and contingency approaches, suggesting that the combined pattern of HRM practices must possess a high degree of internal consistency to facilitate an organization's attempt of achieving its strategic business goals (Wright and McMahan, 1992). Configurational arguments in the SHRM discipline attempt to organize a priori individual HRM practices into ideal archetypes of personnel management or employment systems to predict superior performance (Delery and Doty, 1996). Contingency arguments in the SHRM discipline require these archetypes to support, fit, and be consistent with the demands of an organization’s strategic posture. This dissertation theoretically develops a priori the two HPWS typologies illustrated in Tables 3.1 and 3.2 that are suggested to possess internal consistency and maximize operational performance for each mass customization firm.

The two ideal work system archetypes advocated in this discussion illustrate the complexity associated with HPWS configurations required to support each MCM system.
The conceptual model of these two archetypes represents the theoretical ideal configurations of HRM practices to predict superior performance within each MCM approach. These two theoretically ideal HPWS configurations symbolize commonly occurring coherent patterns of HRM practices that can be systematically observed under a rigorous empirical examination. It is expected that mass customization firms that adhere to the appropriate HPWS archetype will perform better than those who fail to do so.

4.1 Hypothesis Foundation

As noted by previous literature (Lawler, 1992; Pfeffer, 1994; MacDuffie, 1995; Appelbaum et al., 2000), competitively intense manufacturing organizations are more likely to implement innovative high performance work system practices when employees are considered crucial to business success and competitiveness. Employees are more essential in these types of organizations because such firms are employee-centered by design (Lawler, 1992); sharing business information with employees at all levels and providing them the power, incentive, and greater responsibility and opportunity to make operations decisions (Pfeffer, 1994). However, it is the intent of this research inquiry to highlight the plausibility that high involvement and participation in managerial-level decision making, coupled with extensive responsibility for shop floor employees may not be critical determinants of success in all MCM systems and strategic environments. In particular, IMCM producers may adopt holistic systems of HRM practices very differently from those adopted by FMCM producers which suggest the need for an exploratory empirical examination.
To illustrate, in the IMCM approach, firms become much more reliant upon employees and their tacit or specialized knowledge to produce highly customized products and solve unexpected complex operational problems. Members of the workforce are most familiar with the intricacies associated within all four stages of the production cycle and the manufacturing processes that produce unique component designs and assemble complex product configurations to meet unpredictable customer expectations.

To facilitate this approach, Fabricators should implement a complementary holistic set of innovative HRM practices that recruits, selects, develops, retains, and supports a workforce that is self-directed and self-managed with a high level of multi-skills and capabilities to perform various work tasks on a rotational job assignment. This contrasts sharply with a FMCM system where firms should implement a control or restricted oriented approach that stresses work procedure compliance to maintain job fragmentation with task standardization and routinization. By ensuring compliance, individual workers produce high volumes of relatively standardized components to achieve economies of scale and assemble basic firm designed modules into customer identified end-item configurations. Furthermore, each mass customization strategic type should utilize systematic recruitment practices, with emphasis on selecting employees with desirable characteristics for each distinct MCM approach. For example, in the IMCM system, the set of HRM practices aimed at ensuring that the organization attracts and retains people with the right motivation to work under such a system include job security guarantees, attitude surveys with feedback to employees, a high priority given to internal recruitment, and the use of systematic selection methods.
Appelbaum et al. (2000) note that participation in substantive decisions, high levels of workforce skills, and incentive systems are the key elements in which an HPWS differs from traditional work organization. However, what decisions workers make and the type of skills and incentive they need may be different in each MCM system. In the IMCM system, workers have more responsibility and greater levels of skills than FMCM workers, but both have some degree of skill and responsibility; IMCM workers have more because of the high degree of customer involvement and unpredictable product customization in the design and fabrication stages of the production cycle (Duray, 1997). Also, in the IMCM approach, jobs are designed so they are more demanding and involved with increased responsibility to enhance the intrinsic motivation and creative output of the workforce. From this perspective, the IHPWS is unlikely to work unless employees have considerable variation in the tasks they perform and control over how and when they do them. In addition, Appelbaum et al. (2000) argue that work organization practices in an HPWS require front-line workers to gather information, process it, and act on it. I conceptually argue that this is only required in the IHPWS to support a IMCM approach because shop floor employees in the FMCM system should only gather information; management will then process it and effectively direct the workforce on how to execute detailed instructions.

Gephart (1995) argues that in order to be successful, HPWS structures should focus on self-managing teams, quality circles, flatter organizational structures, new flexible technologies, innovative compensation schemes, increased training, and continuous improvement. However, I have presented a strong argument that not all of these work system policies, personnel management practices, and organizational
characteristics are required for FMCM approaches to be successful. The holistic set of HRM practices within the FHPWS permits Assemblers to simultaneously achieve low cost, speed, high quality and flexibility while maintaining discipline in the development of new task standards and in the execution of work activities. In this way, Assemblers learn to cope with the many different, but simple customer specified product configurations. As these actions are embedded into the manufacturing system, the ability of the workforce to do work becomes routine, formal, and standard, even if the specific task procedures and methods vary from one product to the next.

Tu, Vonderembse, and Ragu-Nathan (2001) found that firms with high levels of time-based manufacturing practices have high levels of mass customization capabilities. Interestingly, Rondeau, Vonderembse, and Ragu-Nathan (2000) found that firms with high levels of time-based manufacturing practices tend to have high levels of work system practices characterized by standardization, formalization, and integration. Consequently, it is plausible to conceptualize from the combination of these two studies that an indirect link exists between mass customization capabilities and work system practices characterized by standardization, formalization, and integration. From this indirect linkage perspective, it can be inferred and conceptually argued that manufacturing firms with high levels of mass customization capabilities may have high levels of standardization, formalization, and integration work system practices. However, given that the study of Rondeau, Vonderembse, and Ragu-Nathan (2000) generalizes mass customization capability to include an all-purpose form of mass customization manufacturing and fails to specify under which MCM system the identified work system practices may prevail as advocated by Duray (1997); it is currently argued that these three
work system practices may only be present in the FMCM system. Duray (1997) suggests that mass customization capabilities have evolved from time-based competition initiatives and further provides the foundation to facilitate different types of mass customization. The previous discussion implies that this notion should be empirically investigated and can be potentially supported.

Nevertheless, the previous discussion has illustrated that a comprehensive HPWS can have a positive impact on maximizing performance and competitiveness even when jobs remain highly fragmented and require lower worker skills as in the FMCM systems. Much Japanese management techniques falls in to this category; for example, job rotation and quality circles are often implemented into standardizd assembly line situations were compliance to work procedures are strictly enforced. Therefore, since HPWS effectiveness is a function of internal consistency from a configurational perspective and external congruence from the contingency perspective, both Assemblers and Fabricators firms can implement coherent systems of HRM practices that ensure employees with the required attributes are hired and encouraged to behave and perform in ways consistent with the manufacturing system objectives. Since recruiting and selection, training, job assignment, team work, communication, and incentive compensation practices are argued to function in combination with one another, empirical research that demonstrates a HPWS as a theoretical construct is needed to examine the net performance effect of a coherent internally consistent set of mutually reinforcing HRM practices that are interrelated, rather than simply examining work system practices separately that are used independently (Wright and McMahan, 1992; Snell and Yount, 1995). HRM practices are considered mutually reinforcing and interrelated when using them in a systematic manner.
forms a coherent internally consistent set that result in greater performance than the sum of the performance resulting from using each practice in isolation (Pil and MacDuffie, 1996). Wright et al. (1999) provides additional support noting “The effectiveness of any individual HR practices depends upon its pairing with some other HR or management practice. However, little theoretical guidance or empirical evidence exists for exactly what pairings result in maximum effectiveness” (p. 552). Thus, the purpose of this analysis is to address these configurational and contingency issues by focusing on HPWS used for employees in different MCM environments. It is anticipated that the systematic form of HR investment varies for different workforce skills and behaviors and that these are important determinants of performance in different manufacturing systems of mass customization strategic approaches.

4.1.1 Integrating a FHPWS with a FMCM Approach

The work in FMCM systems is suggested to be narrow, boring, un-involving and de-motivating. As a result, the FHPWS is characterized by less rigorous and extensive recruiting and selecting techniques, proving informal and unstructured training, and assigning jobs based on the explicit functions of the production system that are clearly defined and limited in scope. Employees who work within this personnel management system are not permitted to make administrative decisions regarding the production system and work in off-line improvement teams that are formed by management to solve simple quality problems. They are compensated based on an hourly wage and rewarded based on formal individual results-based performance appraisals that focus on short-term
efficiency and productivity goals. According to the FHPWS perspective, in order to be effective, the performance impact of the HRM practices lies in the architecture of the comprehensive system, not in utilizing any one practice in isolation or independently (Becker and Gerhart, 1996). The HRM practices of the FHPWS are not mutually exclusive, but rather are interrelated and used in concert to maximize performance and enhance competitiveness. Use of these FHPWS practices is consistent with similar work on HR configurations for high performance work systems (Yount, et al., 1996).

The FHPWS is similar to the administrative HR system identified by Yount et al. (1996) that focuses on managing the workforce to maintain internal operational effectiveness. An administrative HR system is characterized by selection for manual skills, policies and procedures training, results-based performance appraisal, hourly pay, and individual incentives. Yount et al. (1996) argue that an administrative HR system has a positive relationship with the requirements of a low cost manufacturing strategy that focuses on standardizing processes, reducing errors, and maximizing production efficiency. The authors found significant empirical support to conclude that a cost manufacturing strategy positively moderated the relationship between an administrative HR system and equipment efficiency and employee productivity. The authors state, “These finding suggest that administrative HR systems are still very appropriate in strategic context that emphasize reducing costs and eliminating uncontrollable behavior.” (p. 859) These results support the notion that a FPHWS will be appropriate in a FMCM approaches to maximize operational performance.
4.1.2 Integrating an IHPWS with a IMCM Approach

A FMCM approach is highly dynamic with increasing complexity and rapid market changes that directly impacts the workforce. This type of mass customizer requires increased manufacturing flexibility and an adaptive work system to be competitive which is dependent on human skills, experience and knowledge and the ability to learn and to act under uncertainty. Workers within this manufacturing system must have the opportunity to participate in substantive decisions in all four stages of production cycle to be effective. These mass customization firms want workers to apply their creativity and imagination to their work tasks and to exploit, in the interest of the customer, their intimate and often unconscious knowledge of the design, production and assembly processes.

An IHPWS underscore flexible job designs and rotational work arrangements, self-managing teams or work groups, greater information sharing and employee involvement in managerial-level decision making, and cooperative labor-management relations to foster a participatory work environment. In the IMCM approach, the IHPWS focuses on recruiting, selecting, and developing a highly skilled, highly flexible, and highly motivated workforce that promotes creativity, innovation and initiatives among shop floor employees. In addition, the IHPWS promises workers challenging, satisfying, and more secure jobs, higher wages, and greater opportunity for control, autonomy, responsibility, involvement and participation. Such IHPWS characteristics increases the imagination and commitment of the workforce which permits a variety of views to be proposed and in many instances contributes to a better coordination of workers efforts to
satisfy unique customer demands for highly customized products in all four stages of the production cycle.

To facilitate success and competitiveness within the IHPWS, these types of MCM implement fewer levels of management and introduce new roles for managers. Managers become coaches, facilitators and integrators because they are required to share responsibility for decision-making and performance results with shop floor employees. When employees are given more responsibility (or opportunity to participate in decision making) they feel empowered which leads them to identify and suggest changes in the workplace (modifying processes) that could lead to improved performance and competitiveness. It is imperative that the IHPWS foster innovations that enhance the quality of products and the delivery service. Such an environment stimulates creativity and promotes constructive employee contributions to innovative improvements in all four stages of the production cycle. In addition, this environment strengthens team spirit and generates a healthy loyalty to the company.

In IMCM, shop floor employees are not confined to an intensive and meaningless work reality; they are encouraged to learn and develop new skills, to use their intelligence and creativity, to collaborate and actively participate in the design, fabrication, and assembly of highly customized products. In the IHPWS, the vanishing organizational boundaries enable the versatile use of an individual’s skills and give the employee a comprehensive view of the whole production cycle. The holistic set of HRM practices used to guarantee that the workforce has the motivation, knowledge and competencies to do multiple job tasks successfully include selective recruitment, training in team working and inter-personal skills, team briefing, appraisal and business information sharing.
Some of the duties of members within self-managed teams include making job assignments to determining bonuses. However, without the horizontal synergy and fit of the holistic system of HR practices, self-managed teams may be less effective than traditional work structures. For instance, the effectiveness of the self-managed work team requires that employees have access to company information. In IMCM approaches, self-managed work teams require access to customer order information because of the unlimited combinations of product configurations demanded. The communication practices of the organization will determine the quality and quantity of data provided to shop floor employees. Individual based pay systems are potentially disruptive of team working, but if well designed, can focus employees on key performance criteria. This would be most appropriate for the FMCM system. On the other hand, systems that are linked to organizational or team performance may be more appropriate in the IMCM system. Also, practices such as profit sharing and employee share ownership may be the most appropriate. However, basing pay on the acquisition of skills (Knowledge based pay) may be used in both manufacturing systems.

The use of IHPWS practices is consistent with similar work on HR configurations for high performance work systems (Yount et al., 1996; Arthur, 1994). The IHPWS is similar to the human-capital-enhancing HR system that requires the upskilling of employees in Yount et al. (1996). A human-capital-enhancing HR system that is characterized by selective staffing, selection for technical and problem solving skills, developmental and behavior-based performance appraisal, group incentives and salaried compensation is suggested to have a positive relationship with the requirements of quality and flexibility manufacturing strategies that focuses on skill acquisition and development.
The authors found significant empirical results that provide strong evidence to conclude that a quality manufacturing strategy positively moderated the relationship between a human-capital-enhancing HR system and equipment efficiency, employee productivity, and customer alignment. However, there was no empirical support for the interaction between a flexibility manufacturing strategy and a human-capital-enhancing HR system to enhance operational performance.

In addition, analogous to the AHPWS is Arthur’s (1994) identification of a “commitment maximizing” workplace industrial relations system that is characterized by high levels of employee involvement in managerial decisions, formal participation programs, training in group problem solving, broadly defined jobs, self-managing teams, and relatively higher wages. The author found significant empirical support to conclude that a commitment maximizing HR system, as apposed to a “control” system emphasizing efficiency and reduction of labor costs, was associated with lower scrap rates, higher labor efficiency and lower employee turnover across 30 U.S. steel mini-mills.

The discussion of a “human-capital-enhancing HR system” and “commitment-maximizing workplace industrial relations system” resonates strongly with the IHPWS that is predicted to maximize operational performance IMCM systems.

4.2 Formulation of Research Hypotheses

As the previous discussion suggests, an organization must adopt the one ideal archetype of a configurational work system that is most consistent with their MCM
approach and strategic posture. In other words, both types of mass customization organizations must maximize both horizontal and vertical fit to be more competitive and successful. This interpretation implies that the effectiveness of an organization’s holistic system of interrelated HRM practices is contingent on the MCM system. I argue that a given work system will maximize operational performance only when it is used in association with the appropriate MCM approach. Therefore, the closer the organization’s work system is to the one discrete ideal theoretical work system that is congruent with the organization’s MCM, the more effective and competitive the organization will be. Thus, consistency within the HPWS (internal fit) and congruence between the appropriate HPWS and the MCM approach (external fit) are necessary to maximize operational performance. Based on the need from a SHRM perspective to develop configurational approaches at a work group level, Meyer, Tsui, and Hinings (1993) argue “If organizations differ in their social and technical configurations, it is reasonable to expect more than one form of socio-technical system to be viable at the work group level. But to date, authors writing in this area have implicitly assumed that there exists but one optimal socio-technical design” (p. 1190).

Gephart and Van Buren (1996) make the assertion that “HPWSs typically reward people for working toward the goals of the entire company. There are many ways to link individual rewards to overall performance, including gain sharing, profit sharing and employee stock option plans. Some of these reward systems may be more effective performance tools than others in particular companies” (p. 22-23). Although the authors do not explicitly link the administration of rewards to any contingent variable, the statement is an example of the contingency perspective in that the specific reward system
practices may be contingent on the particular social and technical characteristics of each mass customization manufacturing system. For example, in a FMCM system, a reward system based on efficiency may substitute for intrinsically interesting work in motivating employees. Thus, the specific reward practices need to complement and support all other HRM practices within the five other broad HR policies. When this is accomplished, the complete holistic set of HRM practices is considered to be horizontally aligned and provides internal fit among one another. When this entire holistic set of HRM practices matches and supports the appropriate MCM approach, the intact holistic set of HRM practices are considered to be vertically aligned and provides strategic fit between the work system and the manufacturing system. Horizontal misalignment occurs when specific HRM practices within a particular HR policy or component interfere with or inhibits other HRM practices and policies. For example, an organization with a IMCM system implements self-managed work teams, but continues to reward individual performance instead of team performance. Also, misalignment would occur when team members are not involved in the recruiting and selection process. This dissertation study is fueled by the conviction that although the possible combinations of work system attributes may be infinite, only a finite number of coherent and horizontally aligned holistic configurations are prevalent in each mass customization strategic environment.

The greater use of a holistic system of innovative practices has been argued to have a positive affect on performance and competitiveness. Results of past studies have supported this notion; however, there is an increasingly number of studies that oppose this assertion. One possible explanation is that the particular HR practices implemented as a system do not support the manufacturing system requirements. I argue that the use of
a holistic system of HR practices facilitates enhanced performance and competitiveness; however, it is not only the intensity usage of the practices, but which particular practices is part of the coherent holistic system. In other words, the use of a consistent holistic system of HR practices must be extensive in addition to supporting the technical characteristics and social requirements embedded within a firm’s MCM system.

Therefore, based on the previous theoretical argument and the conceptualization, this study empirically examines the general proposition that, as firms make greater use of FMCM approaches, the use of IHPWS practices becomes increasingly detrimental to performance. In contrast, as firms make greater use of IMCM approaches, the use of control oriented HR systems becomes increasingly detrimental to performance. Thus, as IMCM approaches are supported by IHPWS configurations and FMCM approaches are supported by FHPWS configurations, it is posited that operation performance within both types of mass customization organizations should be maximized.

By conceptually weaving together scientific knowledge and practical experience, this dissertation proposes the following hypothesis for an empirical investigation and analysis based on the integration of Figure 2.3 in Chapter 2, Tables 3.1 and 3.2 in Chapter 3:

Hypothesis 1: Internally consistent sets of HRM practices are uniquely bundled into two distinct HPWS; namely FHPWS and IHPWS.

Hypothesis 2a: FMCM systems have a moderating effect on the relationship between FHPWS and operational performance. Establishments which utilize FHPWS must also implement FMCM systems in order to maximize operational performance.
Hypothesis 2b: IMCM systems have a moderating effect on the relationship between IHPWS and operational performance. Establishments which utilize IHPWS must also implement IMCM systems in order to maximize operational performance.
5.1 Measurement Instrument Development: Item Generation and Pilot Study

Primarily, this research does not directly develop the instruments to measure HPWS, mass customization, and operational performance. The mass customization and operational performance constructs have had items created to develop reliable and valid instruments to measure them effectively in previous studies. The HPWS construct is an index rather than a scale and does not require to be empirically tested for reliability (Wright and Boswell, 2002). Devillis (1991) highlights the differences between an index and a scale and Delery (1998) makes an important distinction between the use of a scale and an index when measuring HPWS. In Macky and Boxall’s (2007) empirical investigation of HPWS, the authors state that, “A HPWS index requires no assumption of an underlying causal relationship between items. Items would not necessarily need to be highly correlated and the use of internal reliability statistics, such as Cronbach’s coefficient alpha, would not be appropriate for an index”.

However, the HPWS instrument will be evaluated based on a limited pretest within a 3 phase developmental process to assess the content validity of the index. Instruments to measure mass customization and operational performance were adopted
from previous studies with slight modifications. Section 5.2 below discusses these instruments in more detail and the rational for excluding them in the pilot study.

The HPWS measurement instrument is developed by creating an additive index by summing the number of HRM practices a particular establishment indicates they utilize at their facility. Since an index is conceptually different from a scale (Devillis, 1991), it was determined that the HPWS indexes did not require to be empirically tested for reliability and validity; however, it will be assessed for content validity to ensure that the 2 separate indexes measures what they are supposed to measure. Content validity is a qualitative measure of validity and is not quantified with statistical methods.

Content validly is concerned with how well the content domain describes the construct and is demonstrated when the measurement items contained in an instrument are a reasonable way to gain the information the investigator is attempting to obtain. Content validity is enhanced if steps are taken to ensure the design of the measurement instrument and is assessed by subject matter experts. To ensure that the correct HRM practices were being measured to logically represent all the facets of the HPWS construct, the HPWS indexes were developed and evaluated for content validity through a 3 phase process according to Churchill (1979): (1) Item generation, (2) pre-pilot study, and (3) pilot study. Also, this process was implemented to evaluate the length of the survey to ensure a reasonable response rate.

Rigorously following these steps will improve the degree to which the operationalization of the HPWS index is correctly translated. First, an extensive and comprehensive review of the literature will be conducted to identify the content domain of the HPWS index. Initial items of each HRM practices and the conceptual definition of
each HPWS index will be generated from a broad literature review. The pre-pilot study involved detailed discussions with one practitioner expert and one academic expert to further refine the definitions and contents of the measurement items for each index. The third phase was a pilot study targeted at plant managers whose establishment were a member of a regional manufacturing trade association. The HPWS index instrument was then further refined based on the pilot study results for use in the large scale study.

5.1.1 Item generation: HPWS Index

Accurate generation of measurement items of an index ensures construct validity and further assists in determining the effectiveness of an empirical analysis. The fundamental requirements of a good index measure is content validity, which means the measurement items contained in an instrument adequately represent the major content domain of the underlying construct (Churchill, 1979). Content validity is realized through a comprehensive literature review and detailed discussions with subject matter experts in the academia and managerial domains. A list of initial items for each index was generated based on an extensive review of the relevant literature. The pools of items were organized into categories to measure a particular dimension of the index domain. The general literature origin for items in each index is briefly discussed below.

Collectively, all the items used to create the HPWS index for this study have been adopted from previous studies in the broad general organizational behavior literature. In particular, the majority of these measurement items have been implemented in the strategic human resource management and HPWS literature. In some instance, selected
items were generated and developed mainly from the personnel management and mass customization literature. Also, when necessary, a few items were modified based on the labor relations literature. Finally, a review of the universal management literature provided a conceptual foundation to increase or decrease the number of items in the instrument to measure the HPWS indexes.

5.1.2 Pre-pilot Study

To ensure content validity of an index, the measurement items generated from the literature review were pre-tested with one manufacturing manager in a mass customization focused industry and one professor at a large state university. Both individuals have demonstrated to be subject matter experts in the context of mass customization and HPWS. The focus was to confirm the relevance of the index definition, check the clarity of wording of sample items, and determine the effective length of the questionnaire.

The practitioner and professor were presented with a definition of each research index and some open-ended questions were asked about what they think should be representative questions for the index. They were asked to check the consistency of each item with the definition and the content of the corresponding index. Also, they were asked to provide feedback on the accuracy of wording, representativeness, clarity, specificity, ease of understanding and interpretation of the questions. The respondents were encourage to suggest if any item should be kept, modified, or deleted from the survey. In addition, the two subject matter experts were requested to provide input on the
length of the questionnaire. Based on their feedback, redundant and confusing items were modified or discarded, and definitions were revised to ensure the domain of the index is covered and thus strengthen content validity. New items were added whenever deemed necessary. The pre-pilot was repeated several times to refine the instrument for clarity, brevity, and length.

5.1.3 Pilot Study

Conducting a small-scale pilot analysis before administering the large-scale study provides valuable preliminary information about the content validity and effectiveness of the measurement instrument. Furthermore, it offers a final opportunity to refine the index to ensure content validity. To assess the content validity of the HPWS indexes, data for the pilot study was collected via a web-based questionnaire posted on Survey Monkey. Emails were sent to the plant managers of 200 manufacturing establishments who are members of the Pittsburgh Technology Council’s (PTC) Advanced Manufacturing Network. The PTC provides legislative, hiring and networking support to improve performance and growth of Southwestern Pennsylvania manufacturers. The PTC supports local manufacturers through the Advanced Manufacturing Network (AMN).

An interview was conducted with the director of the AMN to determine if the manufacturing establishments would be a good representative sample for the pilot study. A detailed description of the study’s purpose and construct definitions was provided to the AMN director to determine if the manufacturing establishments and corresponding plant managers were appropriate to evaluate the HPWS measurement instrument for
content validity. After answering several of the director’s questions it was concluded that the manufacturing establishments would be more than capable to assess the instrument for content validity.

The director emailed all of the 200 plants managers to inform them that a survey will be emailed to them in the near future and asked them to complete the questionnaire when they received it. Also, a message was provided that explained the purpose of the survey and to ensure the managers that their responses were completely anonymous. I provided the director with the web-link to the pilot study questionnaire posted on Survey Monkey. The director forwarded the survey link to all 200 plant managers. Of the 200 plant managers that received the invitation, only 13 began the survey, however, only 10 completed the survey and provide feedback for a response rate of 5%. A copy of the pilot study questionnaire is provided in appendix A.

The respondents were instructed to complete the questionnaire and provide feedback information regarding the length and difficulty of the survey. Also, they were asked to indicate if they did not understand any question items and provide information to improve the wording, structuring, or definitions of the survey. In general, the common theme of the information provided by these respondents was that the survey appeared to be designed for large organizations and not all selections are appropriate.

Based on the results and information provided by the 10 respondents, 18 questions were eliminated and 3 were modified. The decision to remove 18 questions from the survey was supported by an additional review of the literature to ensure that all important facet of the HPWS index measure was being capture in the instrument. The primary reason that several questions were eliminated was because the respondents
indicated that it took them approximately 25 minutes to complete the survey. Based on this information, it was determined that such a lengthy survey would significantly reduce the response rate of the large-scale study. Multiple measures for the HPWS indexes, as used in other studies would have been favorable. However, the benefits from increasing the question pool were determined to be less than those received from a higher response rate. A revised copy of the questionnaire that was used in the large-scale study is provided in appendix B.

5.2 Instruments Not Pilot Tested

Primarily, there are two instruments adopted for use in this study that were not pilot tested. This included the instrument developed by Duray (1997) that was designed to measure mass customization. Since this instrument has been tested in previous studies (Duray, 1997; Duray et al., 2000) and was found to be valid and reliable using exploratory and confirmatory factor analysis, it was decided that it would not be necessary to evaluate and test it again in the pilot study. Instead, it will be reassessed for reliability and validity in the large scale analysis. Also, there was one additional instrument that was a created for this study by combining five existing instruments into one aggregate scale to measure operational performance. This aggregate instrument was created by the separate performance instruments developed by Ahmad and Schroeder (2003), Kintana et al. (2006), Yount et al. (1996), Duray (1997), Tu, Vonderembse, & Ragu-Nathan (2001), and Liu et al. (2006).
The most predominant approach in the literature is to use cost, quality, delivery, and flexibility as the four basic dimensions of operational performance. The instrument to measure mass customization operational performance was based on the combination of several items adopted from multiple previous studies in the operations management domain and mass customization literature that measures operational cost (Ahmad and Schroeder, 2003; Kintana et al., 2006; Yount et al., 1996), quality (Kintana et al., 2006; Yount et al., 1996), delivery (Rondeau, Vonderembse, and Ragu-Nathan, 2000; Tu, Vonderembse, & Ragu-Nathan, 2001), and flexibility performance (Ahmad and Schroeder, 2003; Tu, Vonderembse, & Ragu-Nathan, 2001; Liu et al., 2006). Mass customization is a multi-dimensional construct that consists of the simultaneous combination of cost, quality, delivery, and flexibility attributes to reflect the performance outcome of providing a wide- variety of low-cost customized products with very high quality in a fast, on-time and reliable time frame. Thus, the operational performance instrument was created by summing the scores of all items in the cost, quality, delivery and flexibility scales to create an aggregated super-scale. Also, to strengthen this instrument, one item was added to the cost dimension to capture the costs associated with carrying excess inventory and one item was added to the flexibility dimension to measure the establishments ability to quickly change-over resources to produce a variety of products. In addition, one item was added to the quality dimension to assess the customer’s perception of overall quality of the establishment’s products. A review of the principle operational performance literature (Hayes and Wheelwright, 1984) suggests that these elements of mass customization performance should be included in the instrument. Since the individual dimensions of these cost, quality, delivery, and flexibility scales
have been tested in previous studies (Rondeau, Vonderembse, & Ragu-Nathan, 2000; Tu, Vonderembse, & Ragu-Nathan, 2001; Liu et al., 2006; Ahmad and Schroeder, 2003; Kintana et al., 2006; Yount et al., 1996) and found to be valid and reliable, it was decided that it would not be necessary to evaluate and test the mass customization operational performance instrument in the pilot study. Instead, it will be reassessed for reliability and validity in the large scale analysis.

5.3 Research Design and Data Collection Procedure: Target Population, Unit of Analysis, and Participants

The target population for this dissertation was based on three criteria: (1) the unit of analysis, (2) organization type, and (3) organization size. The types of organizations used in this study were discrete manufacturing companies that are classified under the Manufacturing Division of the United States Department of Labor (USDL). The Occupational Safety & Health Administration identifies the industries these organizations compete in with a Major Group SIC Code from 20 to 39. In addition, this dissertation includes a combination of small, medium, and large sized manufacturing establishments.

Past survey based empirical studies within the United States focusing on mass customization and HPWS have selectively sampled manufacturing industries and organizations from the 20 major groups within the Manufacturing Division, but none have included all SIC codes in their analyses (Duray, 2000; Tu, Vonderembse, & Ragu-Nathan, 2004; Applebaum, et. al., 2001; Tu, Vonderembse, & Ragu-Nathan, 2001; Arthur, 1992, Yount, et. al., 1996). Also, many of these studies have only focused on
analyzing manufacturing organization of one particular size; small or large (Way, 2002).
One constraint to these previous studies has been the limited generalizability of the research findings to all US manufacturers of varying sizes. This dissertation attempts to improve on the limitations of the past mass customization and HPWS research by including a wider sample range of organizations from all 20 SIC manufacturing industries within the Manufacturing Division Structure consisting of small to large sized organizations. All 20 manufacturing SIC codes were chosen as they have been shown to practice some form of mass customization and/or implement some type of high performance work practices. In addition, it has been demonstrated that all the US manufacturing industries are now operating in complex fast paced competitive environments that require a radical approach to producing products and managing the workforce. Thus, all the manufacturing industries in the Manufacturing Division were chosen as they predominantly represent the focus of this dissertation.

The unit of analysis of this dissertation is on the customized product lines of a single manufacturing establishment. The analysis at this level is consisted with Duray’s (2000) study on mass customization and Arthur’s (1992) analysis of HPWS. In addition, it is at this level that HRM practices are actually implemented to manage the workforce. Many researchers in the HPWS domain emphasis the need to collect and analyze data at the product line and shop-floor level (Wright et al., 1998). Also, measuring operational performance is best captured at the establishment level where the customized products are produced and the workforce operates as opposed to collecting financial outcome data at the organizational level where a firm may have several manufacturing facilities utilizing different managerial practices.
Representative respondents and response rate are the two main factors that influence the quality of an empirical analysis. Since this dissertation has an establishment level focus with the customized product line as the unit of analysis, the target respondents who are the most qualified are those individuals who possess the best detailed knowledge of the mass customization manufacturing approach, the techniques and practices utilized to manage the shop-floor workers that produce mass customized products, and the corresponding overall operational performance of the plant. Thus, the primary respondents identified for this study were plant / operations / production managers, vice presidents of manufacturing/operations, and supervisors of a single manufacturing facility. In some cases, where small manufacturing organizations (less than 100 employees) do not have a vice president, plant or operations manager, then the best representative that qualifies to provide the answers to the survey questions would be the President of the manufacturing establishment. It is reasonable to expect that the President of a manufacturing facility of less than 100 employees will know how the products are being produced, how the workforce is managed, and the cost, quality, delivery and flexibility ability of the plant.

Empirical data was collected using a large scale web-based survey posted on SurveyMonkey.com. A database consisting of 6086 potential respondents based on the criteria mentioned above was purchased from List Orbit on the Internet. List Orbit is an online marketing services provider with a database compiled from the top companies across the US with the complete contact information manufacturing professionals. The list comes with the company name, contact name, job title, address, phone number, email address, SIC code, and fax number. The Manufacturing Division SIC codes, individual
facilities or plants, establishment size, and target respondents were the four criteria used to purchase the email list.

An extensive investigation of these types of organizations resulted in the identification of over 20 different online marketing services providers. Since we can rationally assumed that many of these email list providers will provide to some degree the same manufacturing organizations, it is also realized that many of these lists contain establishments not cross reference between them. For example, Thatte (2008) purchased email lists from 3 different sources and only identified 316 organizations out of 8242 that were duplicates. Based on these facts, I can conclude that purchasing a list of 6086 emails from one online marketing services provider is representative of a random sample of all manufacturing establishments in the Manufacturing Division of the SIC system.

An inspection of the email list from List Orbit indicated that 3332 (55%) of the organizations had less than 100 employees. To ensure a more balanced representative sample from the purchased email list that included large, medium, and small establishments; 2542 establishments with less than 70 employees were removed from the list and not included in the large scale study. This modification provided a more even distribution of establishments based on employee size and will enable the results of the study to be more generalizable across the target sample. The resulting population consisted of 3544 manufacturing establishments with greater than 70 employees and SIC codes ranging from 20-39.

To ensure the quality of the analysis, the web-based survey method was conducted in 3 waves. First, an invitation email message was sent to all 3544 email addresses asking the individual if they would like to participate in the manufacturing
management study from the University of Toledo. The content of the message described the purpose of the study, how it would be administered, and assured the individual that their answers are anonymous. The respondents were not required to provide neither their name nor their company’s name. Also, they were assured that their computer’s IP address would NOT be identified and stored, so there is no way to identify them or their organization. Finally, they have the option to receive a FREE copy of the study results by providing either an email or postal address. See appendix C for the original message sent.

Fifty emails were sent at a time as a block in the mail merge Microsoft Office software. After approximately 20 blocks of 50 emails were sent during the first wave in, it was discovered that several messages were not being received by the intended respondent because most organizations installed anti-spam blocking software to prevent mass emailing from a single IP address. To overcome this limitation, each of the 3544 email messages were sent separately to all potential respondents and not as a block mail-merge software program to guarantee that the email addresses were valid. Based on the first invitation stage, 38 individuals indicated that they did not wish to participate in the study and asked to be removed from the list. Also, there were several emails that were undeliverable for various reasons. The undelivered emails and those opting out of the survey were not counted in the final sample size. In total, 2244 had been removed from the email list resulting in 1262 useable email addresses for the large scale survey.

The second wave web-based survey consisted of sending emails separately to the 1262 addresses that were identified as valid. The subject heading in the email indicated that the content of the message was for the University of Toledo’s Manufacturing Management Study. The content of the email contained a brief description of the study’s
intentions and again emphasized that the respondents answers will be completely anonymous. Also, a link was provided for the respondent to click on that redirected their browser window to Survey Monkey so they could complete the survey. A copy of the email message is provided in the appendix D.

After the second wave of emails were sent, a total of 68 individuals participated in the survey and only 59 completed it for a response rate of 4.6%. An examination of the required sample size for the study’s regression analysis indicates that 59 data points would not yield statistical significant results. To increase the sample size and response rate, a third round of emails were sent out following the same procedure as the previous phase expect that the content of the email message was change to reflect a reference for the importance of collecting the necessary data to complete my dissertation. A copy of the revised email message is provided in the appendix E. An additional 105 individuals participated in the survey of which only 89 completed the questionnaire.

After three rounds of emails, a grand total of 173 individuals participated in the study with 25 respondents exiting the survey before completion resulting in an attrition rate of 14.5%. Therefore, the final number of completed and useable responses was 148. This represents a response rate of 11.7% and provides an adequate amount of observations to conduct a multiple regression analysis and ensure statistical power.

5.3.1 Sample characteristics of the respondents and establishments

The following sections will highlight the sample characteristics for the individual respondents (job title) and the establishment (facility size in terms of number of
employees, age of the facility, SIC code, unionization, and percentage of annual gross sales from customized products).

5.3.1.1 Sample characteristic of respondents

*Job Title of Respondents:* For this studies sample, more than half of the respondents (64%) are Presidents (33%) and Vice-presidents (31%). The plant (12%) and operations/production managers (9%) accounted for another 21% of the respondents. The remaining respondents were either operations/production supervisors (1.5%), other manufacturing position (5.5%), or did not provide their job title (8%). Thus, 85% of the respondents are middle to high level managers, implying a high reliability of the responses received, as these managers have a detailed understanding of how products are made, the workforce managed, and the operational performance of the manufacturing facility. Although 64% of the respondents (95) were manufacturing executives, 60% of those respondents (56) were from establishments with a facility size of less than 100 employees indicating that a low number of executives from medium and large establishments participating in the study (39) would not bias the statistical results. Table 5.1 summarizes the distribution of establishments according to the respondent’s job title.
Table 5.1: Summary of Respondent’s Job Title

<table>
<thead>
<tr>
<th>Job Title</th>
<th>%</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>President</td>
<td>33</td>
<td>49</td>
</tr>
<tr>
<td>Vice-President of Operations/Manufacturing</td>
<td>31</td>
<td>46</td>
</tr>
<tr>
<td>Plant Manager</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>Operations/Manufacturing Manager</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Operations/Manufacturing Supervisor</td>
<td>1.5</td>
<td>2</td>
</tr>
<tr>
<td>Other Manufacturing Position</td>
<td>5.5</td>
<td>8</td>
</tr>
<tr>
<td>Not Provided</td>
<td>8</td>
<td>12</td>
</tr>
</tbody>
</table>

Note: Actual number of respondents in parentheses (#)

5.3.1.2 Sample characteristics of establishments

Establishment Type Based on Industry SIC Code: Surprisingly, 70 respondents did not provide their establishments SIC code. Although, these establishments make up 47% of the sample, the Participants Informed Consent Form indicated that they should not participate in the study if the primary business of their establishment is NOT the manufacture of a physical product. Also, the instructions at the beginning of the questionnaire indicated that the statements and questions in the survey are asked to understand how the business unit manages ONLY the shop-floor workers in the
production and/or assembly areas for ONLY the CUSTOMIZED products manufactured at the facility. It was greatly emphasized throughout the survey that the respondent should answer the following questions regarding only for their customized products. Based on the instructions and precautionary statements at the beginning and throughout the questionnaire, it is reasonable to assume that all of the 80 individuals participating in the survey that did not provide their establishments SIC code were in fact a manufacturing entity that functioned in an industry with the Manufacturing Division of the SIC system. Also, 10 of the 70 respondents that indicated “Other” as a response provided a written description of the primary industry their establishment competes in. All 10 descriptions were some form of manufacturing.

One possible explanation for this omission is that the respondent may not know the official industry classification code for the establishment. Also, their facility may in fact compete in more than one SIC code and therefore opted to skip the question since the respondent could only chose one SIC code. To support this possibility, two individuals (that provided their email addresses) that failed to provide their SIC code were contacted and asked why they did not indicate the establishments SIC code. One respondent replied that they were not familiar with their establishments SIC code and the other indicated that they follow the new classification system based on the NAFTA agreement; the NAICS code. This individual noted that they did not know what the equivalent standard SIC code was for their particular NAICS code.

The following two SIC categories made up an additional 29% of the sample. Twenty-five (17%) establishments indicated that their SIC code began with 35 (Industrial and Commercial machinery and Computer Equipment) and eighteen (12%) indicated
that their SIC code began with 34 (Fabricated Metal Products, Except Machinery and Transportation Equipment). These two SIC codes are consistent with past studies in the mass customization discipline. There were 14 SIC code categories with less than 10 responses and the remaining 4 categories did not have an establishment as a representative in the sample. Contrary to the expectations of the study, the distribution of manufacturing types was not evenly dispersed across the sample. Table 5.2 summarizes the distribution of establishments according to SIC codes.
## Table 5.2: Summary of the Distribution of Establishments According to SIC Codes

<table>
<thead>
<tr>
<th>Division D: Manufacturing – Major Group SIC Codes 20-39 (n=148)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major Group 20: Food And Kindred Products</td>
</tr>
<tr>
<td>Major Group 21: Tobacco Products</td>
</tr>
<tr>
<td>Major Group 22: Textile Mill Products</td>
</tr>
<tr>
<td>Major Group 23: Apparel And Other Finished Products Made From Fabrics And</td>
</tr>
<tr>
<td>Major Group 24: Lumber And Wood Products, Except Furniture</td>
</tr>
<tr>
<td>Major Group 25: Furniture And Fixtures</td>
</tr>
<tr>
<td>Major Group 26: Paper And Allied Products</td>
</tr>
<tr>
<td>Major Group 27: Printing, Publishing, And Allied Industries</td>
</tr>
<tr>
<td>Major Group 28: Chemicals And Allied Products</td>
</tr>
<tr>
<td>Major Group 29: Petroleum Refining And Related Industries</td>
</tr>
<tr>
<td>Major Group 30: Rubber And Miscellaneous Plastics Products</td>
</tr>
<tr>
<td>Major Group 31: Leather And Leather Products</td>
</tr>
<tr>
<td>Major Group 32: Stone, Clay, Glass, And Concrete Products</td>
</tr>
<tr>
<td>Major Group 33: Primary Metal Industries</td>
</tr>
<tr>
<td>Major Group 34: Fabricated Metal Products, Except Machinery And Transportation Equipment</td>
</tr>
<tr>
<td>Major Group 35: Industrial And Commercial Machinery And Computer Equipment</td>
</tr>
<tr>
<td>Major Group 36: Electronic And Other Electrical Equipment And Components, Except Computer Equipment</td>
</tr>
<tr>
<td>Major Group 37: Transportation Equipment</td>
</tr>
<tr>
<td>Major Group 38: Measuring, Analyzing, And Controlling Instruments; Photographic, Medical And Optical Goods; Watches And Clocks</td>
</tr>
<tr>
<td>Major Group 39: Miscellaneous Manufacturing Industries</td>
</tr>
<tr>
<td>Other Manufacturing</td>
</tr>
<tr>
<td>Did Not Provide</td>
</tr>
</tbody>
</table>
Establishment Size Based on Number of Employees: Nearly half (49%) of the establishments for this study were primarily small in size based on the number of employees (70-99). 26% of the respondents indicated that they has between 100-249 employees and another 10% specified that they employed between 250-499 employees at their establishment. Finally, 4% had 500-999 employees and 2.7% had between 1000-2999 employees. It is interesting to note that there were no establishments in the sample with employees greater than 3000. This is not surprising since the unit of analysis of at the establishment level and most individual manufacturing facilities tend to employee smaller amounts of workers. Also, 8% of the respondents did not provide the number of employees at their establishment. Table 5.3 summarizes the distribution of establishments according to employee size.

Table 5.3 Summary of the Distribution of Establishments According to Employee Size

<table>
<thead>
<tr>
<th>Establishment Size Based on Number of Employees (n=148)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 99</td>
<td>48.6% (72)</td>
</tr>
<tr>
<td>100-249</td>
<td>26.4% (39)</td>
</tr>
<tr>
<td>250-499</td>
<td>10% (15)</td>
</tr>
<tr>
<td>500-999</td>
<td>4.1% (6)</td>
</tr>
<tr>
<td>1000-2999</td>
<td>2.7% (4)</td>
</tr>
<tr>
<td>Greater than 3000</td>
<td>(0)</td>
</tr>
<tr>
<td>Did not Provide</td>
<td>8.1% (12)</td>
</tr>
</tbody>
</table>

Note: Actual number of respondents in parentheses (#)
Establishment’s Percentage of Annual Sales, in dollars, from “customized” products:

More than half the establishments (58%) indicated that more than 50% of their sales in dollars come from the customized product lines within the manufacturing facility. Correspondingly, only 6% indicated that less than 10% of their sales in dollars come from their customized product lines. The following table summarizes the distribution of establishments according to their percentage of annual sales in dollars generated from their customized products. Table 5.4 summarizes the distribution of establishments according Percentage of Annual Sales, in dollars, from “customized” products.

Table 5.4 Summary of the Distribution of Establishments According to Percentage of Annual Sales, in dollars, from “Customized” Products

<table>
<thead>
<tr>
<th>Percentage of Annual Sales, in dollars, from “customized” products (n=148)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 10%</td>
<td>6% (9)</td>
</tr>
<tr>
<td>11 to 30%</td>
<td>14.9% (22)</td>
</tr>
<tr>
<td>31 to 50%</td>
<td>10.8% (16)</td>
</tr>
<tr>
<td>51 to 70%</td>
<td>16.9% (25)</td>
</tr>
<tr>
<td>71 to 90%</td>
<td>12.2 % (18)</td>
</tr>
<tr>
<td>Over 90%</td>
<td>29.1% (43)</td>
</tr>
<tr>
<td>Did not Provide</td>
<td>10.1% (15)</td>
</tr>
</tbody>
</table>

Note: Actual number of respondents in parentheses (#)

Establishments Age in Years: More than half (55%) the responding establishments indicated that their production facility has been operating for over 30 years. Correspondingly, only 3% of the establishments have been operating for less than 10
years. Table 5.5 summarizes the distribution of establishments according to the number of years their production facility has been operating.

Table 5.5 Summary of the Distribution of Establishments According Age

<table>
<thead>
<tr>
<th>Establishments Age in Years (n=148)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 5 years</td>
<td>1.3 % (2)</td>
</tr>
<tr>
<td>6 to 10 years</td>
<td>2% (3)</td>
</tr>
<tr>
<td>11 to 20 years</td>
<td>8.8% (13)</td>
</tr>
<tr>
<td>21 to 30 years</td>
<td>23.6% (35)</td>
</tr>
<tr>
<td>Over 30 years</td>
<td>55.4% (82)</td>
</tr>
<tr>
<td>Did not Provide</td>
<td>8.9% (13)</td>
</tr>
</tbody>
</table>

Note: Actual number of respondents in parentheses (#)

Establishments Unionization Status: Only 14% (21) indicated that their establishment was unionized. Correspondingly, 86% (127) of the establishments did not have a union presence in their manufacturing facility.

5.4 Data Collection Procedure: Summary

This study collects data from a single respondent which raises reliability and validity issues (Gerhart, Wright, McMahan, & Snell, 2000). However, given that the study focuses on the customized product line of a single establishment, and the fact that most of the respondents were manufacturing executives from small to medium size
establishments, the key informant approach should not be of major concern (Huselid & Becker, 2000). Also, since over half of the responding establishments indicated that over 50% of their annual sales come from their customized product line, this substantiates using a single informant to provide reliable and valid responses to the survey questions.

5.5 Measures

5.5.1 Independent variables: HRM Practices and Mass Customization

5.5.1.1 Human Resource Policies and Workforce Management Practices

Based on the literature of HPWS and mass customization; the design of this study required a wide range of HRM practices that focused on measuring the 6 broad HR policies in the functional areas conceptualized by Way (2002): (1) recruitment and selection, (2) incentive compensation plans, (3) teamwork, (4) job assignment, (5) skills training, and (6) labor management communication. All the questions in the survey are designed to measure multiple HRM practices within these 6 HR policies for the shop-floor workers in job roles for only the customized products manufactured at the facility. Table 5.6 at the end of this section provides a summary of all the HRM practices used to measure the 6 broad HR policies.

Emails sent to the manufacturing managers asked them to indicate which specific recruitment and selection, incentive compensation, teamwork, job assignment, skills training, and labor management communication practices they used to manage the shop-
floor workers who produce only the customized products manufactured at their plant. The following definitions of customized products and shop-floor workers were provided at the beginning of the questionnaire to assist the respondents in answering the survey questions.

**CUSTOMIZED** products are those products that are designed, altered, or changed to fit the unique specifications of an end-user. Component or intermediate products are only considered to be custom if the user of the finished product dictates or influences the specifications of the component.

**SHOP-FLOOR WORKERS** are non-managerial employees directly involved in the manufacture, assembly and/or design of ONLY CUSTOMIZED products at your facility.

*Compensation and Incentive Practices*. Shop-floor workers total compensation can be determined on base pay, individual performance, team performance, and/or plant performance. Base pay is a basic compensation practice that provides no incentive for shop-floor workers to learn new skills, work in a team, or engage in discretionary production related decisions to improve the operational performance of the plant. Base pay is not considered a HRM practice that is part of a HPWS when used as the only compensation and incentive practice. On the other hand, when base pay is combined with incentives based on individual performance such as piece rate and merit, it becomes more valuable to firms manufacturing basic customized products in the Finite Mass Customization Manufacturing (FMCM) system. Conversely, wages and incentives based on learning new occupation skills, team and establishment performance relate to a more
knowledgeable and involved worker in the production process, rather than on his/her current individual productivity. These types of compensation practices resonate with the Infinite Mass Customization (IMCM) system.

With this in mind, I approach the establishment’s monetary compensation policy by examining its combination of compensation and incentive practices. Respondents were asked to indicate which of the following compensation and incentive practices are included in the total monetary compensation package for only the shop-floor workers who manufacture customized products at their establishment. Respondents were instructed to check all of the following practices that applied:

- Base pay
- Wages, raises, or bonuses based on individual performance
- Wages, raises, or bonuses based on learning new occupational skills
- Wages, raises, or bonuses based on establishment performance
- Wages, raises, or bonuses based on team performance

Human resource practices in the compensation and incentives functional area are measured by the variables as follows. $FHPComp$, $IHPComp$, and $NOHPComp$ are measured to capture if the establishment’s compensation and incentive policy is indicative of a Fundamental High Performance Work System (FHPWS), Innovative High Performance Work System (IHPWS), or no HPWS. $FHPComp$ is a dummy variable that takes on a value of 1 if the respondent indicated that the monetary compensation package for shop-floor workers is based on base pay and individual performance and 0 otherwise. $IHPComp$ is a dummy variable that takes on a value of 1 if the respondent indicated that
the monetary compensation package for shop-floor workers is based on at least one of the following practices; learning new occupational skills, team performance, and establishment performance. Also, the $IHPComp$ variable is coded a value of 1 if bay base is included with the other compensation practices (except individual performance) and 0 otherwise. $NOHPComp$ is a dummy variable that takes on the value of 1 if the only compensation practices used is base pay and 0 otherwise. Thus, each compensation and incentive variable was dummy coded to indicate if the establishment did or did not possess a certain combination of practices. A score of “0” indicated that the establishment did not use compensation and incentive practices for that variable and a score of “1” indicated that they did. However, a score of 1 for the $NOHPComp$ variable indicated that the establishment fails to use any form of a HPWS practice.

*Teamwork Practices.* Manufacturing establishments can implement two different types of teams to involve the workforce in production related activities. First, plants can utilize small teams that meet off-line to address work-related issues and make process improvement suggestions to improve operational performance. These types of teams are generally management controlled and do not permit workers to make work-related decisions on their own. Such improvement teams would be considered more valuable in the FMCM system because the relatively standardization of the production process and the extensive use of automated technologies would prevent shop-floor workers from making operational changes without the consent of engineers and managers.

Conversely, manufacturing establishments can implement teams that operate on-line and manage themselves without direct supervision. These types of teams have
complete day-to-day administrative responsibilities to improve operational performance and full discretion over the method of work, production scheduling, and the assignment of members to different job tasks. Manufacturing establishments operating in an IMCM system would prefer to use these types of teams because the infinite amount of product customization requires the employees to make immediate production and process related decisions without having to wait for management’s approval.

The use of teamwork that does not reflect the characteristics of either an off-line or on-line team would not be considered a HRM practice that is part of a HPWS. Also, if a manufacturing establishment only permits a small portion of their shop-floor workers to engage in self-managing work teams, then they are considered not to have an extensive use of this practice. However, if an establishment engages any amount of employees in off-line teamwork, then they would be considered to use this practice. With this in mind, I approach the establishment’s teamwork policy by examining their use of the two types of teams when manufacturing customized products. Respondents were asked to indicate what percentage of shop-floor workers are involved in off-line improvement teams and teams that are self-managing when performing their primary role in the manufacture of customized products. The response options were 0, 1-50%, or 51-100%.

The following definitions of teams were provided to assist the respondents in answering the teamwork questions.
**IMPROVEMENT** teams are a small group of workers formed by management that meet off-line to address work-related problems, but are NOT permitted to directly make work-related or managerial/administrative decisions (Examples include quality circles, problem-solving groups, committees, “study action” groups, and/or task forces).

**SELF-MANAGED** teams have the following characteristics:

1. They are permanent, functional teams who directly work together on-line.
2. They manage themselves without direct supervision.
3. They jointly have complete day-to-day responsibility and discretion over many production and administrative decisions (e.g., methods of work, work flow, scheduling, assignment of members to different job tasks, etc).

Human resource practices in the teamwork functional area are measured by the variables as follows. **FHPTeam**, **IHPTeam**, and **NOHPTeam** are measured to capture if the establishment’s teamwork policy is indicative of FHPWS system, IHPWS system, or no HPWS. **FHPTeam** is a dummy variable that takes on a value of 1 if the respondent indicated that at least 1-50% of the shop-floor workers are currently involved in improvement teams and 0 otherwise. **IHPTeam** is a dummy variable that takes on a value of 1 if the respondent indicated that at least 51-100% of the shop-floor workers are currently involved in self-managed teams and 0 otherwise. **NOHPTeam** is a dummy variable that takes on a value of 1 if the respondent indicated that they do not have any shop-floor employees participating in improvement teams nor self-managing teams and 0 otherwise.
Thus, each teamwork variable was dummy coded to indicate if the establishment did or did not possess a certain teamwork practices. A score of “0” indicated that the establishment did not use a particular type of team for that variable and a score of “1” indicated that they did. However, a score of 1 for the NOHPTeam variable indicated that the establishment fails to use any form of teamwork practices.

*Shop-floor Worker Development and Skills Training Practices.* Manufacturing establishments can implement several types of developmental activities and training programs to enhance the operational skills and technical knowledge of shop-floor workers. These activities and programs can range from basic occupational training activities to more advanced techniques that develop the shop-floors ability to function in improvement and self-managing teams. Also, the frequency at which training programs are administered has an impact on the effectiveness of the developmental activity and on the shop-floor workers contribution to operational performance. Training and development can be provided in many different intervals ranging from continuously, yearly, to as needed.

Basic occupational training that is job specific, emphasize worker well being, and focuses on compliance with preset production procedures and work instruction would be more valuable to firms manufacturing basic customized products in the FMCM system since the production process is relatively standardized. Also, FMCM establishment would benefit greatly from developmental activities that are technically oriented and training programs that focus on participating in off-line improvement teams because the production processes and customized products do not require constant and immediate
changes. In addition, the characteristic of the FMCM system suggests that these types of training activities would be most effective if provided on a quarterly or yearly basis due to the system’s relative stability. Administering these types of skills training and developmental activities more frequently may result in an increase in costs and prove to be redundant.

Multi-functional cross-training that develops the shop-floor workers skills to perform more than one job task would be extremely important to establishments manufacturing highly customized products in the IMCM system because the production processes must be very flexible requiring highly knowledgeable and adaptive workers. Also, since customer’s requirements are constantly changing and it takes a highly skilled workforce to manufacture the many different end-products, providing training to work in self-managing teams would enhance the establishment’s ability to deliver highly customized products in a timely manner at a reasonable cost. In addition, training in self-managing teams should be supplemented with educational programs that develop the worker’s communication and leadership skills to improve their ability to make administrative and process related decisions independently without consulting management. Finally, training that develops a workers mental reasoning and analytical skills should be provided to facilitate continuous production and quality problem solving without the intervention of management. Since these types of skill training activities and developmental programs focus on adapting to change quickly and having an immediate impact on operational performance, they should be administered on a continuous basis or at the very least monthly intervals. Shop-floor workers that require the high level of skills
and knowledge to function properly in IMCM systems must be provided the training and
development very frequently.

The use of skills training and developmental activities that does not reflect the
characteristics of either basic occupational training or multi-functional training would not
be considered a HRM practice that is part of a HPWS. Also, if a manufacturing
establishment only administers these activities and programs as need or not at all, then
they are considered not to have an extensive use of this HRM practice. With this in mind,
I approach the establishment’s skills training and developmental policy by examining
their use of 12 different training activities and developmental programs when
manufacturing customized products.

The following definition of training programs was provided to assist the
respondents in answering the skills training and development questions. Training
programs are considered to be job developmental activities that have a predefined
objective and are conducted by a qualified person or by other employees or supervisors.
These programs can be conducted in the classroom or on the shop floor. The program
could be a seminar or workshop, an educational program, or an apprenticeship.

Respondents were asked two separate questions. First, respondents were asked
how often do shop-floor workers who are manufacturing customized products receive
training. The response options were: not at all, as needed, continuously, monthly,
quarterly, and yearly. The second question required the respondent to indicate which of
the following training activities and developmental programs are provided to shop-floor
workers who are manufacturing customized products. Respondents were instructed to
check all of the following practices that applied:
• Comply with preset production procedures and work instructions
• Production and quality problem solving
• Communication skills
• Job specific
• Team working in self-managing production groups
• Team working in off-line improvement groups
• Cross-training
• General and basic occupational
• Technical
• Leadership skill
• Health and safety
• Annual recertification procedures

Human resource practices in the training and development functional area are measured by the variables as follows. $FHPTrainType$, $IHPTrainType$, $NOHPTrainType$, $FHPTrainWhen$, $IHPTrainWhen$, and $NOHPTrainWhen$ are measured to capture if the establishment’s training and developmental policy is indicative of a FHPWS system, IHPWS system, or no HPWS. $FHPTrainWhen$ is a dummy variable that takes on a value of 1 if the respondent indicated that shop-floor workers received training yearly or quarterly and 0 otherwise. $IHPTrainWhen$ is a dummy variable that takes on a value of 1 if the respondent indicated that shop-floor workers received training continuously or monthly and 0 otherwise. $NOHPTrainWhen$ is a dummy variable that takes on a value of 1 if the respondent indicated that shop-floor workers receive training as needed or is not provide and 0 otherwise.
*FHPTrainType* is a dummy variable that takes on a value of 1 if the respondent indicated that any of the following training programs are provided to shop-floor workers: comply with preset production procedures and work instructions, job specific, team working in off-line improvement groups, cross-training, general occupational, and technical/machine maintenance. Alternatively, if the respondent did not identify any of these training activities then the *FHPTrainType* variable took on a value of 0.

*IHPTrainType* is a dummy variable that takes on a value of 1 if the respondent indicated that any of the following training programs are provided to shop-floor workers: production and quality problem solving, communication skills, team working in self-managing production groups, cross-training, general and basic occupational, technical, and leadership skills. Otherwise, if the respondent did not identify any of these training activities then the *IHPTrainType* variable took on a value of 0. *NOHPTrainType* is a dummy variable that takes on a value of 1 if the respondent indicated that any of the following training programs are provided to shop-floor workers: general and basic occupational, health and safety, and annual recertification procedures. Correspondingly, the *NOHPTrainType* variable takes on a value of 1 if no training and development programs are provided to the shop-floor workers and 0 otherwise.

Thus, each development and training variable was dummy coded to indicate if the establishment did or did not possess a certain combination of practices. A score of “0” indicated that the establishment did not use development and training practices for that variable and a score of “1” indicated that they did. However, a score of 1 for the *NOHPTrainType* and *NOHPTrainWhen* variables indicated that the establishment fails to use any form of a HPWS practice.
Labor-Management Communication Practices. Many different types of information can be intentionally shared with shop-floor workers to provide feedback on performance and updates on goal attainment. Also, information can be provided to shop-floor workers by their peers, group/team leaders, and/or members of management immediately or intermittently. Information that is intentionally shared can range from individual and team performance to plant and business performance. In addition, intentionally sharing externally oriented types of information such as supplier performance and customer requirements can be provided to shop-floor workers. Providing the necessary information in a timely manner can significantly improve individual, operational, and business performance because workers can make the required process and product changes if the outcomes are poor.

Intentionally sharing individual performance data and providing feedback on work related outcomes would be more valuable to firms manufacturing basic customized products in the FMCM system because shop-floor workers are primarily focused on performing standardized job tasks that require a high degree of receptiveness in the production process. Individual production output, quality reports, working condition, and machine breakdowns provide shop-floor workers with the essential information they need to successfully perform in their job duties for basic customized products. This type of information should be provided by supervisor based on a yearly or quarterly performance appraisal since shop-floors who function in the FMCM system are not members of a self-managing work team and the production process is relatively stable and predictable.
Information that is based on team, plant, supplier, and financial performance would be extremely important to establishments manufacturing highly customized products in the IMCM system because the production processes is highly flexible requiring the necessary information to meet the constant changing needs of the customer. Also, since customer’s requirements and production processes are constantly changing, information must be provided about production schedule compliance and delivery performance for the many different end-products. Providing this type of information to workers in self-managing teams would enhance the establishment’s ability to deliver highly customized products in a timely manner at a reasonable cost. In addition, team, plant, and supplier performance should be provided immediately and continuously by peers, group leaders, and members of management since these types of information focus on adapting to change quickly and having an immediate impact on operational performance. Shop-floor workers that function in self-managing work teams require the appropriate operational and strategic information to function properly in IMCM systems.

Information and feedback that does not reflect the characteristics of individual, team, plant, or operational performance would not be considered a HRM practice that is part of a HPWS. Also, if a manufacturing establishment fails to share this information, then they are considered not to have an extensive use of this HRM practice. With this in mind, I approach the establishment’s labor-management communication policy by examining 11 different type of information that can be intentionally share with shop-floor workers when manufacturing customized products. Also, I assess how often performance appraisals are administered and information feedback is provided and who is responsible for directing them.
Respondents were asked three separate questions. First, respondents were asked how often are formal performance appraisals and feedback provided to shop-floor workers who are manufacturing customized products. The response options were: not provided, continuously, monthly, quarterly, and yearly. The second question required respondents to indicate who administers formal performance appraisals and feedback provided for shop-floor workers who are manufacturing customized products in your plant. The response options were: peers, group leaders, supervisors/managers, and not applicable. The last question required the respondent to indicate which of the types of information are provided to shop-floor workers who are manufacturing customized products. Respondents were instructed to check all of the following practices that applied:

- Do not share information
- Individual performance
- Team performance
- Plant operating performance
- Supplier performance
- Financial performance
- Production schedule compliance and delivery performance
- Frequency of mach breakdown
- Working conditions
- Customer specifications and requirements
- Plant goals, objectives, and future competitive strategies
- Business status
Human resource practices in the Labor-Management Communication functional area are measured by the variables as follows. $\text{FHPInfoShare}$, $\text{IHPInfoShare}$, $\text{NOHPInfoShare}$, $\text{FHPWhoAppras}$, $\text{IHPWhoAppras}$, and $\text{NOHPWhoAppras}$, $\text{FHPWhenAppras}$, $\text{IHPWhenAppras}$, and $\text{NOHPWhenAppras}$ are measured to capture if the establishment’s Labor-Management Communication policy is indicative of a FHPWS system, IHPWS system, or no HPWS.

$\text{FHPWhenAppras}$ is a dummy variable that takes on a value of 1 if the respondent indicated that shop-floor workers receive performance appraisals and developmental feedback yearly or quarterly and 0 otherwise. $\text{IHPWhenAppras}$ is a dummy variable that takes on a value of 1 if the respondent indicated that shop-floor workers receive performance appraisals and developmental feedback continuously or monthly and 0 otherwise. $\text{NOHPWhenAppras}$ is a dummy variable that takes on a value of 1 if the respondent indicated that performance appraisals and developmental feedback is not provided to shop-floor workers and 0 otherwise.

$\text{FHPInfoShare}$ is a dummy variable that takes on a value of 1 if the respondent indicated that any of the following information is intentionally shared with shop-floor workers: individual performance, frequency of machine/equipment breakdowns, working conditions, and customer specifications and requirements; 0 otherwise. $\text{IHPInfoShare}$ is a dummy variable that takes on a value of 1 if the respondent indicated that any of the following information is provided to shop-floor workers: team performance, plant operating performance, financial performance, production schedule compliance and delivery performance, plant goals, objectives and future strategies, and business status. Otherwise, if the respondent did not identify any of these training activities then the
variable took on a value of 0. \textit{NOHPInfoShare} is a dummy variable that takes on a value of 1 if the respondent indicated that no information is provided to shop-floor workers and 0 otherwise.

\textit{FHPWhoAppras} is a dummy variable that takes on a value of 1 if the respondent indicated that only supervisors/managers administer formal performance appraisals and provide developmental feedback to shop-floor workers and 0 otherwise. \textit{IHPWhoAppras} is a dummy variable that takes on a value of 1 if the respondent indicated that formal performance appraisals and developmental feedback are provided to shop-floor workers by either their peers or group leaders and 0 otherwise. \textit{NOHPWhoAppras} is a dummy variable that takes on a value of 1 if the respondent indicated that formal performance appraisals and developmental feedback is not provided to shop-floor workers and 0 otherwise.

Thus, each labor-management communication variable was dummy coded to indicate if the establishment did or did not possess a certain combination of practices. A score of “0” indicated that the establishment did not use development and training practices for that variable and a score of “1” indicated that they did. However, a score of 1 for the \textit{NOHPWhoAppras}, \textit{NOHPInfoShare}, and \textit{NOHPWhenAppras} variables indicated that the establishment fails to use any form of a HPWS practice.

\textit{Recruitment and Selection Practices}. The type of shop-floor workers that a manufacturer employs can have a significant impact on their operational performance. A manufacturer’s particular recruitment and selection practices can assist in hiring qualified shop-floor workers. To recruit the best workers, manufacturers have to provide a realistic
overview of the job and their production facility. Describing both the positive and negative aspects of the job to potential workers develops a stronger more trusting relationship with individuals that motivate them to perform better in their work roles. Also, not only do manufacturers have to recruit capable workers, but they must select the best candidate for the job. Pre-employment selection devices such as interviews, testing, and background checks can ensure that manufacturers are hiring the most qualified individuals to meet their operational needs. However, pre-employment selection devices alone do not guarantee that the right individual will be hired. Manufacturers must also develop appropriate selection criteria that are based on the applicant’s occupational capabilities, past work experiences, and their potential to learn new skills and willingness to work in teams.

Providing a written description of the company, job, and candidates expectations in a formal handbook would be more valuable to firms manufacturing basic customized products in the FMCM system since the job tasks in the production system are relatively standardized and the processes are repetitive. Also, FMCM establishment would benefit greatly from pre-employment selection devices that focus on basic occupational testing, standard drug screens, and references from previous employers because the production processes and customized products do not require a highly skilled and flexible workforce. In addition, the characteristic of the FMCM system suggests that these types of pre-employment devices would be most effective when used with selection criteria that focus on the candidates basic occupational capabilities, past work experience, and potential and willingness to work in off-line improvement teams. Administering advanced
comprehensive testing and more elaborate job previews may result in an increase in costs and prove to be redundant for the establishments with a FMCM system.

Proving a representative video and/or paired shadow time with existing employees would be extremely important to establishments manufacturing highly customized products in the IMCM system because the production processes must be very flexible requiring highly knowledgeable and adaptive workers. Representative videos will show candidates exactly what the job entails and paired shadow time will give the individual a firsthand view of what will be expected from them. Also, since customer’s requirements are constantly changing and it takes a highly skilled workforce to manufacture the many different end-products, providing personality and mental ability testing would determine if the candidate has the ability to work in a team without direct supervision and be able to solve production and quality problems as they occur. In addition, these enhanced job previews and comprehensive testing should be supplemented with selection criteria that determines the candidates potential and willingness to learn new skills, work in a self-managing team and solve production related problems without consulting management.

Recruitment and selection practices that do not reflect the characteristics of simple and extensive job previews, occupational and psychology testing, and basic and advanced selection criteria would not be considered a HRM practice that is part of a HPWS. Also, if a manufacturing establishment fails to provide a job overview or only verbally describes the position, then they are considered not to have an extensive use of this HRM practice. In addition, if manufacturing establishments do not use pre-employment selection criteria to base hiring decisions, then they are considered not to
have an extensive use of this HRM practice. With this in mind, I approach the establishment’s recruitment and selection policy by examining 4 different methods of providing a job preview, 10 pre-employment selection devices, and 6 selection criteria.

Respondents were asked three separate questions. First, respondents were asked to indicate how a realistic overview of the job and company is provided to applicants who will be manufacturing customized products. Respondents were instructed to check all of the following practices that applied:

- No such preview provided
- Verbal descriptions of the company, job, and candidates expectations
- Written descriptions of the company, job, and candidates expectations in a formal employee handbook
- Representative video
- Paired shadow time with existing employees

The second question required respondents to indicate what type of pre-employment selection devices are used for workers who will be manufacturing customized products. Respondents were instructed to check all of the following practices that applied:

- Formal interviews
- Drug screens
- Work sample tests
- Occupational aptitude tests
- Basic technical skills tests
- Personality tests
• Physical performance evaluations
• Background checks
• Mental ability tests
• References from previous employers

The last question required the respondent to indicate what characteristics are important for a shop-floor candidate who will be manufacturing customized products. Respondents were instructed to check all of the following criteria that applied:

• Not applicable
• Basic occupational capabilities
• Past work experiences and knowledge
• Potential and willingness to learn new skills
• Potential and willingness to work in an improvement team
• Potential and willingness to work in a self-managing team
• Ability to solve production and quality problems

Human resource practices in the recruitment and selection functional area are measured by the variables as follows. $FHP_{Preview}$, $IHPP_{Preview}$, $NOHP_{Preview}$, $FHP_{SelectDevice}$, $IHP_{SelectDevice}$, and $NOHP_{SelectDevice}$, $FHP_{SelectIndicat}$, $IHP_{SelectIndicat}$, and $NOHP_{SelectIndicat}$ are measured to capture if the establishment’s Labor-Management Communication policy is indicative of a FHPWS system, IHPWS system, or no HPWS.

$FHP_{Preview}$ is a dummy variable that takes on a value of 1 if the respondent indicated that a written description of the company, job, and candidate’s expectation in a formal handbook are provided to applicants and 0 otherwise. $IHPP_{Preview}$ is a dummy
variable that takes on a value of 1 if the respondent indicated that representative videos or paired shadow time with existing employee are provided to applicants and 0 otherwise. 

$NOHPPreview$ is a dummy variable that takes on a value of 1 if the respondent indicated that no such preview is provided or is provided verbally to the applicant and 0 otherwise.

$IHPSelectDevice$ is a dummy variable that takes on a value of 1 if the respondent indicated that any of the following pre-employment selection devices are use for applicants who will be manufacturing customized products: personality tests, mental ability tests, or occupational aptitude test. Alternatively, if the respondent did not identify any of these selection devices then the $IHPSelectDevice$ variable took on a value of 0. 

$FHPSelectDevice$ is a dummy variable that takes on a value of 1 if the respondent indicated that any of the following pre-employment selection devices are used for applicants who will be manufacturing customized products: formal interviews, drug screens, work samples test, basic technical skills tests, physical performance evaluations, background checks, or references from previous employee. Otherwise, if the respondent did not identify any of these selection devices then the $FHPSelectDevice$ variable took on a value of 0. $NOHPSelectDevice$ is a dummy variable that takes on a value of 1 if the respondent indicated that pre-employment selection devices are not use for applicants who will be manufacturing customized products and 0 otherwise.

$FHPSelectIndicat$ is a dummy variable that takes on a value of 1 if the respondent indicated that the most important characteristics for a shop-floor candidate are: basic occupational capabilities, past work experience, or potential and willingness to work in an improvement team and 0 other wise. $IHPSelectIndicat$ is a dummy variable that takes on a value of 1 if the respondent indicated that the most important characteristics for a
shop-floor candidate are: potential and willing to learn new skills, potential and willingness to work in a self-managing team, or ability to solve production and quality problems and 0 otherwise. \( NOHPS{electIndicat} \) is a dummy variable that takes on the value of 1 if the respondent indicated that it this question was not applicable and 0 otherwise.

Thus, each recruitment and selection variable was dummy coded to indicate if the establishment did or did not possess a certain combination of practices. A score of “0” indicated that the establishment did not use recruitment and selection practices for that variable and a score of “1” indicated that they did. However, a score of 1 for the \( NOHPS{electIndicat} \), \( NOHP{review} \), and \( NOHPS{electDevice} \) variables indicated that the establishment fails to use any form of a HPWS practice.

Job Design. Designing job duties for shop-floor workers is one of the most important decisions manufacturing establishments can make to improve operational performance. In particular, it becomes even more critical for mass customization manufacturers. The very nature of producing customized products suggests that it greatly depends on the skills and knowledge of shop-floor workers and how jobs are designed to facilitate the use of their capabilities. Mass customizers should design jobs that permits shop-floor workers to perform multiple job tasks and empowers them to make administrative and operational decision without consulting management. Also, jobs should be created to encourage shop-floor workers to communicate with other individuals if they need to solve production related problems.

Jobs that are designed so that shop-floor workers perform multiple job tasks within the production process would be more valuable to establishments manufacturing
basic customized products in the FMCM system since the production system is relatively standardized and the processes are repetitive. The multiple types of job tasks in FMCM systems are not difficult and can be easy performed by different shop-floor workers. Designing jobs that require shop-floor workers to set-up and operate equipment, conduct routine machine maintenance, perform quality and material handling tasks, and assemble products provides them with the complete understanding of the entire manufacturing process and the detailed knowledge of how customized products are made. This understanding and knowledge enables shop-floor worker to function more effectively in off-line improvement teams and permits them to make good suggestions to solve production related problems. In FMCM systems, the production processes and customized products are not complex requiring simple quick solutions that shop-floor workers can implement. Also, FMCM establishment would benefit greatly from designing jobs that allow shop-floor workers to consult with other workers and managers within their immediate work area to solve production related because they are all familiar with every job tasks, the standardized production processes, and basic customized products.

When designing jobs to perform multiple tasks are combined with providing shop-floor workers the authority to make administrative and production related decisions without consulting management, it becomes more valuable to firms manufacturing advanced customized products in the IMCM system because production processes are highly flexible to meet the constant changing needs of the customer. Highly flexible processes are more effective when multi-functional shop-floor workers have more administrative control over how job tasks and production flows are designed, make
production scheduling decisions and provide immediate performance feedback to other individuals. Also, since customer’s requirements are constantly changing in the IMCM system, shop-floor workers should have the authority to select new equipment, certify suppliers, and address strategic issues related to implementing new technology and redesigning the plant for more process flexibility and better quality. As shop-floor worker become more engaged in these administrative responsibilities, they should also be permit to consult with customer, suppliers, and other functional experts outside their immediate work area to solve production related problems.

Job design practices that do not reflect the characteristics of multiple job tasks and administrative decision making would not be considered a HRM practice that is part of a HPWS. Also, if a manufacturing establishment fails to permit shop-floor workers from consulting other individuals to solve production related problems, then they are considered not to have an extensive use of this HRM practice. With this in mind, I approach the establishment’s job design policy by creating a scale to measure the importance of 6 different job tasks shop-floor workers can perform and 8 different types of administrative decisions they can make without consulting with management when manufacturing customized products. Also, I assess who shop-floor workers consult with to solve production related problems when manufacturing customized products.

Respondents were asked three separate questions. First, respondents were who shop-floor workers normally consult with if they need to solve production related problems when manufacturing customized products. Respondents were instructed to check all of the following practices that applied:

- Do not consult with others
• Customers
• Suppliers
• Their immediate supervisor and/or other workers in their immediate work area
• Other workers, managers, and functional experts outside their immediate work area

The second question asked respondents to indicate how important it is for shop-floor workers to perform 6 different job tasks when they are manufacturing customized products. A scale was created and respondents were instructed to choose a number from 1 - 4 with 1 = not important, 2 = slightly important, 3 = important, 4 = extremely important for the following job tasks:

• Equipment set-up, adjustments, and/or programming tasks
• Equipment routine maintenance tasks
• Component part production tasks
• Assembly tasks
• Quality insurance tasks
• Material handling tasks

A multiple job tasks score was calculated for each establishment by summing the values of the six responses. Scores ranged from a minimum of 6 to a maximum of 24.

The third question asked respondents to indicate how important it is for shop-floor workers to make the following 8 decisions without consulting with management when they are manufacturing customized products. A scale was created and respondents were
instructed to choose a number from 1 - 4 with 1 = not important, 2 = slightly important, 3 = important, 4 = extremely important for the following types of decisions:

- Design/redesign all or part of their primary job duties
- Design/redesign production methods, flows, and processes
- Select new machinery and equipment
- Select and certify new suppliers
- Take immediate action to diagnose and solve production and quality problems
- Address managerial/administrative issues (e.g., production scheduling, methods of work, assign daily work task to employees, schedule routine maintenance)
- Address human resource issues (e.g., provide individual and group performance feedback, schedule worker vacations, deal with individual absences)
- Address strategic related issues (e.g., redesign the plant, new technology implementation, investment plans, new products)

A decisions type score was calculated for each establishment by summing the values of the eight responses. Scores ranged from a minimum of 8 to a maximum of 32.

Human resource practices in the job design functional area are measured by the variables as follows. *FHPConsult, IHPConsult, NOHPConsult, FHPJobDesign, IHPJobDesign*, and *NOHPJobDesign* are measured to capture if the establishment’s job design policy is indicative of a FHPWS system, IHPWS system, or no HPWS. These 6 job design variable are dummy coded based on the following coding criteria:
• If an establishment received a score 15 or more on the multiple job tasks score, but less than 21 on the decision type scale; then the following job design variables were coded as follows: $FHP\text{JobDesign}$ received a score of 1 and $IHP\text{JobDesign}$ and $NOHP\text{JobDesign}$ was assigned a score of 0.

• If an establishment received a score 15 or more on the multiple job tasks score and a score of greater than 20 on the decision type scale; then the following job design variables were coded as follows: $IHP\text{JobDesign}$ received a score of 1 and $FHP\text{JobDesign}$ and $NOHP\text{JobDesign}$ was assigned a score of 0. Also, If an establishment received a score less than 15 on the multiple job tasks score, but greater than 20 on the decision type scale; then the following job design variables were coded as follows: $IHP\text{JobDesign}$ received a score of 1 and $FHP\text{JobDesign}$ and $NOHP\text{JobDesign}$ was assigned a score of 0.

• If an establishment received a less than 15 on the multiple job tasks score and less than 21 on the decision type scale; then the following job design variables were coded as follows: $NOHP\text{JobDesign}$ received a score of 1 and $IHP\text{JobDesign}$ and $FHP\text{JobDesign}$ was assigned a score of 0.

$FHP\text{Consult}$ is a dummy variable that takes on a value of 1 if the respondent indicated that shop-floor workers only consult with their immediate supervisor and/or other workers in their immediate work area and 0 otherwise. $IHP\text{Consult}$ is a dummy variable that takes on a value of 1 if the respondent indicated that shop-floor workers consult with any of the following: customers, suppliers, or others outside of their immediate work area. Otherwise, if the respondent did not identify any of these as consultants then the
The *FHPSelectDevice* variable took on a value of 0. *NOHPConsult* is a dummy variable that takes on the value of 1 if the respondent indicated that shop-floor workers do not consult with others and 0 otherwise.

Thus, each job design variable was dummy coded to indicate if the establishment did or did not possess a certain combination of practices. A score of “0” indicated that the establishment did not use job design practices for that variable and a score of “1” indicated that they did. However, a score of 1 for the *NOHPConsult* and *NOHPJobDesign* variables indicated that the establishment fails to use any form of a HPWS practice.

Table 5.6: Summary of HRM Variables

<table>
<thead>
<tr>
<th>HR Functional Policy</th>
<th>Variable Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compensation &amp; Incentives</td>
<td><em>FHPComp</em>, <em>IHPComp</em>, and <em>NOHPComp</em></td>
</tr>
<tr>
<td>Teamwork</td>
<td><em>FHPTeam</em>, <em>IHPTeam</em>, and <em>NOHPTeam</em></td>
</tr>
<tr>
<td>Skills Training and Worker Development</td>
<td><em>FHPTrainType</em>, <em>IHPTrainType</em>, <em>NOHPTrainType</em>, <em>FHPTrainWhen</em>, <em>IHPTrainWhen</em>, and <em>NOHPTrainWhen</em></td>
</tr>
<tr>
<td>Labor-Management Communication</td>
<td><em>FHPInfoShare</em>, <em>IHPInfoShare</em>, <em>NOHPIInfoShare</em>, <em>FHPWhoAppras</em>, <em>IHPWhoAppras</em>, <em>NOHPWhoAppras</em>, <em>FHPWhenAppras</em>, <em>IHPWhenAppras</em>, and <em>NOHPWhenAppras</em></td>
</tr>
<tr>
<td>Recruitment &amp; Selection</td>
<td><em>FHPPreview</em>, <em>IHPPreview</em>, <em>NOHPPreview</em>, <em>FHPSelectDevice</em>, <em>IHPSelectDevice</em>, <em>NOHPSSelectDevice</em>, <em>FHPSelectIndicat</em>, <em>IHPSelectIndicat</em>, and <em>NOHPSSelectIndicat</em></td>
</tr>
<tr>
<td>Job Design</td>
<td><em>FHPConsult</em>, <em>IHPConsult</em>, <em>NOHPConsult</em>, <em>FHPJobDesign</em>, <em>IHPJobDesign</em>, and <em>NOHPJobDesign</em></td>
</tr>
</tbody>
</table>
5.5.1.2 HPWS Indexes: FHPWS and IHPWS

Consistent with the conventional process followed by the HPWS literature, this study combines several measures of individual HRM practices into a unitary aggregate index that measures a HPWS (Becker and Huselid, 1998; Kintatna, 2006; Way, 2002; Macky and Boxall, 2007; Guest, 1999; Macduffie, 1995; Yount et al., 1996; Arthur, 1992). The fundamental assumption of the additive approach is based on the notion that bundling several HRM practices into an aggregate index can improve performance either by increasing the number of practices used in the system or by employing a technique to exploit practices in HPWS more extensively and comprehensively (Yount et al., 1996). The additive approach is conceptually and empirically more effective than the multiplicative approach to developing a HPWS since the value of the aggregate index does not diminish to zero if a single HRM practice is omitted from the system (Osterman, 2000). Instead, the missing practice only weakens the remaining effectiveness of the system (Delery, 1998).

With the exception of Yount et al. (1996) and Arthur (1992, 1994), HPWS researchers traditionally create only one HPWS index for each respondent to include in their analysis. However, this study does not follow the conventional methods of the literature entirely and follows Yount et al. (1996) and Arthur (1992, 1994) by creating two distinct HPWS indexes for each establishment. This study differs from previous HPWS research in that it develops two separate HPWS indexes that represent different approaches to managing the workforce in MCM environment. Thus, the FHPWS and IHPWS are two distinct unitary indexes created by summing a unique set of HRM
practices that are appropriate only for that particular structure. Becker and Huselid (1998) concludes that a HPWS is “a unitary index that contains a set (though not always the same set) of theoretically appropriate HRM practices derived from prior work.”

Previous HPWS research suggest that determining which HRM practices to include in such indexes should be based on practices in prior research (Becker and Huselid, 1998). However, many researchers disagree on which practices should be included in a HPWS (Becker and Gerhart, 1996; Delery, 1998). Also, this study conceptually develops a HPWS that resonates with basic HRM practices that were not included in previous research. Because the specific HRM practices that should be included in the IHPWS and FHPWS have not been previously identified in previous empirical studies, the different HRM practices identified in this study are combined into two separate indexes based on a normative approach derived from previous studies on HPWS (Yount et al., 1996; Arthur, 1992, 1994). Guest (2001) suggestion that HRM practices should be combined based on prior theory rather than statistical analysis. In particular, HRM practices were bundled together that captures the extent to which establishments tend to make use of IHPWS and FHPWS when managing shop-floor workers who manufacture different types of customized products.

All establishments received a value for each HPWS by summing the HRM variables described above. More specifically, the value of the FHPWS index was determined by adding together the following 12 HRM variables that the establishment utilizes to manage shop-floor workers who manufacture customized products: \( FHP\text{Comp}, FHP\text{Team}, FHP\text{TrainType}, FHP\text{TrainWhen}, FHP\text{InfoShare}, FHP\text{WhoAppras}, FHP\text{WhenAppras}, FHP\text{Preview}, FHP\text{SelectDevice}, FHP\text{SelectIndicat}, FHP\text{Consult}, \) and
The variables were dummy coded “1” if they employed that practice or “0” if they did not; therefore, the value of the FHPWS index varies between 0 and 12. Correspondingly, the value of the IHPWS index was determined by adding together the following 12 HRM variable that the establishment utilizes to manage shop-floor workers who manufacture customized products: IHPComp, IHPTeam, IHPTrainType, IHPTrainWhen, IHPInfoShare, IHPWhoAppras, IHPWhenAppras, IHPPreview, IHPSelectDevice, IHPSelectIndicat, IHPConsult, and IHPJobDesign. The variables were dummy coded “1” if they employed that practice or “0” if they did not; therefore, the value of the IHPWS index varies between 0 and 12.

High values of a particular index would be indicative of an establishment with a comprehensive bundle of consistent HRM practices close to the theoretical ideal of HPWS for that type. This indicates that an establishment cannot have high values for each HPWS type. For example, an establishment with 12 FHPWS practices cannot have any HRM practices associated with a IHPWS and vice versa. The amount of fundamental and innovative HRM practices will be distributed between the two types of HPWS. Conversely, this distribution is not required to be equal since an establishment may not use a specific HRM practice, thus not contributing to the overall summed values for each HPWS type. Thus, of the 12 different HRM practices that an establishment may implement; they could use 7 fundamental and 3 innovative practices and fail to use the other two practices giving them a FHPWS value of 7 and a IHPWS value of 3.

Validating each HPWS index via construct reliability and validity analysis was not conducted in this study. Previous research (Bollen and Lennox, 1991; Cattell and Tsujioka, 1964) has successfully argued that indexes are conceptually different from
scales which require high internal consistency (i.e. high value of Cronbach’s alpha). An index is a multidimensional construct made up of cause indicators or items that does not reflect a unified underlying construct because the individual items together determine the level of the construct by representing different aspects of it (Devillis, 1991). For indexes, the items are presumably not caused by the construct indicating that “items would not necessarily need to be highly inter-correlated and the use of internal reliability statistics, such as Cronbach’s coefficient alpha, would not be appropriate for an index (Macky and Boxall, 2007).” Conversely, scales are unobservable constructs with multiple observable reflective indicators that measure the same underlying phenomenon (Fornell and Bookstein, 1982). It is assumed that the set of items (questions) in the scale all measure the same single underlying construct (Macky and Boxall, 2007). Also, changes in the actual level of the phenomenon (the unobserved construct) will cause the changes in the observable indicators (Bollen, 1989; Chin, 1998). Thus, in scales, responses to items presumably are caused by the construct (Devillis, 1991) indicating that “multiple items should be used to improve the measurement reliability and should have high inter-correlations, as indicted by statistical techniques such as factor analysis and correlation-based reliability statistics (Macky and Boxall, 2007).”

Delery (1998) highlights an important distinction between the use of a scale and an index when measuring HPWS noting that “scales assume that items are measuring an underlying construct while indexes are measures of the level of the construct.” He suggests that researchers should use a unitary index approach to measure HPWS rather than scales because different HRM practices may act as substitutes for each other resulting in a relatively weak underlying construct across practices. Macky and Boxall
(2007) note that “Delery’s discussion points to the need to test for collinearity between items to identify substitutable HR practices or items whose inclusion in an additive index would be redundant, and lead to overestimating the degree of association between the HPWS and the outcome variable being measured.” Following the work of Macky and Boxall (2007) this study examines the correlation matrix for the 12 FHPWS HRM practices and the correlation matrix for the 12 IHPWS HRM practices separately. A weak correlation coefficient between all pairs of the 12 different HRM practices for each HPWS index would indicate that item redundancy is not a problem and creating an additive index would be appropriate for this study.

An examination of the correlation matrix in Table 5.7 for all the HRM practices for the IHPWS indicates that the highest significant correlation was between “IHPInfoShare” and “IHPTrainType” (r (148) = .301; p = .000). The relatively weak correlation between these variables indicates that collinearity is not evident, and therefore, item redundancy is not a problem. The HRM variables that received a code of “1” were, therefore, summed to create an additive IHPWS index for use in testing Hypothesis 2b.

A visual examination of the normal probability plot in chart 5.1 and frequency histogram in chart 5.2 shows the IHPWS index to be approximately normally distributed. Also, the skewness Z-value of .94 and the kurtosis Z-value of .01 falls between +/- 1.96 indicating that the skewness and kurtosis estimates are not significantly different form a value of 0; furthermore, concluding that we can fail to reject the assumption about normality of the IHPWS distribution at the .05 probability level and be 95% confident that the scores are from a distribution whose population mean is zero. Based on the
results of a visual inspection charts 5.1 and 5.2 and the statistical significances of the skewness and kurtosis Z-values, it can be concluded that a moderate violations of the normality assumption of the IPWS index would be acceptable for a regression analysis.

An examination of the correlation matrix in Table 5.8 for all the HRM practices for the FHPWS indicates that the highest significant correlation was between “FHPInfoShare” and “FHPTrainType” (r (148) = .301; p = .000). The relatively weak correlation between these variables indicates that collinearity is not evident, and therefore, item redundancy is not a problem. The HRM variables that received a code of “1” were, therefore, summed to create an additive FHPWS index for use in testing Hypothesis 2a.

A visual examination of the frequency histogram in chart 5.3 shows that the distribution curve for the FHPWS index is slightly skewed to the left; however, the normal probability plot in chart 5.4 very clearly indicates that this variable is approximately normally distributed. Also, the skewness Z-value of .367 and the kutosis Z-value of -.77 falls between +/- 1.96 indicating that the skewness and kurtosis estimates are not significantly different form a value of 0; furthermore, concluding that we can fail to reject the assumption about normality of the IHPWS distribution at the .05 probability level and be 95% confident that the scores are from a distribution whose population mean is zero. Based on the results of a visual inspection charts 5.3 and 5.4 and the statistical significances of the skewness and kurtosis Z-values, it can be concluded that a slight deviations from normality of the IPWS index would be acceptable for a regression analysis.
Table 5.7: Correlation Matrix for 12 IHPWS practices

<table>
<thead>
<tr>
<th></th>
<th>PHWES COMPENSATION</th>
<th>PHWES CONSULTATION</th>
<th>PHWES JOB DESIGN</th>
<th>PHWES INFORMATION SHARING</th>
<th>PHWES Who Performs Appraisal</th>
<th>PHWES When Appraisal Provided</th>
<th>PHWES Training Type</th>
<th>PHWES Train When</th>
<th>PHWES How Preview Provided</th>
<th>PHWES Selection Devices</th>
<th>PHWES Selection Indicator</th>
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<td>0.382</td>
<td>0.388</td>
<td>-0.136</td>
<td>0.099</td>
<td>0.121</td>
<td>0.029</td>
<td>0.005</td>
<td>0.037</td>
<td>0.045</td>
<td>0.091</td>
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<td>PHWES Selection Devices</td>
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</table>

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).
### Table 5.8: Correlation Matrix for 12 FHPWS Practices

<table>
<thead>
<tr>
<th>Practice Row</th>
<th>IHPS COMPENSATION Correlation Coefficient</th>
<th>IHPS CONSULTATION Correlation Coefficient</th>
<th>IHPS JOB DESIGN Correlation Coefficient</th>
<th>IHPS INFORMATION SHARING Correlation Coefficient</th>
<th>IHPS Who Performs Appraisal Correlation Coefficient</th>
<th>IHPS When Appraisal Provided Correlation Coefficient</th>
<th>IHPS Training Type Correlation Coefficient</th>
<th>IHPS How Preview Provided Correlation Coefficient</th>
<th>IHPS Selection Devices Correlation Coefficient</th>
<th>IHPS Selection Indicator Correlation Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>IHPS COMPENSATION</td>
<td>1.000</td>
<td>0.327</td>
<td>0.357</td>
<td>0.282</td>
<td>0.175</td>
<td>0.168</td>
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<td>0.147</td>
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<tr>
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<td>0.139</td>
<td>0.105</td>
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<tr>
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<tr>
<td>IHPS How Preview Provided</td>
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<td>0.040</td>
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</tr>
</tbody>
</table>

**Correlation is significant at the 0.01 level (2-tailed).**

*Correlation is significant at the 0.05 level (2-tailed).*
Chart 5.1: Normal P-P Plot for the IHPWS Index

Normal P-P Plot of IHPWS

- Expected Cum Prob
- Observed Cum Prob
Chart 5.2: Frequency Histogram for the IHPWS Index
Chart 5.3: Frequency Histogram for FHPWS Index

Histogram

Mean = 5.46
Std. Dev. = 1.7
N = 148
Chart 5.4: Normal P-P Plot of FHPWS Index
5.5.1.3 Mass Customization

The instrument to measure mass customization manufacturing (MCM) was adopted from Duray (1997) with minor modifications to the wording of the items and the use of a different set of response options. Also, because the instrument was quite lengthy, it was decided that it should be simplified before use in the large-scale study. Therefore, the number of items representing the mass customization construct was reduced to 15 items. This was completed by first reviewing the author’s reported results and then retaining the items with the highest factor loadings.

To support the contention of this study, it was imperative that two different mass customizer types be identified based on their approach to manufacturing customized products. To facilitate the statistical analysis of the data to generate two distinct mass customizer groups, the response options for all 15 items were based on a four point scale to reflect how often establishments involved the customer and implemented certain types of modularity in the different stage of the production cycle for customized products. Customer involvement and type of modularity was represented on the survey instrument by the following items in Table 5.9. The four response options were “All of the Time”, “Most of the Time”, “Occasionally”, and “Never”.

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Table 5.9: Mass Customization Item from Survey Instrument

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<tr>
<th>Item Number</th>
<th>Customer Involvement</th>
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<tr>
<td>Ci1</td>
<td>Each customer order requires the fabrication of unique components prior to assembly</td>
</tr>
<tr>
<td>Ci2</td>
<td>Customers can assemble a product from components Customers can specify new product features</td>
</tr>
<tr>
<td>Ci3</td>
<td>Customers can specify size of products</td>
</tr>
<tr>
<td>Ci4</td>
<td>Customers can select features/options/accessories from pre-subscribe listings</td>
</tr>
<tr>
<td>Ci5</td>
<td>Customer’s specifications are used to alter components for each order</td>
</tr>
<tr>
<td>Ci6</td>
<td>Each customer order is assembled from components in stock</td>
</tr>
<tr>
<td>Ci7</td>
<td>Customer's requests are uniquely designed into the finished product</td>
</tr>
<tr>
<td></td>
<td><strong>Type of Modularity</strong></td>
</tr>
<tr>
<td>Pc1</td>
<td>How often do the following statements apply to your CUSTOMIZED products?</td>
</tr>
<tr>
<td>Pc2</td>
<td>End-products have inter-changable features/options/accessories</td>
</tr>
<tr>
<td>Pc3</td>
<td>End-products are assembled from standard components</td>
</tr>
<tr>
<td>Pc4</td>
<td>Main/primary components are selected from a pre-subscribe list</td>
</tr>
<tr>
<td>Pc5</td>
<td>Main/primary components can be uniquely designed or altered to end-user specifications</td>
</tr>
<tr>
<td>Pc6</td>
<td>Features/options/accessories can be uniquely designed or altered to end-user specifications</td>
</tr>
<tr>
<td>Pc7</td>
<td>Main/primary components can be shared across end-products</td>
</tr>
<tr>
<td>Pc8</td>
<td>Components dimensions can be changed for each end-user application</td>
</tr>
</tbody>
</table>

Principle component extraction method was employed to determine the composition of factors to represent the concept of two mass customization types. Conceptually, a two factor solution is essential to accurately identify the two types of mass customizers. Four factors were selected with eigenvalues greater than 1, accounting for 64.69% of the variance, as can be seen in Table 5.10. Based on the guidelines in Hair et al. (1998) for identifying significant factor loadings based on sample size, an item is
deleted if its factor loading is less than .45. Significance is based on a .05 significance level, a power level of 80%, and standard errors assumed to be twice those of conventional correlation coefficients. An examination of the factor matrix in Table 5.10 indicates that item #s Ci5 and Ci7 will be deleted because they are cross loading on more than one factor. A subsequent principle component analysis was conducted on the remaining 13 items to identify a 2 factor solution.

Table 5.10  First Factor Matrix for Mass Customization Items

<table>
<thead>
<tr>
<th>Item #</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ci1</td>
<td>.648</td>
<td>-.069</td>
<td>.202</td>
<td>-.223</td>
</tr>
<tr>
<td>Ci2</td>
<td>.329</td>
<td>-.073</td>
<td>.557</td>
<td>.400</td>
</tr>
<tr>
<td>Ci3</td>
<td>.638</td>
<td>-.297</td>
<td>.198</td>
<td>.075</td>
</tr>
<tr>
<td>Ci4</td>
<td>.692</td>
<td>.017</td>
<td>.308</td>
<td>.184</td>
</tr>
<tr>
<td>Ci5</td>
<td>.109</td>
<td>.598</td>
<td>.469</td>
<td>-.271</td>
</tr>
<tr>
<td>Ci6</td>
<td>.675</td>
<td>.159</td>
<td>.209</td>
<td>.151</td>
</tr>
<tr>
<td>Ci7</td>
<td>-.225</td>
<td>.577</td>
<td>-.223</td>
<td>.543</td>
</tr>
<tr>
<td>Ci8</td>
<td>.713</td>
<td>-.034</td>
<td>-.208</td>
<td>.418</td>
</tr>
<tr>
<td>pc1</td>
<td>.094</td>
<td>.579</td>
<td>.419</td>
<td>-.283</td>
</tr>
<tr>
<td>pc2</td>
<td>-.266</td>
<td>.785</td>
<td>-.042</td>
<td>.291</td>
</tr>
<tr>
<td>pc3</td>
<td>-.100</td>
<td>.812</td>
<td>.153</td>
<td>-.048</td>
</tr>
<tr>
<td>pc4</td>
<td>.705</td>
<td>.201</td>
<td>-.378</td>
<td>-.159</td>
</tr>
<tr>
<td>pc5</td>
<td>.671</td>
<td>.259</td>
<td>-.482</td>
<td>-.183</td>
</tr>
<tr>
<td>pc6</td>
<td>-.047</td>
<td>.755</td>
<td>-.179</td>
<td>-.055</td>
</tr>
<tr>
<td>pc7</td>
<td>.671</td>
<td>.273</td>
<td>-.300</td>
<td>-.117</td>
</tr>
<tr>
<td>Eigenvalues</td>
<td>3.929</td>
<td>3.177</td>
<td>1.539</td>
<td>1.058</td>
</tr>
</tbody>
</table>
The results of a second factor analysis indicates a three factor solution be selected based on eigenvalues greater than 1, accounting for 60.614% of the variance, as can be seen in Table 5.11. An examination of the factor matrix in Table 5.11 indicates that item # pc 1 will be deleted because it is cross loading on more than one factor. A subsequent principle component analysis was conducted on the remaining 12 items to identify a 2 factor solution.

The results of a third factor analysis suggests that a three factor solution be selected based on eigenvalues greater than 1, accounting for 65.92% of the variance, as can be seen in Table 5.12. An examination of the factor matrix in Table 5.12 indicates that item # Ci2 is the only item with a factor loading above the required .45 value. Since, factor 3 accounts for only 10.451% of the variance and has only one item with a loading greater than the required .45 minimum; item Ci2 will be removed from the analysis resulting in an additional principle component analysis on the remaining 11 items to identify a 2 factor solution.

The results of a fourth factor analysis suggests that a three factor solution be selected based on eigenvalues greater than 1, accounting for 65.32% of the variance, as can be seen in Table 5.13. An examination of the factor matrix in Table 5.13 indicates that item # Ci4 is the only item with a factor loading above the required .45 value. Since, factor 3 accounts for only 9.42% of the variance and has only one item with a loading greater than the required .45 minimum; item Ci4 will be removed from the analysis resulting in an additional principle component analysis on the remaining 10 items to identify a 2 factor solution.
Table 5.11  Second Factor Matrix for Mass Customization Items

<table>
<thead>
<tr>
<th>Item #</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ci1</td>
<td>.635</td>
<td>-.112</td>
<td>.162</td>
</tr>
<tr>
<td>Ci2</td>
<td>.323</td>
<td>-.141</td>
<td>.683</td>
</tr>
<tr>
<td>Ci3</td>
<td>.620</td>
<td>-.353</td>
<td>.181</td>
</tr>
<tr>
<td>Ci4</td>
<td>.687</td>
<td>-.068</td>
<td>.331</td>
</tr>
<tr>
<td>Ci6</td>
<td>.675</td>
<td>.096</td>
<td>.229</td>
</tr>
<tr>
<td>Ci8</td>
<td>.727</td>
<td>-.062</td>
<td>-.088</td>
</tr>
<tr>
<td>pc1</td>
<td>.102</td>
<td>.581</td>
<td>.459</td>
</tr>
<tr>
<td>pc2</td>
<td>-.220</td>
<td>.779</td>
<td>.121</td>
</tr>
<tr>
<td>pc3</td>
<td>-.072</td>
<td>.799</td>
<td>.212</td>
</tr>
<tr>
<td>pc4</td>
<td>.720</td>
<td>.225</td>
<td>-.348</td>
</tr>
<tr>
<td>pc5</td>
<td>.692</td>
<td>.276</td>
<td>-.466</td>
</tr>
<tr>
<td>pc6</td>
<td>-.015</td>
<td>.806</td>
<td>-.093</td>
</tr>
<tr>
<td>Pc7</td>
<td>.688</td>
<td>.279</td>
<td>-.271</td>
</tr>
</tbody>
</table>

Eigenvalues

|     | 3.88 | 2.611 | 1.386 |

Percent of Variance

|      | 29.866 | 20.086 | 10.661 |
Table 5.12: Third Factor Matrix for Mass Customization Items

<table>
<thead>
<tr>
<th>Item #</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ci1</td>
<td>.635</td>
<td>-.135</td>
<td>.083</td>
</tr>
<tr>
<td>Ci2</td>
<td>.321</td>
<td>-.222</td>
<td>.678</td>
</tr>
<tr>
<td>Ci3</td>
<td>.627</td>
<td>-.374</td>
<td>.096</td>
</tr>
<tr>
<td>Ci4</td>
<td>.687</td>
<td>-.085</td>
<td>.358</td>
</tr>
<tr>
<td>Ci6</td>
<td>.670</td>
<td>.091</td>
<td>.295</td>
</tr>
<tr>
<td>Ci8</td>
<td>.732</td>
<td>.010</td>
<td>.030</td>
</tr>
<tr>
<td>pc2</td>
<td>-.243</td>
<td>.763</td>
<td>.281</td>
</tr>
<tr>
<td>pc3</td>
<td>-.096</td>
<td>.769</td>
<td>.346</td>
</tr>
<tr>
<td>pc4</td>
<td>.714</td>
<td>.277</td>
<td>-.348</td>
</tr>
<tr>
<td>pc5</td>
<td>.687</td>
<td>.349</td>
<td>-.448</td>
</tr>
<tr>
<td>pc6</td>
<td>-.037</td>
<td>.818</td>
<td>.051</td>
</tr>
<tr>
<td>pc7</td>
<td>.683</td>
<td>.344</td>
<td>-.200</td>
</tr>
</tbody>
</table>

| Eigenvalue | 3.876 | 2.381 | 1.254 |
| Percentage of Variance | 32.297 | 19.854 | 10.451 |

Extraction Method: Principal Component Analysis.
Table 5.13: Fourth Factor Matrix for Mass Customization Item

<table>
<thead>
<tr>
<th>Item #</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ci1</td>
<td>.623</td>
<td>-.146</td>
<td>.029</td>
</tr>
<tr>
<td>Ci3</td>
<td>.613</td>
<td>-.391</td>
<td>.207</td>
</tr>
<tr>
<td>Ci4</td>
<td>.740</td>
<td>-.091</td>
<td>.518</td>
</tr>
<tr>
<td>Ci6</td>
<td>.665</td>
<td>.082</td>
<td>.435</td>
</tr>
<tr>
<td>Ci8</td>
<td>.730</td>
<td>-.010</td>
<td>.057</td>
</tr>
<tr>
<td>pc2</td>
<td>-.229</td>
<td>.787</td>
<td>.235</td>
</tr>
<tr>
<td>pc3</td>
<td>-.085</td>
<td>.792</td>
<td>.292</td>
</tr>
<tr>
<td>pc4</td>
<td>.733</td>
<td>.236</td>
<td>-.400</td>
</tr>
<tr>
<td>pc5</td>
<td>.718</td>
<td>.296</td>
<td>-.436</td>
</tr>
<tr>
<td>pc6</td>
<td>-.013</td>
<td>.822</td>
<td>-.041</td>
</tr>
<tr>
<td>pc7</td>
<td>.702</td>
<td>.309</td>
<td>-.200</td>
</tr>
</tbody>
</table>

Eigenvalue  | 3.779 | 2.350 | 1.073 |
Percentage of Variance  | 34.535 | 21.366 | 9.423 |

Extraction Method: Principal Component Analysis.
The results of a fifth factor analysis identifies the required two factor solution based on eigenvalues greater than 1, accounting for 57.77% of the variance, as can be seen in Table 5.14. An examination of the final factor matrix in Table 5.14 indicates that factor 1 consists of 7 items with a Cronbach’s reliability coefficient of .815. For the purpose of item purification, the Corrected-Item Total Correlation (CITC) was calculated for each item. All items have CITC values above the required .50 threshold except for item # Ci3 which was .428. Removing this item from the first factor increases the explained variance by 2% and the scale’s reliability alpha value decreased by only .001 to .814. Thus, item # Ci1 was deleted from the scale for future analyses. The remaining six items; ci 1, 6, 8, and Pc 4, 5, & 7, are part of a scale that measure the point of customer involvement and type of modularity used in the production for a IMCM system. Accordingly, this factor will be labeled IMCM.

The second factor solution consists of 3 items with CITC values above .50 and a Cronbach’s alpha value of .788. However, these three items, Pc2, 3, & 6, only measure the type of modularity a firm uses in the production cycle when manufacturing customized products. Factor 2 does not have an item that measures the point of customer involvement in the production cycle. To overcome this limitation, an additional factor analysis was conducted to include Ci7 which was determined to be the most theoretical relevant item that should be included in the scale for future analyses. The item loaded on factor 2 with a value of .717 and did not cause the other factor structure to change. Item Ci 7 has a CITC value of .514 and increases the scales alpha value to .788. Thus, the factor 2 items of Ci7, Pc 2, 3, & 6 are part of a scale that measures the point of customer
involvement and type of modularity used in the production for a FMCM system. Accordingly, this factor will be labeled FMCM.

Table 5.14: Final Factor Matrix for Mass Customization Items

<table>
<thead>
<tr>
<th>Item #</th>
<th>Factor 1</th>
<th>Factor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ci1</td>
<td>.620</td>
<td>-.174</td>
</tr>
<tr>
<td>Ci3</td>
<td>.577</td>
<td>-.412</td>
</tr>
<tr>
<td>Ci6</td>
<td>.636</td>
<td>.063</td>
</tr>
<tr>
<td>Ci8</td>
<td>.737</td>
<td>-.044</td>
</tr>
<tr>
<td>pc2</td>
<td>-.217</td>
<td>.803</td>
</tr>
<tr>
<td>pc3</td>
<td>-.082</td>
<td>.805</td>
</tr>
<tr>
<td>pc4</td>
<td>.774</td>
<td>.194</td>
</tr>
<tr>
<td>pc5</td>
<td>.763</td>
<td>.254</td>
</tr>
<tr>
<td>pc6</td>
<td>.043</td>
<td>.816</td>
</tr>
<tr>
<td>pc7</td>
<td>.721</td>
<td>.275</td>
</tr>
<tr>
<td>Eigenvalue</td>
<td>3.424</td>
<td>2.342</td>
</tr>
<tr>
<td>Percentage of Variance</td>
<td>34.244</td>
<td>22.432</td>
</tr>
</tbody>
</table>

Extraction Method: Principal Component Analysis.
I follow Duray’s (1997) method to classify establishments as FMCM or IMCM. I differ from her approach in that this study only has two different types of mass customizers where she classified four distinct groups. Three dummy variables are created to represent if an establishment has a FMCM, IMCM, or no MCM system. The variable $FiniteMass$ is coded 1 if the establishment is classified as a FMCM and 0 otherwise. The variable $InfiniteMass$ is coded 1 if the establishment is classified as an IFMC and 0 otherwise. The variable $NoMass$ is coded as 1 if the establishment is not classified as a mass customizer and 0 otherwise.

To classify establishments based on their MCM approach, the criteria is based on the factor scores for the IMCM and FMCM scales calculated in the previous factor analysis. A positive score indicates that the respondent facility utilizes that type of MCM system. If a facility’s response yields a negative score, then they do not utilize that type of MCM system.

Each establishment is classified and the corresponding dummy variables are coded based on the following categorization scheme:

- If a respondent facility scores positively on both the IMCM and FMCM scores, then the factor with the highest score value will determine how the establishment will be classified;
  - If the IMCM factor score is larger than the FMCM score, then the $InfiniteMass$ variable is coded 1 and the other two variables 0. Conversely, if the FMCM factor score is larger than the IMCM score, then the $FiniteMass$ variable is coded 1 and the other two variables 0.
- If the scores for both IMCM and FMCM are negative, then the NoMass is coded as 1 and the other two variables 0.
- If the IMCM factor score is positive and the FMCM score is negative, then the InfiniteMass variable is coded 1 and the other two variables 0.
- If the FMCM factor score is positive and the IMCM score is negative, then the FiniteMass variable is coded 1 and the other two variables 0.

A review of the frequencies of each variable indicates that 58 establishment have been classified as FMCM, 56 are identified as IMCM, and 34 fail to be categorized as a mass customizer.

5.5.2 Dependent Variable

The measure of operational performance is based on a subjective assessment of the manufacturing manager at a production facility. It is particularly difficult to obtain objective and financial outcome measures at the establishment level. Subjective data is appropriate when objective data are not available and measures of productivity are difficult to identify. Since the level of analysis is at the facility level for the customized product lines, manufacturing managers may not have readily accessible records of operational performance if the facility is part of a larger corporation. This would pose an analysis problem among all study respondents. Also, subjective measures of operational performance are used in similar types of research and have been shown to be reliable and
valid (Ahmad and Schroeder, 2003; Kintana et al., 2006; Yount et al., 1996; Duray, 1999; Tu et al., 2001; and Liu et al., 2006; Guest, 2001).

5.5.2.1 Operational Performance

Mass customization is a function of producing a unique product at mass production costs with exceptional quality in a relatively short period of time (Pine, 1989). The measurement of operational performance for mass customization requires a representative set of cost, quality, delivery, and flexibility items to capture the dynamic underlying aspects of manufacturing these types of products. This study creates an instrument to measure mass customization operational performance by combining several items from existing scales that measure cost, quality, delivery, and flexibility performance from five existing instruments into one aggregate scale. This aggregate scale was created by theoretically selecting the most representative items from the operational performance instruments in the manufacturing management literature developed by Ahmad and Schroeder (2003), Kintana et al. (2006), Yount et al. (1996), Duray (1997), Rondeau, Vonderembse, and Ragu-Nathan (2000), Tu, Vonderembse, & Ragu-Nathan (2001), and Liu et al. (2006). Table 5.15 below provides a summary of the 15 items that were adopted from previous research that are used in this study.

Since these prior instruments all had different response options, this study created a set of new response categories to standardize the choices across all items. The instrument contained 5 response options and were coded as follows: 1 = Much worse than estimated, 2 = Slightly worse than estimated, 3 = As estimated, 4 = Slightly better
than estimated, and 5 = Much better than estimated. Also, respondents were instructed to rate their establishments actual performance for ONLY the CUSTOMIZED products manufactured at their facility.

The following two items were adopted from the literature to capture the cost element of mass customization. The item “Overall manufacturing cost per unit output” was adopted from Ahmad and Schroeder (2003) and the item “Plant capacity utilization (productive hours relative to total number of hours available)” was adopted from Kintana et al. (2006). To strengthen this instrument, one item was added to the cost dimension to capture the costs associated with carrying excess inventory. Hayes and Wheelwright (1984) suggest that inventory is a major contributor to a manufacturing firm.

The following two items were adopted from Kintana et al. (2006) to capture the quality element of mass customization; “component part scrap/rework rate” and “module and final assembly scrap/rework rate”. In addition, the following item was based on Duray (1997); “customers’ perception of overall product quality”.

Delivery performance was based on 4 items; 3 items from Rondeau, Vonderembse, and Ragu-Nathan, (2000) and one item from Tu et al. (2001). “Ability to provide on-time delivery to customers”, “Ability to provide fast delivery to customers and “Ability to provide reliable delivery to customer” were adopted from Rondeau, Vonderembse, and Ragu-Nathan, (2000). The item “Ability to quickly translate customer requirements into technical designs” was adopted from Tu et al. (2001).

A combination of items were adopted from Duray (1997), Liu et al. (2006), and Tu et al. (2001) to capture the flexibility elements of mass customization. The items “Ability to handle variations in inputs” and “Ability to process both large and small
orders without increasing cost and decreasing quality’ was adopted from Duray (1997). The item “Ability to make rapid production volume changes without increasing cost and decreasing quality” was from Tu et al. (2001) and Liu et al. (2006) provided “Ability to produce a number of different products without increasing cost and decreasing quality”. To strengthen this instrument, one item was added to the flexibility dimension to determine the ability to quickly change-over resources. Hayes and Wheelwright (1984) suggest that fast set-up times are a major contributor to a manufacturing firm.
<table>
<thead>
<tr>
<th>Operational Performance Domain</th>
<th>Literature Citation</th>
<th>Measurement Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>Ahmad and Schroeder (2003)</td>
<td>Overall manufacturing cost per unit output</td>
</tr>
<tr>
<td></td>
<td>Kintana et al. (2006)</td>
<td>Plant capacity utilization (productive hours relative to total number of hours available)</td>
</tr>
<tr>
<td></td>
<td>Hayes and Wheelwright (1984)</td>
<td>Inventory Costs</td>
</tr>
<tr>
<td>Quality</td>
<td>Kintana et al. (2006)</td>
<td>Component part scrap/rework rate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Module and final assembly scrap/rework rate</td>
</tr>
<tr>
<td></td>
<td>Duray (1997)</td>
<td>Customers’ perception of overall product quality</td>
</tr>
<tr>
<td>Delivery</td>
<td>Rondeau, Vonderembse, and Ragu-Nathan, (2000)</td>
<td>Ability to provide on-time delivery to customers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ability to provide fast delivery to customers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ability to provide reliable delivery to customer</td>
</tr>
<tr>
<td></td>
<td>Tu et al. (2001)</td>
<td>Ability to quickly translate customer requirements into technical designs</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Duray (1997)</td>
<td>Ability to handle variations in inputs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ability to process both large and small orders without increasing cost and decreasing quality</td>
</tr>
<tr>
<td></td>
<td>Tu et al. (2001)</td>
<td>Ability to make rapid production volume changes without increasing cost and decreasing quality</td>
</tr>
<tr>
<td></td>
<td>Liu et al. (2006)</td>
<td>Ability to produce a number of different products without increasing cost and decreasing quality</td>
</tr>
<tr>
<td></td>
<td>Hayes and Wheelwright (1984)</td>
<td>Ability to quickly set-up/change-over resources</td>
</tr>
</tbody>
</table>

Respondents were instructed to rate their establishments actual performance for ONLY the CUSTOMIZED products manufactured at their facility. Response options were coded as follows: 1 = Much worse than estimated, 2 = Slightly worse than estimated, 3 = As estimated, 4 = Slightly better than estimated, and 5 = Much better than estimated.
Since mass customization operational performance is a one dimensional construct consisting of numerous distinct elements, it is expected that a four factor solution would appropriately represent this concept. Exploratory factor analysis was employed to determine which items from all four factor components should be used in the aggregate uni-dimensional measurement scale. A principle component extraction method with promax rotation was specified to conduct the factor analysis and assist in determining the composition of the factor structure to represent this one dimensional concept. Following the criteria of Hair et al. (1998) for determining the number of factors to extract, only the factors having latent roots or eigenvalues greater than 1 will be retain for structure interpretation.

The initial four factor solution accounting for 62.434% of the variance is presented in Table 5.16. Based on the guidelines in Hair et al. (1998) for identifying significant factor loadings based on sample size, an item is deleted if its factor loading is less than .45. Significance is based on a .05 significance level, a power level of 80%, and standard errors assumed to be twice those of conventional correlation coefficients. An examination of the factor matrix in Table 5.16 indicates that items \textit{qp3} and \textit{dp4} will be deleted from the analysis. A subsequent principle component analysis was conducted on the remaining items.

Table 5.17 provides the results for the revised four factor solution. The data indicates that all items have factor loadings above the .45 required minimum and each factor consists of only the a priori conceptualized items that measure the explicit dimensions of mass customization performance. For example, factor component 1 contains only the 5 items that were created to measure the flexibility dimension of mass
customization operational performance. In addition, Table 5.17 indicated that the revised
four factor solution accounts for 68% of the variance and the Bartlett test of sphericity is
statistically significant at the .0001 level supporting the requirement that there is presence
of nonzero correlations among the individual items. The Kaiser-Meyer-Olkin Measure of
Sampling Adequacy value of .826 further supports the high degree of intercorrelations
among items indicating that that reduced set of items meets the fundamental requirements
for factor analysis.

Thus, as expected, mass customization operational performance is a one
dimensional construct consisting of numerous distinct elements. Based on the empirical
support of the four factor solution and the theoretical foundation of the mass
customization literature, I create an aggregate uni-dimensional scale to measure mass
customization operational performance. Following the recommendation of Hair, et al.
(1998), a summated scale was created by combining all 14 items into a single composite
measurement scale. Reliability assessments were made using Cronbach’s reliability
coefficient. The aggregated uni-dimensional scale achieved a Cronbach’s alpha of .857
exceeding the suggested of 0.60 for exploratory research by Nunnally (1978). This
instrument, labeled \textit{OpPerform}, will function as the dependent variable in a regression
model to test hypotheses 2a and 2b.

A visual examination of the normal probability plot in Chart 5.5 and frequency
histogram in Chart 5.6 shows the \textit{OpPerform} variable to be approximately normally
distributed. Cohen and Cohen (1983) suggest that a slight deviation from normality of the
dependent variable would be acceptable for a regression analysis.
### Table 5.16: Initial Factor Matrix for Operational Performance Items

<table>
<thead>
<tr>
<th>Item #</th>
<th>Item</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
<th>Commonalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>cp1</td>
<td>Overall manufacturing cost per unit output</td>
<td>-.092</td>
<td>.145</td>
<td>-.049</td>
<td>.804</td>
<td>.681</td>
</tr>
<tr>
<td>cp2</td>
<td>Plant capacity utilization (productive hours relative to total number of hours available)</td>
<td>.237</td>
<td>.041</td>
<td>-.005</td>
<td>.546</td>
<td>.456</td>
</tr>
<tr>
<td>cp3</td>
<td>Inventory Costs</td>
<td>.197</td>
<td>-.143</td>
<td>-.030</td>
<td>.641</td>
<td>.453</td>
</tr>
<tr>
<td>qp1</td>
<td>Component part scrap/rework rate</td>
<td>.035</td>
<td>.000</td>
<td></td>
<td>.883</td>
<td>-.009 .795</td>
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<tr>
<td>qp2</td>
<td>Module and final assembly scrap/rework rate</td>
<td>.096</td>
<td>-.043</td>
<td></td>
<td>.930</td>
<td>-.078 .868</td>
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<tr>
<td>qp3</td>
<td>Customers’ perception of overall product quality</td>
<td>-.273</td>
<td>.271</td>
<td>.429</td>
<td>.355</td>
<td>.485</td>
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<tr>
<td>dp1</td>
<td>Ability to provide on-time delivery to customers</td>
<td>.018</td>
<td></td>
<td>-.038</td>
<td>.093</td>
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<tr>
<td>dp2</td>
<td>Ability to provide fast delivery to customers</td>
<td>.218</td>
<td></td>
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<tr>
<td>dp3</td>
<td>Ability to provide reliable delivery to customer</td>
<td>.033</td>
<td>.904</td>
<td>.009</td>
<td>-.021</td>
<td>.831</td>
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<tr>
<td>dp4</td>
<td>Ability to quickly translate customer requirements into technical designs</td>
<td>.358</td>
<td>.287</td>
<td>.012</td>
<td>.011</td>
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<tr>
<td>fp1</td>
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<td></td>
<td>.511</td>
<td>-.242</td>
<td>.119 .321 .440</td>
</tr>
<tr>
<td>fp2</td>
<td>Ability to make rapid production volume changes without increasing cost and decreasing quality</td>
<td></td>
<td>.726</td>
<td>.085</td>
<td>-.097</td>
<td>.016 .549</td>
</tr>
<tr>
<td>fp3</td>
<td>Ability to process both large and small orders without increasing cost and decreasing quality</td>
<td>.720</td>
<td>.107</td>
<td>-.029</td>
<td>.136</td>
<td>.657</td>
</tr>
<tr>
<td>fp4</td>
<td>Ability to produce a number of different products without increasing cost and decreasing quality</td>
<td>.727</td>
<td>.081</td>
<td>.067</td>
<td>.069</td>
<td>.656</td>
</tr>
<tr>
<td>fp5</td>
<td>Ability to handle variations in inputs</td>
<td>.784</td>
<td>.085</td>
<td>.056</td>
<td>-.128</td>
<td>.645</td>
</tr>
</tbody>
</table>

**Eigenvalues**

<p>| | | | | |</p>
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<td></td>
<td>5.268</td>
<td>1.563</td>
<td>1.416</td>
<td>1.119</td>
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**Percent of Variance**

<p>| | | | | |</p>
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<td></td>
<td>35.119</td>
<td>10.420</td>
<td>9.438</td>
<td>7.458</td>
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215
Table 5.17: Final Factor Matrix for Operational Performance Items

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<tr>
<th>Item #</th>
<th>Item</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
<th>Commonalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>cp1</td>
<td>Overall manufacturing cost per unit output</td>
<td>-.134</td>
<td>.159</td>
<td>-.038</td>
<td>.810</td>
<td>.672</td>
</tr>
<tr>
<td>cp2</td>
<td>Plant capacity utilization (productive hours relative to total number of hours available)</td>
<td>.076</td>
<td>.077</td>
<td>.075</td>
<td>.649</td>
<td>.544</td>
</tr>
<tr>
<td>cp3</td>
<td>Inventory Costs</td>
<td>.183</td>
<td>-.118</td>
<td>-.021</td>
<td>.623</td>
<td>.446</td>
</tr>
<tr>
<td>qp1</td>
<td>Component part scrap/rework rate</td>
<td>-.083</td>
<td>.046</td>
<td>.932</td>
<td>.074</td>
<td>.880</td>
</tr>
<tr>
<td>qp2</td>
<td>Module and final assembly scrap/rework rate</td>
<td>.074</td>
<td>-.016</td>
<td>.922</td>
<td>-.064</td>
<td>.864</td>
</tr>
<tr>
<td>dp1</td>
<td>Ability to provide on-time delivery to customers</td>
<td>-.032</td>
<td>.875</td>
<td>-.022</td>
<td>.115</td>
<td>.810</td>
</tr>
<tr>
<td>dp2</td>
<td>Ability to provide fast delivery to customers</td>
<td>.153</td>
<td>.812</td>
<td>.047</td>
<td>-.055</td>
<td>.773</td>
</tr>
<tr>
<td>dp3</td>
<td>Ability to provide reliable delivery to customer</td>
<td>.007</td>
<td>.915</td>
<td>.008</td>
<td>-.013</td>
<td>.838</td>
</tr>
<tr>
<td>fp1</td>
<td>Ability to quickly set-up/change-over resources</td>
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<td>-.254</td>
<td>.090</td>
<td>.278</td>
<td>.446</td>
</tr>
<tr>
<td>fp2</td>
<td>Ability to make rapid production volume changes without increasing cost and decreasing quality</td>
<td>.707</td>
<td>.082</td>
<td>-.087</td>
<td>.023</td>
<td>.529</td>
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<tr>
<td>fp3</td>
<td>Ability to process both large and small orders without increasing cost and decreasing quality</td>
<td>.762</td>
<td>.092</td>
<td>-.058</td>
<td>.092</td>
<td>.681</td>
</tr>
<tr>
<td>fp4</td>
<td>Ability to produce a number of different products without increasing cost and decreasing quality</td>
<td>.792</td>
<td>.079</td>
<td>.031</td>
<td>.007</td>
<td>.708</td>
</tr>
<tr>
<td>fp5</td>
<td>Ability to handle variations in inputs</td>
<td>.791</td>
<td>.078</td>
<td>.050</td>
<td>-.138</td>
<td>.641</td>
</tr>
</tbody>
</table>

Eigenvalues

|        | 4.886 | 1.549 | 1.292 | 1.104 |

Percent of Variance

|        | 37.582 | 11.917 | 9.940 | 8.493 |

Cronbach’s Reliability Alpha Coefficient

|       | .857   |

Kaiser-Meyer-Olkin Measure of Sampling Adequacy

|       | .826   |

Bartlett's Test of Sphericity

|       | df = 78 |
|       | Approx. Chi-Square = 743.016 |
|       | Sig. = .000 |
Chart 5.5: Normal Q-Q Plot for Operation Performance
Chart 5.6: Frequency Histogram for Mass Customization Operational Performance

Histogram

Mean = 3.08
Std. Dev. = 0.551
N = 148
5.5.3 Control Variables

The following establishment variables are included in this study to statistically control for their confounding effects on operational performance in a mass customization environment that manages shop-floor workers with a HPWS. Prior research indicates that unions can have a significant impact on the effectiveness of HPWS in various manufacturing setting suggesting that operational performance may be a result of unionization and not directly on how shop-floor workers are managed (Applebaum and Bhatt, 1992; Gill, 2009). *Unionization* is a dummy variable taking on the value of 1 if the respondent indicates that their establishment is a union shop.

Firm size, in terms of number of employees and gross sales, is included as a statistical control mechanism as it has previously been found to influence operational performance and the extensiveness of HPWS. The number of individuals that an establishment employs has been shown to effect the degree in which HPWS are implemented (Way, 2002) and the extensiveness of mass customization production at a particular manufacturing facility (Silveira, Borenstein, and Fogliatto, 2001). Firms with a larger amount of employees tend to adopt more HRM practices in a HPWS than smaller companies because the cost of implementing all the required practices becomes extremely expensive (Macky and Boxall, (2007). Also, smaller firm tend to focus more on MCM because they are more flexible and tend to have a closer relationship with their customers. To control for the impact the number of individuals an establishment employs, a question was asked for to determine how many employees are currently working at the production facility. The variable *employeesize* was coded 1 if respondents indicated that
there were less than 99 employees, 2 if between 100 – 249, 3 if 250 to 499, 4 if 500 – 999, 5 if 1000 – 2999, and 6 if there were more than 5000 employees. The variable gross sales (in millions of $) was coded 1 if respondents reported that gross sales in the last fiscal year is less than 5 million, 2 if 5 to 10, 3 if 11 to 25, 4 50 to 100, and 6 if over 100 million.

Since this study focuses directly on an establishment’s customized product line, an additional variable was created to control for the amount of sales, in dollars, is attributed to customized products. Respondents were asked to indicate what percentage of sales, in dollars, comes from customized products. The variable percentsaledollar was coded 1 if respondents reported that the percentage sales, in dollars, is less than 10%, 2 if 11% to 30%, 3 if 31% to 50%, 4 if 51% to 70%, 5 if 71% to 90%, and 6 if greater than 90%.

Since this study samples all manufacturing establishments, industry effects are controlled for by dummy coding all 20 SIC codes with the not provided response option as the reference category.

5.6 Large Scale Study Questionnaire

A copy of the questionnaire used for this study is provided in Appendix B and can be accessed at the following web-link.

6.1 Descriptive Statistics of Control, Independent, and Dependent Variables

Table 6.1 reports the relevant descriptive statistics for, and intercorrelations between, the control, independent, and dependent variables included in this study. In particular, Table 6.1 presents the means and standard deviations for this study’s key variables: unionization, employee size, facility age, gross sales, percentages of sales from customized products (in dollars), SIC code, IHPWS index, FHPWS index, FMCM, IMCM, and operational performance.
## Table 6.1
Descriptive Statistics and Correlation

| Variable                      | Mean   | sd    | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    | 11    | 12    | 13    | 14    | 15    | 16    | 17    | 18    | 19    | 20    | 21    | 22    | 23    | 24    | 25    | 26    | 27    | 28    |
|-------------------------------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. Operational Performance   | 3.08   | 0.55  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 2. Unionized employees       | 0.14   | 0.35  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 3. facilityage               | 4.42   | 0.97  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 4. % Sales from Customized Products | 4.13  | 1.59  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 5. sic20                      | 0.01   | 0.08  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 6. sic21                      | 0.01   | 0.08  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 7. sic22                      | 0.01   | 0.08  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 8. sic23                      | 0.01   | 0.08  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 9. sic24                      | 0.01   | 0.08  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 10. sic25                     | 0.01   | 0.08  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 11. sic26                     | 0.01   | 0.08  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 12. sic27                     | 0.01   | 0.08  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 13. sic28                     | 0.01   | 0.08  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 14. sic29                     | 0.01   | 0.08  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 15. sic30                     | 0.01   | 0.08  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 16. sic31                     | 0.01   | 0.08  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 17. sic32                     | 0.01   | 0.08  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 18. sic33                     | 0.01   | 0.08  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 19. sic34                     | 0.01   | 0.08  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 20. sic35                     | 0.01   | 0.08  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 21. sic36                     | 0.01   | 0.08  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 22. sic37                     | 0.01   | 0.08  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 23. FiniteMass                | 0.01   | 0.08  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 24. InfiniteMass              | 0.01   | 0.08  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 25. IHPWS subjectivecode     | 5.00   | 2.15  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 26. FHPWS subjectivecode     | 5.46   | 1.70  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |

* = p < 0.05, ** = p < 0.01, *** = p < 0.001
Among this study’s sample of US manufacturing establishments the mean IHPWS unitary index is 5.00 (S.D. = 2.151) and the FHPWS unitary index is 5.46 (S.D. = 1.70) out of a possible score of twelve. The FHPWS ranges from 0 to 9 and the IHPWS ranges from 0 to 12. It is interesting to note that the two HPWS index scores are relatively equal in terms of the average number of HRM practices employed. Also, the results indicate that US manufacturing establishments are not fully utilizing HPWS practices to manage shop-floor workers at their plants.

Also, Table 6.1 provides the zero-order correlations of the control variables, HPWS indexes, MCM type and operational performance. As expected, the table shows a significant high negative correlation between the two HPWS indexes and significant moderate negative correlation between the two MCM systems. Also, operational performance was significantly associated with both HPWS indexes but not the MCM variables. In particular, operational performance is positively correlated with the IHPWS, but interestingly, negatively associated with the FHPWS. One final noteworthy association is the negative significant correlation between unionization and the IHPWS index and not with the FHPWS.

6.2 Hypothesis Testing and Results

A hierarchical cluster analysis is employed to test Hypothesis 1: *Internally consistent sets of HRM practices are uniquely bundled into two distinct HPWS; namely FHPWS and IHPWS.* To test Hypothesis 2a: *FMCM systems have a moderating effect on the relationship between FHPWS and operational performance. Establishments which*
utilize FMCM systems must also implement FHPWS in order to maximize operational performance and Hypothesis 2b: IMCM systems have a moderating effect on the relationship between IHPWS and operational performance. Establishments which utilize IMCM systems must also implement IHPWS in order to maximize operational performance, I use hierarchical regression analysis in order to isolate the main effects of the establishment characteristics and the individual HRM practices on operation performance. In addition, this approach provides a means to control for the main effects of the HPWS and MCM types and to independently evaluate how each MCM system moderated the relationship between HPWS and operational performance.

6.2.1 Hierarchical Cluster Analysis

One principle goal of this study was to determine if several different types HRM practices can be uniquely bundled into a meaningful structure or taxonomy. Cluster analysis is an exploratory data analysis technique which aims to sort different objects (cases or variables) into groups in a way that the relationship between two objects is maximized if they belong to the same group more than the relationship to objects in other groups. The primary purpose of cluster analysis is to maximize homogeneity within clusters of objects and simultaneously maximize heterogeneity across clusters objects. For the purpose of this study, objects are considered to be the HRM practices an establishment uses to manage their workforce. Arthur (1992) conducted a cluster analysis in his study of HPWS but based the relationships on cases to identify groups of similar firms based on the types of HRM practices they utilize. This study differs from Arthur
that the goal is to identify how firms are using several different individual HRM in combination with each other. Thus, a cluster analysis will be administered to test Hypothesis 1 that a discrete set of HRM practices can be uniquely bundled into two distinct HPWS; namely FHPWS and IHPWS. Also, the results of this analysis will provide as a validity test for the additive unitary HPWS indexes created above; supporting the notion that the specific HRM practice identified for each HPWS are appropriate.

There are three basic decisions that must be made to conduct a cluster analysis (Milligan, 1996). First, the type of cluster analysis must be chosen. Broadly, the two most popular types are the hierarchical and K-means approaches. I utilize the hierarchical approach because the method generally starts with all objects (variables) on their own and progressively groups them together to form clusters of objects with the same characteristics. Also, the K-means approach does not permit clustering by variables, only on a case basis. Thus, the hierarchical approach provides the only method to test Hypothesis 1.

Second, the clustering method must be specified to determine how individual objects will be linked to clusters. There are seven linkage or amalgamation rules (methods) available in the latest SPSS 17.0 statistical package. These amalgamation rules determine when two clusters are sufficiently similar to be linked together. Generally, there is no theoretical basis for choosing one method over another. In selecting a linkage method, the research must determine the goals of the analysis and determine which method is appropriate. The with-in group linkage will form clusters so that the with-in variance is minimized producing a tighter cluster than the other techniques. Also, the
with-in group linkage was chosen because it will produce a cluster in the form of a “cluster” as opposed to creating a cluster in the form of a chain. This type of clustering method fits the conceptualization of how HRM practices are bundled together to create a HPWS. The basic premise of HPWS are that HRM practices are complementary and produce a synergistic effect, whereas chaining would assume that the practices would be used linearly which is not consistent of the HPWS definition. Also, the with-in group linkage method will identify the HRM practices that have the least amount variance between them; thus, supporting the contention of complementarities of practices.

The last decision that must be made is choosing a distance (proximity) measure that defines the distance between objects and is used to detect groups in the data. This reflects the degree of closeness or separation between objects to be clustered. Since the HRM practices to be cluster are dummy variables, a binary proximately measure must be chosen. There are several different types of binary proximately measures with no theoretical basis to suggest which is most appropriate. Again, the research must determine the goals of the analysis and determine which measure is appropriate. The binary shape difference measure was selected as the proximately measure for this study. This measure has no upper or lower limit in its calculation that defines the distance between objects (variables). It was determined that this measure provides the best method to calculate the degree of closeness or separation between HRM practices to be clustered since the focus on this study is to determine which specific practices bundle together to form a distinct HPWS.

All of the following variables were entered simultaneously into the analysis and the program was instructed to form clusters based on variables rather than cases.
IHPComp, IHPTeam, IHPTrainType, IHPTrainWhen, IHPInfoShare, IHPWhoAppras, IHPWhenAppras, IHPPreview, IHPSelectDevice, IHPSelectIndicat, IHPConsult, and IHPJobDesign, FHPComp, FHPTeam, FHPTrainType, FHPTrainWhen, FHPInfoShare, FHPWhoAppras, FHPWhenAppras, FHPPreview, FHPSelectDevice, FHPSelectIndicat, FHPConsult, and FHPJobDesign. Since the use of a cluster analysis was primarily for a confirmatory analysis of Hypothesis 1 rather than a general exploratory examination of the data, the analysis was specified to produce a two cluster solution in which the selected variables can be classified into groups.

The results in Table 6.1 of the analysis indicates that the 2 cluster solution grouped all of the IHPWS HRM practices together and all of the IHPWS practice together; thus providing support for Hypothesis 1 that internally consistent sets of HRM practices are uniquely bundled into two distinct HPWS; namely FHPWS and IHPWS. A visual examination of Figure 6.1 confirms that bundles of HRM practices conceptualized to be part of a HPWS cluster together to form a unified set workforce management practices.
### Chart 8.1 HPWS Cluster Solution

<table>
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<th>Variables</th>
<th>2 Clusters</th>
</tr>
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</tr>
<tr>
<td>FHPWS TEAM</td>
<td>1</td>
</tr>
<tr>
<td>FHPWS CONSULTATION</td>
<td>1</td>
</tr>
<tr>
<td>FHPWS JOB DESIGN</td>
<td>1</td>
</tr>
<tr>
<td>FHPWS INFORMATION SHARING</td>
<td>1</td>
</tr>
<tr>
<td>FHPWS Who Performs Appraisal</td>
<td>1</td>
</tr>
<tr>
<td>FHPWS When Appraisal Provided</td>
<td>1</td>
</tr>
<tr>
<td>FHPWS Training Type</td>
<td>1</td>
</tr>
<tr>
<td>FHPWS Train When</td>
<td>1</td>
</tr>
<tr>
<td>FHPWS How Preview Provided</td>
<td>1</td>
</tr>
<tr>
<td>FHPWS Selection Devices</td>
<td>1</td>
</tr>
<tr>
<td>FHPWS Selection Indicator</td>
<td>1</td>
</tr>
<tr>
<td>IHPWS COMPENSATION</td>
<td>2</td>
</tr>
<tr>
<td>IHPWS TEAM</td>
<td>2</td>
</tr>
<tr>
<td>IHPWS CONSULTATION</td>
<td>2</td>
</tr>
<tr>
<td>IHPWS JOB DESIGN</td>
<td>2</td>
</tr>
<tr>
<td>IHPWS INFORMATION SHARING</td>
<td>2</td>
</tr>
<tr>
<td>IHPWS Who Performs Appraisal</td>
<td>2</td>
</tr>
<tr>
<td>IHPWS When Appraisal Provided</td>
<td>2</td>
</tr>
<tr>
<td>IHPWS Training Type</td>
<td>2</td>
</tr>
<tr>
<td>IHPWS Train When</td>
<td>2</td>
</tr>
<tr>
<td>IHPWS How Preview Provided</td>
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### Figure 6.1 Dendrogram using Average Linkage (Within Group)

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6.2.2 Hierarchical Regression Analysis

The primary focus of this study was to determine if organizations with distinct MCM approaches that are supported by a particular HPWS structure have higher operational performance than organizations that do not. To test Hypothesis 2a and 2b, I use hierarchical regression analysis (Cohen and Cohen, 1983). This procedure is appropriate because it facilitates an analysis of the effects of groups of variables in an incremental, systematic manner. The overall procedure to conduct the analysis is as follows.

In step 1, the establishment control variables (\textit{percentsale, grossale, SIC code, employeesize, unionization, and facilityage}) were added as a set. These variables were included first to control for any extraneous effects of the sample establishments. In step 2, the two HPWS (i.e., FHPWS and IHPWS) and two MCM dummy variables (i.e., IMCM and FMCM) were entered as set to control for main effects of HR work systems and the MCM approach prior to examining potential HPWS-MCM interaction effects (Stone & Hollenbeck, 1989). The omitted category from the MCM dummy variables is \textit{NoMass}. Finally, in step 3, the cross products of the HPWS and MCM systems (e.g., IHPWS by IMCM, and FHPWS by FMCM) were entered as a set. Entering the 2 interaction term simultaneously controlled for possible multicollinearity among the variables (Yount et al., 1996). Evidence of moderation is demonstrated when the set of interaction terms accounts for significant residual variable in the dependent variable. Significant effects here would indicate that MCM moderated the relationship between HPWS and operational performance. More specifically, support for hypotheses 2a and 2b would exist if the individual interaction terms accounted for significant residual variance in
operational performance. Table 6.3 shows the results of the moderated hierarchical regression analysis. To assess the assumptions of multiple regression analysis, a visual examination of the standardized residual plots in charts 6.2, 6.3, and 6.4 were completed. The histogram graph, P-P plot, and scatterplot show minor violations and indicate that the data acceptably satisfies the assumptions of homoscedasticity, linearity, and normality. Minor violations of the assumptions of homoscedasticity, linearity, and normality do not invalidate the regression results in as much as weakens it. It can be reasonable concluded that there are no major deviations from the regression assumptions in this analysis.

Chart 6.2 Residual Histogram

Dependent Variable: Operational Performance

[Histogram showing regression standardized residuals]
In step 1, the establishment variables as a set were not significantly related to operational performance ($R^2 = .162, F = 1.161, \text{n.s.}$); however, *SIC Code 21*, was shown to have a significant main effect on its own ($b = 1.284, p< .05$). Although the establishment control variables do not account for a significant amount of variance in operational performance, they are retained in the model as a control in later steps. In step 2, the two HPWS and two MCM system variables as a set were marginally associated with operational performance ($\Delta R^2 = .060, F = 2.371, p < .1$). Specifically, *IHPWS* ($b = .089, p< .05$) had a statistically significant association with operational performance. In addition, the individual effects of the *FHPWS, IMCM*, and *FMCM* variables entered in...
step 2 were not predictive of operational performance. This result provided limited support for the universalistic perspective that a HPWS would have a positive impact on performance in any business environment. Furthermore, the results indicate that FHPWS and MCM in isolation do not have a significant effect on operational performance.

Provided there were no direct relationships between the FHPWS variable and operational performance and the two MCM systems and operational performance, support was found in step 3 supporting the contingency approach to HPWS implementation. As a set, the two HPWS-MCM interaction terms accounted for significant incremental variance in operational performance ($\Delta R^2 = .043$, $F = 1.608$, $p < .05$). In testing the specific moderation hypotheses, I found that a FHPWS interacts with a FMCM system to predict an increase in operational performance ($b = .186$, $p < .01$). This result indicates that a FMCM does in fact moderate the FHPWS – operational performance relationship, thereby providing support for hypothesis 2a. Contrary to expectations, the IHPWS – IMCM interaction had a significant negative relationship with operational performance ($b = -.106$, $p < .05$). This result was counter to my anticipated results and therefore provides no support for hypothesis 2b.

Note that the interaction between IHPWS and IMCM has a negative coefficient (-.106). While at first glance this appears to provide evidence contradicting Hypothesis 2b, an examination of Table 6.1 shows that the negative coefficient is likely a result of multicollinearity. Table 6.1 indicates that the interaction between IHPWS and IMCM has a significant positive correlation with operational performance when taken by itself. However, in the hierarchical regression of Table 6.3 the inclusion of multiple variables in the model causes some of the variables to take negative correlations, a common
occurrence in regression analysis (Cohen and Cohen, 1983). In short, the analysis indicates that IHPWS and FHPWS overlap substantially in their relationship with operational performance such that both scales explain a significant proportion of variance individually.

Overall, the moderation results provide mixed support that MCM influences the HPWS – operational performance relationship. In particular, a FMCM system interacts with a FHPWS to positively predict a significant increase in operational performance; however, IMCM systems interacting with an IHPWS has a negative but marginal influence on operational performance. The plot of the IHPWS – IMCM interaction in Chart 6.5 clearly shows that an IHPWS has a more negative effect for IMCM systems than it does for the FMCM system or no MCM system at all. Thus, since the estimate of the interaction term is negative, it indicates that the effect of a IHPWS on a IMCM system is more negative than the effect of IHPWS on MCM systems other than IMCM.

Conversely, the plot of the FHPWS – FMCM interaction in Chart 6.6 clearly shows that a FHPWS has a more positive effect for FMCM systems than it does for the IMCM system or no MCM system at all. Thus, since the estimate of the interaction is positive, it indicates that the effect of a FHPWS on a FMCM system is more positive than the effect of FHPWS on MCM systems other than FMCM. In short, operational performance is significantly influenced by how the HPWS are aligned with the MCM systems. These findings imply that it is misleading to suggest that an IHPWS has a greater effect on operational performance in a IMCM system, however, it can be concluded that FHPWS have a greater effect on increasing operational performance in a FMCM system.
The regression model shown in Table 6.3 has three major implications. First, the overall results indicate that operational performance is not influenced by MCM systems alone, only the interaction between HPWS and MCM systems has a significant effect. This outcome is important because it provides support for the contention that the level of investment in managing the workforce is associated with operational performance. In particular, the results indicate that the use of basic HRM practices to manage shop floor workers in standardized manufacturing systems provides substantial operational benefits in terms of reduced cost, increased quality and better delivery to basic mass customizers.

Second, the significant negative impact of the interaction between IHPWS and IMCM on operational performance are interesting results because they suggest that while more innovative HRM practices leads to increased operational performance, implementing a IHPWS in an IMCM system does not provide an incremental increase in operational performance. One possible explanation is that shop floor workers experience greater pressures in IMCM systems because of the continuously changing product complexity and the exposure of innovative HRM practices in IHPWS provides a negative perception for employees (Guest, 2002). Another potential reason could be that IMCM may lack the complexity that was previously thought requiring a different set of HRM practices. These rationalizations highlight the need for additional research to focus on identifying the particular set of innovation HRM needed in advanced MCM systems to manage shop floor workers. Lastly, the significant main effects of IHPWS in the second step of the regression model may suggest that innovative HRM practices are not beneficial in MCM environments. It maybe that this studies particular set of innovative HRM would be more beneficial in manufacturing environments characterized by
flexibility and lean production methods. Also, it may be that the innovative HRM practices in the IHPWS are not creating more value than the costs associated with adding more of these comprehensive practices.

Table: 6.3

**Regression of Mass Customization Operational Performance on HPWS and MCM Systems**

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>R²</th>
<th>Std. Err.</th>
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<td>Employee Size</td>
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</tr>
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<td>Facility Age</td>
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<td>Gross Sales</td>
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</tr>
<tr>
<td>% Sales from Customized Products (in $)</td>
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<tr>
<td>Overall Model F</td>
<td>.162</td>
<td>.545</td>
<td></td>
</tr>
</tbody>
</table>

| Step 2                |    |           |          |
| Finite Mass           | -.037 | .037      |          |
| Infinite Mass         | -.053 | .053      |          |
| IHPWS                 | .089* | .089*     |          |
| FHPWS                 | .021 | .021      |          |
| Overall Model F       | .223 | .533      |          |

| Step 3                |    |           |          |
| Infinite Mass*IHPWS   | -.106* | .106*     |          |
| Finite Mass*FHPWS     | .186** | .186**    |          |
| Overall Model F       | .266 | .522      |          |

Regression β weights are un-standardized coefficients taken at the final step of the equation

* = p < .05,  ** = p < .01,  *** = p < .001

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Chart 6.5: IHPWS – IMCM Interaction Plot

Operational Performance

Low IHPWS  High IHPWS

- No IHPWS
- Yes IHPWS
Chart 6.6: FHPWS – FMCM Interaction Plot

Operational Performance

Low FHPWS  High FHPWS

No FHPWS

Yes FHPWS
7.1 Theoretical Contribution

The predominate literature on HPWS to date has been primarily focused on identifying a comprehensive set of extensive, comprehensive, and innovative HRM practices that are bundled together to have a positive impact on worker outcomes and organization performance. There is limited research that empirically investigates creating bundles of basic HRM practices into a HPWS and examining the fundamental structure’s influence on performance. Furthermore, the literature on MCM has been primarily focused on identifying the operational, engineering, and marketing aspects of mass customization. There is limited research that investigates the human and social aspects of implementing mass customization capabilities on operational performance at the establishment level. With the exception of Liu et al. (2006), there has been scarce empirical research that investigates how shop-floor workers are developed, motivated, and managed in MCM environments. Based on a resource view of a firm, this study provides a large scale empirical analysis of HPWS and MCM integration at the establishment level to statistically examine their interaction effects on operational performance. The study use a sample of 148 manufacturing managers from various manufacturing industries to test the theoretically conceptualized model involving 2
distinct forms of HPWS and 2 different MCM systems and their moderated influence on operational performance.

A cluster analysis was conducted to identify how twenty-four different individual HRM practices are bundled together to create a HPWS structure. The results of the cluster analysis identified a two cluster solution that consisted of twelve different HRM practices for each cluster. More specifically, the fundamental cluster (FHPS) contained a set of 12 different HRM practices that were all characterized by the SHRM literature as basic personnel practices to manage shop-floor workers. Subsequently, the innovative (IHPWS) cluster contained a set of 12 different HRM that were all characterized by the SHRM literature as extensive and comprehensive personnel practices to manage member of the blue-collar workforce. The results of the cluster analysis provides support for the assertion that internally consistent sets of HRM practices are uniquely bundled into two distinct HPWS; namely FHPWS and IHPWS. This outcome is consistent with the configurational perspective in the SHRM literature that a HPWS is a coherent work system that possesses a high degree of complementarities among a holistic set or bundled pattern of multiple HRM practices and HR activities. Furthermore, these cluster results provided the empirical basis to create two separate HPWS unitary indexes that will be used in a moderated hierarchical regression analysis to test their interaction effects on operational performance in an explicit MCM system.

The results of a moderated hierarchical regression analysis indicate that operational performance is enhanced when an establishment creates a specific HPWS that supports a particular MCM approach. More specifically, the outcome of the analysis suggests that a fundamental HPWS consisting of a complementary set of basic HRM
practices has a greater positive influence on operational performance when utilized in a MCM system that utilizes modularity and involves the customer in the later stages of the production cycle (i.e., FMCM). Also, the results of the regression analysis is consistent with the contingency perspective in the SHRM literature that a HR function’s initiatives, activities, and subsequent HRM policies and practices must be consistent with an organization’s specific strategic posture and tailored to their competitive situation. Thus, the overall results of this study supports the notion that the configurational and contingency perspectives, based within a SHRM-MCM context, are not mutually exclusive; but rather they can be complementary and supportive in an attempt to investigate the integrative nature of HPWS and MCM approaches on operational performance.

7.2 Empirical Contribution

This study builds on Arthurs’ (1992) work of analyzing the integration of HPWS in a manufacturing and business strategy context. In particular, the results of a cluster analysis were consistent with Arthur’s (1992) cluster analysis. Both studies empirically identified distinct types of workforce management approaches. However, this study differs from that of Arthurs in that this study’s clusters consisted of an explicit combination of HRM practices where his analysis formed clusters of firms. In Arthur’s study, he labels the two clusters as “cost reduction” or “employee commitment industrial relation systems. My results parallel that of Arthurs in that I identify two clusters that are consistent with his; namely the FHPWS and the IHPWS. The FHPWS cluster is
conceptually similar to the “cost reduction” system and the IHPWS is conceptually similar to the “employee commitment” industrial relation system. In addition, the FHPWS and IHPWS clusters are conceptually similar to Yount’s et al. (1996) classification of a “human-capital-enhancing” and “administrative” HR system. However, each system in their study is created based on a normative approach and not on an empirical analysis.

In following the work of Yount et al. (1996), I empirically analyze the impact of each HPWS with an explicit business contextual condition. More specifically, I empirically examine the contingent relationship between a FHPWS and FMCM system and IHPWS and IMCM system. The findings of this study indicate that a FHPWS interacts with a FMCM system to enhance operational performance. This finding suggests the basic workforce managerial approaches are very appropriate in MCM contexts that emphasize process standardization and shop-floor worker control. These results are consistent with Yount et al. (1996) who found that administrative HR systems interact with a cost manufacturing strategy to enhance employee productivity and also works with a delivery flexibility strategy to improve customer alignment.

Contrary to expectations, the IHPWS – IMCM interaction has a moderately significant negative impact on operational performance. These results can be interpreted to indicate that operational performance will begin to decline as IMCM establishments increase the number of innovative HRM practices to manage shop-floor workers. Although I conceptualized that IMCM systems would require a more extensive workforce management approach, it may in fact be the case that more is not better when it comes to producing highly customized products. One possible explanation is that shop-
floor workers experience greater pressures and have a negative perception to the exposure of innovative HRM practices (Guest, 2002). As more demands are placed on shop-floor employees to work in self-managing work teams and make production related decisions, their stress level increases and performance declines. These negative worker outcomes can have an adverse effect on operational performance in advanced MCM systems. An additional reason why IHPWS can have a negative impact on operational performance in IMCM systems is that these manufacturing systems may not be very complex and do not require extensive HRM practice and the comprehensiveness associated with IHPWS. Mass customization is conceptually different from pure craft production and requires high volume to accomplish the “mass” component. Although IMCM can theoretically produce unlimited customized products, it may be the relative high volume production of component parts and modules that reduces the complexities associated with craft production, thus requiring a less skilled workforce and minimal worker involvement in the production process. Conversely, IMCM system may be so complex that researchers have not identified the specific HRM that improve performance in these manufacturing systems. The results of this analysis indicate that after a certain number of HRM practices in an IHPWS, operational performance begins to decline. Thus, it may be that the specific HRM practices analyzed in this study do not support a IMCM system and require some other combination of managerial policies.

7.3 Limitations and Recommendations for Future Research
Certain limitations of this study restrict the interpretation of the results. The data used in the analysis were self-reported by respondents and are cross-sectional, so determining causality is unachievable. However, it should be noted that many previous studies have used self report data to make inferences between managerial practices and performance (Jayaram et al., 1999). Also, gaining a clearer understanding of the relationships between HPWS and MCM approaches will require a longitudinal analysis.

This study’s the data do not include all the variables that could affect operational performance. Future research should be directed at identifying other managerial practices that may interact with HPWS in MCM system. In addition, the use of objective measures for capturing dimensions of operational performance should be collected such as manufacturing asset productivity, agility, customer responsiveness, and innovation.

This study fails to identify the specific HRM practices that are included in each of HPWS. The results can only indicate that a bundle of HRM practices have an impact on operational performance, but cannot directly specify which ones. Future research can be directed at a meta-analysis of key HRM practices of HPWS. Also, this study only examined the moderating effects of MCM on the HPWS – performance relationship. It is quite possible that other organizational characteristics such as structure, technology, and supply chain orientation may affect this relationship as well.

Finally, the HPWS used in this study consisted of HRM practices that were combined in an additive rather than the multiplicative manner. In the future, more detailed work is needed to create HPWS index that exhibit synergistic properties.
7.4 Conclusion

This study establishes a new paradigm of HPWS to include a set of basic and fundamental HRM practices that are complementary. Also, this study highlights the importance of integrating the workforce as an effective organizational resource to accomplishing MCM. In particular, the results of this study highlight the importance of integrating HPWS in MCM systems. More specifically, I demonstrated that operational performance increase when manufacturing establishments integrate a FHPWS in a FMCM system. This finding indicates that mass customization manufactures are capitalizing on the opportunity to improve performance by combining a basic workforce management approach with a basic manufacturing system.


Appendix A: Pilot Study Questionnaire

HPWS-Mass Customization_Pittsburgh Technology Council

Research Participant's Informed Consent Form

As an active member of the Pittsburgh Technology Council, your organization has been selected by Zachary Leffakis, Ph.D. candidate, of the University of Toledo to participate in an important survey about High Performance Work Systems and Mass Customization Manufacturing. You will be asked to answer a variety of questions in which you will indicate how shop-floor employees are managed, how your products are design and manufactured, how you interact with customers, and the level of operational performance at your manufacturing facility. Your participation is VERY important and will provide significant insight to how high performing mass customizing manufacturers are managing their workforce. It will take you approximately 15 minutes to complete the questionnaire.

You can be assured that your answers will be kept completely confidential. You are not required to provide your name nor your company. More importantly, your computer's IP address will NOT be identified and stored, so there is no way to identify you, your responses and your organization.

Your participation is voluntary and your refusal to participate in this study will involve no penalty or negative exposure. In addition, you may discontinue participation at any time without any penalty or negative exposure. Before you decide to accept this invitation to take part in this study, you may ask any questions that you might have. If you have any questions at any time before, during or after your participation you should contact Dr. Dale Dwyer at dale.dwyer@utoledo.edu (419-530-4059) or Zachary Leffakis at zleffakis@utnet.utoledo.edu (419-367-8060). If you have questions beyond those answered by the research team or your rights as a research subject or research-related injuries, please feel free to contact the Chairperson of the SBE Institutional Review Board, Dr. Barbara Chesney, in the Office of Research on the main campus at (419) 530-2844.

You are making a decision whether or not to participate in this research study. By clicking on the "NEXT" button below, you are indicating that you have read the information provided above, you have had all your questions answered, and you have decided to take part in this research.
Survey Definitions

The following statements and questions in the next six sections are asked to understand how your business unit manages ONLY the shop-floor workers in the production and/or assembly areas for ONLY the "customized" products manufactured at your facility. Use the following definitions to assist in your responses to the following questions.

"Customized" products are those products that are designed, altered, or changed to fit the unique specifications of an end-user. Component or intermediate products are only considered to be custom if the user of the finished product dictates or influences the specifications of the component.

Shop-floor workers are non-managerial employees directly involved in the manufacture, assembly and/or design of ONLY "customized" products.

Please answer the following questions regarding ONLY your "customized" products.
Compensation & Incentives

The following questions in this section are asked to understand how your business unit compensates and provides incentives to ONLY shop-floor workers in the production and/or assembly area for ONLY "customized" products.

1. Which of the following are included in your monetary compensation package for shop-floor workers? (Check all that apply)
   - [ ] Base pay (e.g., salary or hourly)
   - [ ] Raises based on learning/acquiring new occupational skill/knowledge (e.g., skill based pay)
   - [ ] Bonuses based on individual performance (e.g., merit)
   - [ ] Team/group based performance (e.g., gainsharing)
   - [ ] Business unit/firm performance (e.g., profit sharing, stock options)

2. How do you typically promote existing shop-floor workers for managerial and supervisory positions (or non-entry level vacancies) within the plant or unit?
   - [ ] Only on seniority
   - [ ] Mostly on seniority with some emphasis on individual performance
   - [ ] Mostly on individual performance with some emphasis on seniority
   - [ ] Only on individual performance
   - [ ] Do not promote existing shop-floor employee

3. Are shop-floor workers' wages (e.g., salary or hourly) ..........
   - [ ] Below market average
   - [ ] Meet market average
   - [ ] Above market average
Team Design

The following statements and questions in this section are asked to understand how your business unit utilizes ONLY shop-floor workers in teams in the production and/or assembly area for ONLY "customized" products.

Use the following definitions of teams to assist in your response to the questions below:

Improvement teams are a small voluntarily group of workers formed by management that meet off-line to address work-related problems, but are not permitted to directly make work-related or managerial/administrative decisions (Examples include quality circles, problem-solving groups, committees, “study action” groups, and/or task forces).

Self-managed teams are permanent, functional groups who directly work together on-line, that manage themselves and jointly have complete day-to-day responsibility and discretion over many production and administrative decisions (e.g., methods of work, work flow, scheduling, assignment of members to different job tasks, etc).

4. What primary work areas are IMPROVEMENT teams used in your manufacturing plant? (Check all that apply)
   - [ ] Not Applicable
   - [ ] Assembly
   - [ ] Fabrication/production
   - [ ] Other (please specify)

5. What primary work areas are SELF-MANAGED work teams used in your manufacturing plant? (Check all that apply)
   - [ ] Not Applicable
   - [ ] Assembly
   - [ ] Fabrication/production
   - [ ] Other (please specify)

6. What percentage of your shop-floor employees are currently involved in IMPROVEMENT work teams when performing a major part of their work roles?
   - [ ] 0
   - [ ] 1 - 50%
   - [ ] 51 - 100%

7. What percentage of your shop-floor employees are currently involved in SELF-MANAGED teams when performing a major part of their work roles?
   - [ ] 0
   - [ ] 1 - 50%
   - [ ] 51 - 100%
HPWS-Mass Customization_Pittsburgh Technology Council

Job Design

The following statements and questions in this section are asked to understand how your business unit designs & assigns jobs to ONLY shop-floor workers in the production and/or assembly area for ONLY "customized" products.

8. When your shop-floor workers rotate between jobs, is it typically....
   (Check all that apply)
   - [ ] Within their primary work area
   - [ ] Within their primary work team
   - [ ] Do not rotate between jobs
   - [ ] Outside their primary work area
   - [ ] Outside their primary work team

9. What percentage of shop-floor workers are involved in job rotation?
   - [ ] 0
   - [ ] 1 - 50%
   - [ ] 51 - 100%

10. When your shop-floor workers need to solve work-related problems and coordinate production deadline and deliveries, do they typically consult with ...(Check all that apply)
    - [ ] Do not consult with others
    - [ ] Their immediate supervisor and/or other employees
    - [ ] Customers
    - [ ] Suppliers
    - [ ] Other workers, managers, and functional experts (e.g., engineers, HR, purchasing, sales & marketing) outside their immediate work area or work group
11. Using the scale provided, please click the appropriate option that best indicates how important it is for ALL shop-floor workers to perform the following work tasks.

<table>
<thead>
<tr>
<th>Work Task</th>
<th>Not Important</th>
<th>Slightly Important</th>
<th>Important</th>
<th>Extremely Important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine/equipment set-up, adjustments, and/or programming</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Machine/equipment operation</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Machine/equipment maintenance</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Product/part assembly</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Product/part design</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Product/part inspection and testing</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Material handling</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Shipping and/or receiving</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
12. The following statements describe the types of work-related decisions shop-floor workers may be permitted and encouraged to participate in. Using the scale provided, please click the appropriate letter that best indicates which statement applies to your manufacturing plant.

A) Are not involved in making decision
B) Provide input and suggestions individually to management
C) Are consulted as part of an ad hoc involvement team that is management controlled, but they do not directly make decisions
D) Formal joint labor-management committees directly make the decision together
E) As a self-directed/managed work-team, have complete autonomy to directly make decisions when needed

<table>
<thead>
<tr>
<th>Statement</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design/redesign all or part of their primary jobs, tasks, activities, and duties</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design/redesign work/production methods, flow, and processes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design new and/or redesign customer products including components parts, sub-assemblies, and end-item configurations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health, safety, and working conditions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Select new machinery, technology, and/or equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Select and certify suppliers/vendors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taking immediate action to solve production/work related quality problems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taking immediate action to solve production/work methods, flow, and process problems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Address managerial/administrative issues (e.g., set production goals, plan and schedule the production of parts and assemblies, sequencing of work, assign daily work tasks to employees, schedule and assign routine machine/equipment maintenance)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Address human resource issues (e.g., provide feedback about individual and group performance, schedule vacations, absences, compensation performance appraisals, individual performance problems)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Address strategic related issues (e.g., redesign of a plant, implementation of new technology, investment plans, marketing strategies, and markets/products)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The following statements and questions in this section are asked to understand how managers in your business unit communicate what type of information to ONLY shop-floor workers in the production and/or assembly area for ONLY "customized" products.

13. What type of information do front-line supervisors or managers intentionally share with shop-floor workers? (Check all that apply)

- Individual performance
- Team/group performance
- Plant operating performance
- Supplier performance
- Financial performance
- Production schedule compliance and delivery performance
- Frequency of machine breakdown
- Other (please specify)

- Working conditions, health and safety issues
- Customer fabrication specifications
- Customer assembly specifications
- Customer delivery requirements
- Plant goals, objectives and future competitive strategies (e.g., business & marketing plans)
- Do not share information

14. How does your business unit identify shop-floor worker morale issues? (Check all that apply)

- Employee attitude surveys
- Quality of work life programs
- Formal and structured grievance procedure
- Formal and structured complaint resolution system
- Grapevine (i.e., rumor mill)
- Not applicable

- Other (please specify)
15. Which of the following statements bests indicates the extent to which shop-floor workers' suggestions are implemented.

- Rarely are employee suggestions implemented
- A low ratio of employee suggestions are implemented to those received
- A high ratio of employee suggestions are implemented to those received
- All employee suggestions are implemented

16. Is your manufacturing establishment unionized?

- Yes
- No

17. Who performs formal performance appraisals and feedback for shop-floor workers in your manufacturing plant? (Check all that apply)

- Peers
- Supervisors/managers
- Subordinates
- Not applicable
- Other (please specify)

18. How often are formal performance appraisals and feedback provided to shop-floor workers?

- Not provided
- Continuously
- Monthly
- Quarterly
- Yearly

19. In your manufacturing plant, are formal performance appraisals primarily used for: (Check all that apply)

- Discipline
- Certification/recertification
- Team assignment
- Termination
- Identify training needs
- Team performance behaviors
- Pay raises (annual)
- Individual performance behaviors
- Team performance results
- Individual incentive or merit pay
- Individual performance results
- Gainsharing incentive pay
- Skill assessment
- Employee development
- Promotions
- Other (please specify)
Skills Training & Development

The following statements and questions in this section are asked to understand how your business unit provides training and development activities to ONLY shop-floor workers in the production and/or assembly area for ONLY "customized" products. Use the following definitions of training programs to assist in your responses to the questions below:

Formal training programs are considered to be structured developmental activities that have a predefined objective and are conducted by a qualified person in classrooms, as seminars, educational programs, workshops, apprenticeships, or any other activity not conducted directly on the shop floor.

Informal training programs are considered to be unstructured developmental activities conducted by other employees and immediate supervisors on the job directly on the shop floor.

20. Please indicate how the following types of training programs and developmental activities are provided to new and experienced shop-floor workers in your manufacturing plant?

<table>
<thead>
<tr>
<th>Activity</th>
<th>Formal</th>
<th>Informal</th>
<th>Both</th>
<th>Not Provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comply with preset production standards, rules, policies, procedures,</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>and work instructions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Problem solving (e.g., mental reasoning abilities, analytical,</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>conceptual)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication (e.g., interpersonal)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Job specific (e.g., set-up, operation, assembly)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Team-working in self-managing production groups (e.g., complete</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>autonomy)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team-working in involvement groups (e.g., management directed</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>quality circles)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managerial decision making</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Cross-training (e.g., multi-functional, perform more than one task,</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>broader skills)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General and basic occupational (e.g., base line skills)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Technical (e.g., mechanical, electronic, computer, mathematical,</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>machine maintenance)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leadership skills</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Basic skills (e.g., literacy, writing, math)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Health and safety</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Role change</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Quality</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Annual recertification procedures</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Coaching/mentoring</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

21. How often do shop-floor workers receive FORMAL training?

☐ Not provided  ☐ Continuously  ☐ Monthly  ☐ Quarterly  ☐ Yearly  ☐ As Needed
22. How often do shop-floor workers receive INFORMAL training?

- Not provided  
- Continuously  
- Monthly  
- Quarterly  
- Yearly  
- As Needed

23. What percentage of shop-floor workers receive FORMAL training?

- 0%  
- 1 - 50%  
- 51 - 100%

24. What percentage of shop-floor workers receive INFORMAL training?

- 0%  
- 1 - 50%  
- 51 - 100%
Recruitment & Selection

The following statements and questions in this section are asked to understand how your business unit recruits and selects ONLY shop-floor workers in the production and/or assembly area for ONLY "customized" products.

25. When you include existing shop-floor workers in the selection process, do they typically

☐ Are not included in the selection process
☐ Only meet the potential applicant informally
☐ Only observe (or meet) the potential candidate as a group with other members of the organization
☐ Meet and interview the potential candidate as a group with other members of the organization
☐ Personally interview the candidate one-on-one (face-to-face)

26. How do you typically provide an extensive realistic preview of the company and job to potential applicants, including both positive and negative aspects? (Check all that apply)

☐ No such preview is provided
☐ Verbal descriptions of the company, job, and candidate’s expectations
☐ Written descriptions of the company, job, and candidate’s expectations in a formal employee handbook
☐ Representative video
☐ Paired shadow time with existing employees
27. How do you typically conduct formal interviews with the potential candidate?
- Do not conduct formal interviews
- One unstructured, non-standardized interview (question vary depending on applicant)
- Multiple unstructured, non-standardized interviews using a variety of employees and managers
- One structured, standardized interview (same questions asked to all applicants)
- Multiple structured, standardized interviews using a variety of employees and managers

28. How do you typically advertise for job openings in your manufacturing plant? (Check all that apply)
- Within plant postings
- Word of mouth
- Walk-in applicants and on-site applications
- Newspaper
- Employment agencies
- Other (please specify)

29. What types of pre-employment selection devices does your manufacturing plant require? (Check all that apply)
- Interviews
- Drug screenings
- Work sample test (e.g., performance demonstration)
- Occupational aptitude tests
- Basic technical skills tests
- Personality tests
- Physical performance evaluations (e.g., heavy lifting)
- Background checks
- Mental ability tests
- Assessment center exercises
- Psychological tests and assessments
- References from previous employers
- Other (please specify)
30. Which of the following is the best indicator of your focus in determining potential applicants for shop-floor positions?

- Not applicable
- Managerial decision making competencies
- Basic occupational capabilities
- Ability to work in a team
- Advanced and specialized abilities
- Problem solving abilities

31. What is the estimated proportion of all your shop-floor workers?

<table>
<thead>
<tr>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract</td>
</tr>
<tr>
<td>Temporary</td>
</tr>
<tr>
<td>Part-time</td>
</tr>
<tr>
<td>Full-time</td>
</tr>
</tbody>
</table>
The following questions are asked to determine the extent of customer influence in the manufacture of ONLY the "customized" products at your facility.

Customized products are those products that are designed, altered, or changed to fit the unique specifications of an end-user. Component or intermediate products are only considered to be custom if the user of the finished product dictates or influences the specifications of the component. Please answer the following questions regarding only your “customized” products.

32. Please indicate how often the following statements apply to your relationship with your customers for "customized" products.

<table>
<thead>
<tr>
<th>Statement</th>
<th>All of the Time</th>
<th>Most of the Time</th>
<th>Occasionally</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each customer order requires the fabrication of unique components prior to assembly</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Customers can assemble a product from standard components</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Customers can specify new product features</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Customers can specify size of products</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Customers can select features from listings of standard options/accessories</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Customers directly consult with design engineers</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Customer’s specifications are used to alter components for each order</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Each customer order is assembled from components in stock</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Customer orders are filled from stock</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
33. Who is/are your primary customers for "customized" products? (Check all that apply)

☐ OEM Manufacturer  ☐ Distributor  ☐ Wholesaler  ☐ Retailer  ☐ End-Consumer

34. At what point in the production of a "customized" product is a customer order assigned to a specific product?

☐ Design  ☐ Fabrication  ☐ Assembly  ☐ Inventory/Delivery  ☐ Not applicable

35. What portion of your sales volume (in units) can be considered to be "customized"?

☐ 0 to 10%  ☐ 11% to 30%  ☐ 31% to 50%  ☐ 51% to 70%  ☐ 71% to 90%  ☐ over 90%

36. What portion of your sales volume (in dollars) is attributed to "customized" products?

☐ 0 to 10%  ☐ 11% to 30%  ☐ 31% to 50%  ☐ 51% to 70%  ☐ 71% to 90%  ☐ over 90%

37. What portion of the main component parts and sub-assemblies for your completed "customized" products are manufactured and provided by outside vendors or suppliers.

☐ 0 to 25%  ☐ 26% to 50%  ☐ 51% to 75%  ☐ 76% to 100%
Product Customization

The following questions are asked to determine how ONLY the "customized" products are designed and manufactured at your facility.

Customized products are those products that are designed, altered, or changed to fit the unique specifications of an end-user. Please answer the following questions regarding only your "customized" products. Component or intermediate products are only considered to be custom if the user of the finished product dictates or influences the specifications of the component.

38. Please indicate how often the following statements apply to your "customized" products.

<table>
<thead>
<tr>
<th>Statement</th>
<th>All of the Time</th>
<th>Most of the Time</th>
<th>Occasionally</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>End-products have inter-changeable features/options/accessories</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>End-products are assembled from standard components</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Main/primary components are selected from a pre-subscribe list</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Main/primary components are uniquely designed or altered to end-user specifications</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Features/options/accessories are uniquely designed or altered to end-user specifications</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Main/primary components are shared across end-products</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Features/options/accessories are selected from a pre-subscribe list</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Components dimensions are changed for each end-user</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Components are sized for each application</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>
### Cost Performance

39. Using the scale provided, please rate your company’s actual performance on the following statements for ONLY the "customized" products manufactured at your facility.

<table>
<thead>
<tr>
<th>Cost Component</th>
<th>Much worse than estimated</th>
<th>Slightly worse than estimated</th>
<th>As estimated</th>
<th>Slightly better than estimated</th>
<th>Much better than estimated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall manufacturing cost per unit output</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct labor cost per unit output</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material cost per unit output</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design cost per unit output</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Plant capacity utilization (productive hours relative to total number of hours available)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw material and purchased component parts inventory cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work in process inventory cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finish goods inventory cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
40. Using the scale provided, please rate your company’s actual performance on the following statements for ONLY the "customized" products manufactured at your facility.

<table>
<thead>
<tr>
<th></th>
<th>Much worse than estimated</th>
<th>Slightly worse than estimated</th>
<th>As estimated</th>
<th>Slightly better than estimated</th>
<th>Much better than estimated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component part scrap rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component part rework rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Module and final assembly scrap rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Module and final assembly rework rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product conformance to specifications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customers’ perception of overall product quality</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
41. Using the scale provided, please rate your company’s actual performance on the following statements for ONLY the "customized" products manufactured at your facility.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Much worse than estimated</th>
<th>Slightly worse than estimated</th>
<th>As estimated</th>
<th>Slightly better than estimated</th>
<th>Much better than estimated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource breakdowns or delays (e.g., equipment, machinery, tooling, work centers, manufacturing cells)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Production completion time (e.g., manufacturing cycle time or throughput time)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Ability to provide on-time delivery to customers</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Ability to provide fast delivery to customers</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Ability to provide reliable delivery to customers</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
42. Using the scale provided, please rate your company’s actual performance on the following statements for ONLY the "customized" products manufactured at your facility.

<table>
<thead>
<tr>
<th></th>
<th>Much worse than estimated</th>
<th>Slightly worse than estimated</th>
<th>As estimated</th>
<th>Slightly better than estimated</th>
<th>Much better than estimated</th>
</tr>
</thead>
<tbody>
<tr>
<td>New component part development cycle time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New end-product development cycle time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time to translate customer requirements into technical designs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
43. Using the scale provided, please rate your company’s actual performance on the following statements for ONLY the "customized" products manufactured at your facility.

<table>
<thead>
<tr>
<th>Ability</th>
<th>Much worse than estimated</th>
<th>Slightly worse than estimated</th>
<th>As estimated</th>
<th>Slightly better than estimated</th>
<th>Much better than estimated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to set-up/change-over resource</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(e.g., equipment, machinery, tooling,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>work centers, manufacturing cells)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to make rapid production volume</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>changes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to process both large and small</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>orders</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to produce a number of different</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>products</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to handle variations in inputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to adjust the methods of delivery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Demographics

44. Your Job Title
   - V.P. of Operations/Manufacturing
   - Plant Manager
   - Operations/Production Manager
   - Operations/Production Supervisor
   - Other (please specify)

45. How many years have you worked in your current position?
   - > 2
   - 3 to 5
   - 6 to 10
   - 11 to 15
   - < 15

46. How many years have you worked for this current organization?
   - > 2
   - 3 to 5
   - 6 to 10
   - 11 to 15
   - < 15

47. How many shop-floor workers are currently employed at your production facility?
   - Up to 99
   - 100 to 249
   - 250 to 449
   - 500 to 999
   - 1000 to 2999
   - 3000 to 4999
   - 5000 to 9999
   - over 5000
Demographics

48. What is your average gross annual sales in millions of $?
   ○ under 5  ○ 5 to 10  ○ 11 to 25  ○ 26 to 49  ○ 50 to 100  ○ over 100

49. Please indicate the first 2 digits of the SIC Code that best describes your primary business or indicates what industry your business unit participates in?
   SIC Code
   __________

50. How many years has your manufacturing plant or production facility been operating?
   ○ 0 to 5  ○ 6 to 10  ○ 11 to 20  ○ 21 to 30  ○ over 30
51. Approximately how many minutes did it take you to complete the survey?

- [ ] 5 - 10
- [ ] 11 - 15
- [ ] 16 - 20
- [ ] 21 - 25
- [ ] 26 - 30
- [ ] more than 30

52. Please indicate how difficult it was to complete the survey?

- [ ] Not Difficult
- [ ] Slightly Difficult
- [ ] Difficult
- [ ] Very Difficult

53. Please indicate any additional information you feel would improve the questions within the survey. (e.g., wording, structuring, length)
Appendix B: Questionnaire for Large-Scale Study

Manufacturing Management Study

Participant Informed Consent Form

Your manufacturing organization has been selected by Dr. Dale Dwyer and Zachary Leffekis, Ph.D. candidate, of the University of Toledo to participate in an important survey about Manufacturing Management. You will be asked to answer a variety of questions in which you will indicate how shop-floor employees are managed, how your products are designed and manufactured, how you interact with customers, and the level of operational performance at your manufacturing facility. Your participation is VERY important and will provide significant insight to how manufacturers are managing their workforce to improve operational performance. It will take you approximately 10 minutes to complete the questionnaire.

You can be assured that your answers are anonymous. You are not required to provide either your name or your company’s name. More importantly, your computer’s IP address will NOT be identified and stored, so there is no way to identify you or your organization. Also, you will have the option to receive a FREE copy of the study results.

Your participation is voluntary and your refusal to participate in this study will involve no penalty or negative exposure. In addition, you may discontinue participation at any time without any penalty or negative exposure. Before you decide to accept this invitation to take part in this study, you may ask any questions that you might have. If you have any questions at any time before, during or after your participation you should contact Dr. Dale Dwyer at dale.dwyer@utoledo.edu (419-530-4059) or Zachary Leffekis at zleffekis@utoledo.edu (419-367-8060). If you have questions beyond those answered by the research team or your rights as a research subject or research-related injuries, please feel free to contact the Chairperson of the SBE Institutional Review Board, Dr. Barbara Chesney, in the Office of Research on the main campus at (419) 530-2844.

You are making a decision whether or not to participate in this research study. By clicking on the "NEXT" button below, you are indicating that you have read the information provided above, you have had all your questions answered, and you have decided to take part in this research.

If the primary business of your organization is NOT the manufacture of a physical product, please do not participate in this study.
Manufacturing Management Study

Survey Definitions

The following statements and questions in the next six sections are asked to understand how your business unit manages ONLY the shop-floor workers in the production and/or assembly areas for ONLY the CUSTOMIZED products manufactured at your facility. Use the following definitions to assist in your responses to the following questions.

CUSTOMIZED products are those products that are designed, altered, or changed to fit the unique specifications of an end-user. Component or intermediate products are only considered to be custom if the user of the finished product dictates or influences the specifications of the component.

Shop-floor workers are non-managerial employees directly involved in the manufacture, assembly and/or design of ONLY CUSTOMIZED products.

Please answer the following questions regarding ONLY your CUSTOMIZED products.
1. For shop-floor workers who manufacture CUSTOMIZED products, which of the following items are included in their total monetary compensation package? (Check all that apply)

- Base pay (e.g., salary or hourly wage)
- Wage, raises, or bonuses based on individual performance (e.g., piece rate, merit)
- Wage, raises, or bonuses based on learning/acquiring new occupational skill/knowledge (e.g., skill/knowledge based pay)
- Wage, raises, or bonuses based on business unit/firm performance (e.g., gainsharing, profit sharing, stock options)
- Wage, raises, or bonuses based on team performance (e.g., meet production goals, quality/process improvements)
Manufacturing Management Study

Team Design

Use the following definitions of teams to assist in your response to the questions below:

IMPROVEMENT teams are a small group of workers formed by management that meet off-line to address work-related problems, but are NOT permitted to directly make work-related or managerial/administrative decisions (Examples include quality circles, problem-solving groups, committees, “study action” groups, and/or task forces).

SELF-MANAGED teams have the following characteristics:
(1) They are permanent, functional teams who directly work together on-line.
(2) They manage themselves without direct supervision.
(3) They jointly have complete day-to-day responsibility and discretion over many production and administrative decisions (e.g., methods of work, work flow, scheduling, assignment of members to different job tasks, etc).

2. In what primary work areas are IMPROVEMENT teams used when manufacturing CUSTOMIZED products? (Check all that apply)
   - Not Applicable
   - Assembly
   - Fabrication/production
   - Other (please specify)

3. In what primary work areas are SELF-MANAGING teams used when manufacturing CUSTOMIZED products? (Check all that apply)
   - Not Applicable
   - Assembly
   - Fabrication/production
   - Other (please specify)

4. What percentage of your shop-floor workers are currently involved in IMPROVEMENT teams when performing their primary role in the manufacture of CUSTOMIZED products?
   - 0
   - 1-50%
   - 51-100%

5. What percentage of your shop-floor workers are currently involved in SELF-MANAGED teams when performing their primary role in the manufacture of CUSTOMIZED products?
   - 0
   - 1-50%
   - 51-100%
6. Who do shop-floor workers normally consult with if they need to solve problems when manufacturing CUSTOMIZED products? (Check all that apply)

- Do not consult with others
- Suppliers
- Customers
- Their immediate supervisor and/or other shop-floor workers within their immediate work area or work group
- Other shop-floor workers, managers, and functional experts outside their immediate work area or work group (e.g., engineers, HR, purchasing, sales & marketing)
7. How important is it for shop-floor workers to perform the following tasks when they are manufacturing CUSTOMIZED products?

<table>
<thead>
<tr>
<th>Task</th>
<th>Not Important</th>
<th>Slightly Important</th>
<th>Important</th>
<th>Extremely Important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine/equipment set-up, adjustments,</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>and/or programming tasks</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Machine/equipment basic/routine maintenance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tasks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component part production tasks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assembly tasks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality assurance tasks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material handling tasks</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
8. How important it is for shop-floor workers to make the following decisions WITHOUT consulting with management when they are manufacturing CUSTOMIZED products?

<table>
<thead>
<tr>
<th>Decision</th>
<th>Not Important</th>
<th>Slightly Important</th>
<th>Important</th>
<th>Extremely Important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design/redesign all or part of their primary jobs, tasks, and duties</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design/redesign production methods, flow, and processes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Select new machinery, technology, and/or equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Select and certify suppliers/vendors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taking immediate action to diagnose and solve production and quality problems</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Address managerial/administrative issues (e.g., production scheduling, deciding on methods of work, assign daily work tasks to employees, schedule routine equipment maintenance)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Address human resource issues (e.g., provide feedback about individual and group performance, schedule vacations, deal with individual absences)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Address strategic related issues (e.g., redesign of a plant, implementation of new technology, investment plans, marketing strategies, and markets/products)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
9. What information do front-line supervisors or managers intentionally share with shop-floor workers who are manufacturing CUSTOMIZED products? (Check all that apply)

- Do not share information
- Individual performance
- Team performance
- Plant operating performance
- Supplier performance
- Financial performance
- Production schedule compliance and delivery performance
- Frequency of machine breakdown
- Working conditions, health and safety issues
- Customer specifications and requirements
- Plant goals, objectives and future competitive strategies (e.g., business & marketing plans)
- Business Status

Other (please specify):
10. Is your manufacturing establishment unionized?
- Yes
- No

11. Who administers formal performance appraisals and provides feedback for shop-floor workers who are manufacturing CUSTOMIZED products in your plant? (Check all that apply)
- Peers
- Group Leaders
- Supervisors/managers
- Not applicable
- Other (please specify):

12. How often are formal performance appraisals and feedback provided to shop-floor workers who are manufacturing CUSTOMIZED products?
- Not provided
- Continuously
- Monthly
- Quarterly
- Yearly
Manufacturing Management Study

Skills Training & Development

Use the following definition of training programs to assist in your responses to the questions below:

Training programs are considered to be job developmental activities that have a predefined objective and are conducted by a qualified person or by other employees or supervisors. These programs can be conducted in the classroom or on the shop floor. The program could be a seminar or workshop, an educational program, or an apprenticeship.

13. Which training programs and developmental activities are provided to shop-floor workers who are manufacturing CUSTOMIZED products?

<table>
<thead>
<tr>
<th>Training Program</th>
<th>Provided</th>
<th>Not Provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comply with preset production standards, rules, policies, procedures, and work instructions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production and quality problem solving (e.g., mental reasoning abilities, analytical, conceptual)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication (e.g., interpersonal)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job specific (e.g., set-up, operation, assembly)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team-working in self-managing production groups (e.g., complete autonomy)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team-working in involvement groups (e.g., management directed quality circles)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cross-training (e.g., multi-functional, perform more than one job task, broader skills)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General and basic occupational (e.g., base line skills)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical (e.g., mechanical, electronic, computer, mathematical, machine maintenance)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leadership skills</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health and safety programs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual recertification procedures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (please specify)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

14. How often do shop-floor workers who are manufacturing CUSTOMIZED products receive training?

- Not provided
- Continuously
- Monthly
- Quarterly
- Yearly
- As Needed
15. Regarding positive and negative aspects, how do you provide a realistic overview of the job and your company to applicants who will be manufacturing CUSTOMIZED products? (Check all that apply)

☐ No such overview is provided

☐ Verbal descriptions of the company, job, and candidate’s expectations

☐ Written descriptions of the company, job, and candidate’s expectations in a formal employee handbook

☐ Representative video

☐ Paired shadow time with existing employees
16. What types of pre-employment selection devices does your plant use for workers who will be manufacturing CUSTOMIZED products? (Check all that apply)

- Formal interviews
- Drug screenings
- Work sample test (e.g., performance demonstration)
- Occupational aptitude tests
- Other (please specify)
- Basic technical skills tests
- Personality tests
- Physical performance evaluations (e.g., heavy lifting)
- Background checks
- Mental ability tests
- References from previous employers

17. What characteristics are important for a shop-floor candidate who will be manufacturing CUSTOMIZED products? (Check all that apply)

- Not applicable
- Basic occupational capabilities
- Past work experiences & knowledge
- Potential & willingness to learn new skills (e.g., aptitude)
- Potential & willingness to work in an improvement team
- Potential & willingness to work in a self-managing team
- Ability to solve production and quality problems
Manufacturing Management Study

Customer Involvement

The following questions are asked to determine your customers' influence in the manufacture of ONLY the CUSTOMIZED products at your facility.

CUSTOMIZED products are those products that are designed, altered, or changed to fit the unique specifications of an end-user. Component or intermediate products are only considered to be custom if the user of the finished product dictates or influences the specifications of the component. Please answer the following questions regarding only your CUSTOMIZED products.

18. How often do the following statements apply to your relationship with your customers for CUSTOMIZED products.

<table>
<thead>
<tr>
<th>Statement</th>
<th>All of the Time</th>
<th>Most of the Time</th>
<th>Occasionally</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each customer order requires the fabrication of unique components prior to assembly</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Customers can assemble a product from components</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Customers can specify new product features</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Customers can specify size of products</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Customers can select features/options/accessories from pre-subscribe listings</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Customer's specifications are used to alter components for each order</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Each customer order is assembled from components in stock</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Customer's requests are uniquely designed into the finished product</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
19. Who is/are your primary customer(s) for CUSTOMIZED products? (Check all that apply)

☐ OEM Manufacturer  ☐ Distributor  ☐ Wholesaler  ☐ Retailer  ☐ End-Consumer

20. What percentage of the main component parts and sub-assemblies for your finished CUSTOMIZED products are provided by outside vendors or suppliers.

☐ 0 to 25%  ☐ 51% to 75%

☐ 26% to 50%  ☐ 76% to 100%
Manufacturing Management Study

Product Customization

The following questions are asked to determine how ONLY the CUSTOMIZED products are designed and manufactured at your facility.

CUSTOMIZED products are those products that are designed, altered, or changed to fit the unique specifications of an end-user. Please answer the following questions regarding only your CUSTOMIZED products. Component or intermediate products are only considered to be custom if the user of the finished product dictates or influences the specifications of the component.

21. How often do the following statements apply to your CUSTOMIZED products.

<table>
<thead>
<tr>
<th></th>
<th>All of the Time</th>
<th>Most of the Time</th>
<th>Occasionally</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>End-products have interchangeable features/options/accessories</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>End-products are assembled from standard components</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main/primary components are selected from a pre-subscribe list</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main/primary components can be uniquely designed or altered to</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>end-user specifications</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Features/options/accessories can be uniquely designed or altered</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to end-user specifications</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main/primary components can be shared across end-products</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Components dimensions can be changed for each end-user application</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
22. Please rate your company’s ACTUAL COST performance for ONLY the CUSTOMIZED products manufactured at your facility.

<table>
<thead>
<tr>
<th></th>
<th>Much worse than estimated</th>
<th>Slightly worse than estimated</th>
<th>As estimated</th>
<th>Slightly better than estimated</th>
<th>Much better than estimated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall manufacturing cost per unit output</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Plant capacity utilization (productive hours relative to total number of hours available)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Inventory costs</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
## Manufacturing Management Study

### Quality Performance

23. Please rate your company’s ACTUAL QUALITY performance for ONLY the CUSTOMIZED products manufactured at your facility.

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Much worse than estimated</th>
<th>Slightly worse than estimated</th>
<th>As estimated</th>
<th>Slightly better than estimated</th>
<th>Much better than estimated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component part scrap/rework rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Module and final assembly scrap/rework rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customers’ perception of overall product quality</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
24. Please rate your company’s ACTUAL DELIVERY performance for ONLY the CUSTOMIZED products manufactured at your facility.

<table>
<thead>
<tr>
<th>Ability to provide on-time delivery to customers</th>
<th>Much worse than estimated</th>
<th>Slightly worse than estimated</th>
<th>As estimated</th>
<th>Slightly better than estimated</th>
<th>Much better than estimated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to provide fast delivery to customers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to provide reliable delivery to customer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to quickly translate customer requirements into technical designs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Manufacturing Management Study

Flexibility Performance

25. Please rate your company’s ACTUAL FLEXIBILITY performance for ONLY the CUSTOMIZED products manufactured at your facility.

<table>
<thead>
<tr>
<th>Ability to quickly set-up/change-over resources (e.g., equipment, machinery, tooling, work centers, manufacturing cells)</th>
<th>Much worse than estimated</th>
<th>Slightly worse than estimated</th>
<th>As estimated</th>
<th>Slightly better than estimated</th>
<th>Much better than estimated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to make rapid production volume changes without increasing cost and decreasing quality</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Ability to process both large and small orders without increasing cost and decreasing quality</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Ability to produce a number of different products without increasing cost and decreasing quality</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Ability to handle variations in inputs</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>
26. Your Job Title

- President
- V.P. of Operations/Manufacturing
- Plant Manager
- Operations/Production Manager
- Operations/Production Supervisor

- Other (please specify)

27. How many shop-floor workers are currently employed at your production facility?

- Up to 99
- 100 to 249
- 250 to 499
- 500 to 999
- 1000 to 2999
- 3000 to 4999
- Over 5000

28. How many years has your production facility been operating?

- 0 to 5
- 6 to 10
- 11 to 20
- 21 to 30
- Over 30

29. What are the first 2 major group digits of the SIC Code that describes your primary business or indicates what industry your business unit is in?

<table>
<thead>
<tr>
<th>Your Business Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIC Code</td>
</tr>
</tbody>
</table>

- Other (please specify)
30. What was your company’s gross sales in the last fiscal year?
- under 5 million
- 5 to 10 million
- 11 to 25 million
- 26 to 49 million
- 50 to 100 million
- over 100 million

31. What percentage of your sales, in UNITS, comes from “customized” products?
- 0 to 10%
- 11% to 30%
- 31% to 50%
- 51% to 70%
- 71% to 90%
- over 90%

32. What percentage of your sales, in DOLLARS, comes from “customized” products?
- 0 to 10%
- 11% to 30%
- 31% to 50%
- 51% to 70%
- 71% to 90%
- over 90%

33. If you would like a copy of the study results, please provide an email or postal address in the box below indicating where you would like the report sent. You may also contact the researchers at dale.dwyer@utoledo.edu or zleffak@utnet.utoledo.edu for more information on the results of the analysis.
Appendix C: Invitation and Op-Out Mailer to Potential Respondents

Dear ######,

Your organization has been selected by Dr. Dale Dwyer and Zachary Leffakis from the University of Toledo to participate in an important academic survey about High Performance Work Systems and Mass Customization Manufacturing. Your participation is VERY important and will provide significant insight into how manufacturers are managing their workforce. The survey will be conducted on-line at SurveyMonkey.com and will take you approximately 15 minutes to complete.

You can be assured that your answers are anonymous. You are not required to provide either your name or your company's name. More importantly, your computer's IP address will NOT be identified and stored, so there is no way to identify you or your organization. Also, you will have the option to receive a FREE copy of the study results. You can read more information regarding the survey by clicking on the University of Toledo logo.

We enthusiastically invite you to participate in our academic survey; your input is VERY valuable. An email will be sent to you in the near future with a web-link to the survey.

If you prefer not to participate, then please respond to this email indicating to exclude your name from the survey list.

We greatly appreciate your time and participation,

Dr. Dale J. Dwyer, Chair and Professor

Zachary Leffakis, CPIM, MBA

Department of Management
Mail Stop #103
The University of Toledo
2801 W. Bancroft St.
Toledo, Ohio 43606-3390
419-530-4059 (voice)
419-530-2365 (fax)
www.homepages.utoledo.edu
Appendix D: Original Email Message Sent to Potential Respondents

Hello “NAME”

We are requesting your participation in the University of Toledo’s Manufacturing Management academic study. Given that most manufacturers have recently implemented some forms of High Performance Work Systems and Mass Customization Manufacturing, your contribution is very important and will provide significant insight into how manufacturers are managing their workforces. The questionnaire will take you approximately ten minutes to complete and can be accessed by clicking on the path given below.

You can be assured that your answers are anonymous. You are not required to provide either your name or company’s name. More importantly, your computer’s IP address will not be identified and stored, so there is no way to identify you or your organization. Also, you will have the option to receive a complementary copy of the study results at no cost.

Click below to complete questionnaire:

We greatly appreciate your time and participation,

Zachary Leffakis, CPIM, MBA
Zachary.Leffakis@utoledo.edu

Dr. Dale J. Dwyer, Chair and Professor
Dale.Dwyer@utoledo.edu

Department of Management
Mail Stop #103
The University of Toledo
2801 W. Bancroft St.
Toledo, Ohio 43606-3390
419-530-4059 (voice)
Appendix E: Revised Email Message Sent to Potential Respondents

Good Day “NAME”

Would you please help me collect the data I need to complete my doctoral dissertation from the University of Toledo? My dissertation research is designed to determine…

1. How you manage shop-floor workers who manufacture CUSTOMIZED products
2. How your CUSTOMIZED products are designed and manufactured
3. How your company interacts with your customers who buy CUSTOMIZED products
4. Your company’s level of operational performance for CUSTOMIZED products

Your answers are anonymous and your computer’s IP address will not be identified. You can receive a complimentary copy of the study results at no cost. I hope the results of my research will help you improve your company’s operational performance for CUSTOMIZED products.

The questionnaire will take you approximately ten minutes to complete and ALL questions must be answered to be included in the analysis. You may exit and re-enter the survey at any time by clicking on the link below to finish.

Click below to complete the questionnaire:

I greatly appreciate your time and participation,

Zachary Leffakis, CPIM, Ph.D. Candidate
419-367-8060 (Cell)
989-964-2742 (Office)
Zachary.Leffakis@utoledo.edu