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RMS in Production Management

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ABSTRACT

Reconfigurable manufacturing system (RMS) is making headlines in the academic arena as one of the next tendencies in manufacturing. Such manufacturing systems may indeed be essential for continuous improvement, but as market structure, demand and technologies continue to evolve unexpectedly over time, globalization has made difficult to gain a sustainable competitive advantage for long by just implementing such innovative systems. Last, it is very unlikely that their adoption will have a universal or "one-size" fits all approach. Therefore, this paper tries to provide guides for possible manufacturing practices and contexts where RMS may fit a company. In order to do so, the general requirements and characteristics of RMS are discussed by a brief overview of available and related high performance manufacturing programs, some of their practices, and their impacts on operational performance. The high performance path is highlighted as being aware of such characteristics and pointing them out within present plant contexts while looking at the linkages. Therefore, rather than advertising RMS as yet another new tendency, a road map for choice and implementation is provided. Finally, suggestions of RMS in the context of World Class Manufacturing (WCM) are made and future research directions are identified.

Keywords: World Class Manufacturing (WCM), High Performance Manufacturing (HPM), Reconfigurable Manufacturing Systems (RMS)

1. INTRODUCTION

Throughout the production and operations management literature it has been well established that increasing global competition has made the industry turn its attention to critical issues such as productivity and quality, and in doing so, manufacturers, for one part, seek new approaches to production processes and manufacturing techniques, and explore new boundaries of technology. Therefore, plants are looking for ways to respond quickly to changes induced by customers, competitors, and technologists. As a result, flexibility has become an important tool in this struggle for success, i.e. ability to meet an increasing variety of customer expectations without excessive costs, time, or organizational disruptions, by increasing the range of products available, improving a firm's ability to respond quickly, and achieving good performance over this wide range of products (Upton, 1995). From this perspective, one of the frequently prescribed remedies for the problem of decreased productivity and declining quality is the automation of factories. More specifically, technologies such as Computer Integrated Manufacturing Systems (CIMs), robotics, and Flexible Manufacturing Systems (FMSs) have been the focal points of much research and exploration (e.g. Borenstein et al., 1999; Kaighobadi and Venkatesh, 1994; Suarez et al., 1995).

The tendency to institutionalize practices perceived as valuable even in the absence of empirical evidence of its effectiveness is not only constrained within manufacturing flexibility, but also, as seen below, throughout production and operations management (POM) in general. The attempt to increase performance, through the search and exploration of the best solutions in order to accomplish better operations in manufacturing, seems never ending. All together, many times these solutions create new practices or initiatives in operations as general tendencies within manufacturing plants. This permanent research, to get each time better manufacturing performances, continues, and promises to continue drawing a crowd of managers and academics from different parts of the world, not only in POM, but also from the whole community of business administration, economics and engineering in general.

In the manufacturing literature, a search for reconfigurable manufacturing goes as far as 1990 with Liles and Huff. Furthermore, the idea of agile manufacturing started in 1991 by Iacocca Institute, enabling short changeover times between manufacturing different products (Sanchez y Nagi, 2001). Ever since then, one of the agile production system trends in flexibility has been towards reconfigurability (e.g. Sheridan, 1993). Some concrete examples within this trend in agile manufacturing are two Intelligent Manufacturing Systems (IMS) projects, one which includes the search of reconfigurability by means of improving FMS with parallel processing, dynamic scheduling, process combination, simultaneous parallel, high-speed processing (2004), and the other takes in both Scalable FMS (SFMS) and manufacturing cells together (1994, 2000, 2005). On the other hand, as far as responsiveness performance goes, it is not limited only by the search of reconfigurability (Bozart and Chapman, 1996), and it has been a challenge since as early as 1988 (e.g. Stalk and Hout, 1990).

Consequently, if currently turbulent global economic competition and rapid social and technological changes results are time and size market fragmentation, higher products at lower cost, and shorter product cycles, etc., making timely response to market changes becomes the competitive advantage, then plants must now be requiring and showing appropriate manufacturing strategy and other initiatives to deal with such results.

2. RMS BASE: WCM

Unless when working in quantum mechanics, a specific cause has a specific effect, so it should not be very challenging to empirically test the link between a manufacturing initiative and performance dimensions. In WCM, the challenge should be justifying and examining why and under which condition any initiative or a set of them may have competitive value (Ketokivi and Schoeder, 2004). The competitive impact must be considered because the typical dependent variable in an initiative-performance study is some kind of competitive performance, whether it is operational (costs, delivery time, etc.) or financial (e.g. ROE, ROA) performance among the competition. Therefore, it is obvious that new technologies, products, processes, techniques, practices and systems are intensifying global competition among industrial companies, and in most plants is necessary a revision of the manufacturing strategy since each technology, process, technique, system, or combinations of them may be appropriate for different business environments. They can result in better performance if the key features are thoughtfully analyzed and concepts are carefully adopted. The literature suggests that there are different ways to achieve the same results in different environments (Sahin, 2000).

We may also include other manufacturing practices becoming institutionalized such as FMS. In an empirical study, FMS users say that FMSs are not living up to their full potential, and many have purchased FMS with excess capacity (eventually used) and excess features (in many case not eventually used). There are a variety of problems associated with FMS such as training, reconfigurability, reliability and maintenance, software and communications, and initial cost (Mehrabi et al., 2002). Paradoxically, the main disadvantage with FMS is its inflexibility. Its quality is often called “short-term” flexibility in the literature. The ability to change the system to produce new products is "long-term" flexibility (Buzacott, 1982). To this, we have to add that, in most cases, manufacturing tendencies, unfortunately, are not necessarily universals. As a result, their implementation may be very complex and may require a great deal of resources, which would end up dissipating the real opportunities of the desired improvement. Many times, the effect of assuming the proposal of “one size fits all” may be of not achieving the conditions or requirements to get high performances, when for instance, a company takes the wrong path. Thus, during decades many companies have tried to improve their performance by launching many kinds of practices or initiatives, which have been successful in other companies (JIT, TPM, TQM, FMS, etc.). Even though when some progress is made, some companies have been disappointed with the results of some of these practices, and they have even concluded that these practices do not effectively work (Schroeder and Flynn, 2001).

In most cases, these initiatives apparently provide the most effective and efficient solutions to solve the problems of manufacturing operations, and they are well defined and contain in an extensive body of knowledge. However, the practical application of this body of knowledge with high performing results is something not easily found. Could it be that these techniques do not have what the company needs? It could be, but there is also a possibility that these techniques need absolute prerequisites for its effective application.

World Class/High Performance is a moving target that requires constant attention and effort; the process is a never-ending journey. The truth for this is that every company is unique and the process to build a high performance business (one which consistently works fine over time) is more than applying every practice that turns up as a fashion. The groundwork for high performance must be designing constant and individually, according to the distinctive conditions of companies. This design is the planning and process of continuous improvement, where the company selects and modifies manufacturing practices (e.g. TOC, JIT, TQM, MRP, MRPII, ERP, etc.), which manage global high performance manufacturing according to its context, which may vary from country, industry, and size of the company, among other contingencies. Likewise, in this design, the existing practices must be linked together in order to get the objectives of the business. Ultimately, there is no long term sustained advantage, except the ability to continuously design for high performance (Schroeder and Flynn, 2001).

Historically, the idea with what most companies are familiar is recommending manufacturing managers to adopt every manufacturing initiative that appears as a tendency. This work, on the contrary, marks away from such idea, by associating to the company the concept exposed on the previous paragraph, whose focus is linking only the manufacturing practices (with or without adaptations) which jointly achieve a high performance organization. But before such linkage between practices, there must be a strategic plan of contingency based in the particular situation of the company, in order to select, adapt (when needed), and implement the practices, or the efforts of design will not have the desired effect (a more successful business). This process of contingence and linkage must be united with a deliberated path of continuous improvement. This approach is called World Class Manufacturing (WCM) or High Performance Manufacturing (HPM).

The increment of world competition and the assessment that management approaches transcend national frontiers have created the movement of World Class Manufacturing (WCM) and more recently High Performance Manufacturing (HPM) in business and academic circles. This movement has revealed a necessity of higher integration of manufacturing process, human resources management and organization characteristics to achieve the objectives of world competitiveness by means of higher manufacturing management.

Throughout time, many companies have been in the advance party of the “best practices” in diverse aspects of Production and Operations Management. Their developments have nurtured the academic world, which in turn have been a focus for reprocessing and/or making knowledge to transfer to companies. However, the concept behind WCM/HPM is not establishing the fashion of a new practice or program, but focusing manufacturing in order to get global high performance or world class. As pointed out above, the essence of this paradigm is the idea of contingency (each company is unique and special). Likewise, it makes use of both, the linkages among practices and continuous improvement. Organizations, which adopt this philosophy constantly, search for opportunities to improve in key competitive areas, such as quality, cost, delivery, flexibility, innovation, etc. Such improvements are essential in the company for its survival, benefit, and performance (Schroeder and Flynn, 2001).

From some of the existing programs, this paper explores the literature of world class manufacturing to globally examine present conditions of plant contingency and practice linkages set in stage for reconfigurability. Thus, the starting point for this is the conceptualization itself of RMS with two of its key issues: 1) Several authors (Koren et al., 1998) have formulated RMS as a system that revolutionizes or at least evolves from FMS (Figure 1Figure 1), and as such it has been studied empirically as part of WCM. 2) RMS literature goes further by explicitly saying that this new system has the means of improving the performance multidimensionality of not only FMS, but also lean manufacturing and mass production (Figure 2Figure 2). So, taking into account the fact that lean manufacturing encompasses many of the WCM programs such as JIT, TPM, HR, TQ, technology, and manufacturing strategy, this is also another key issue to consider in the present paper.

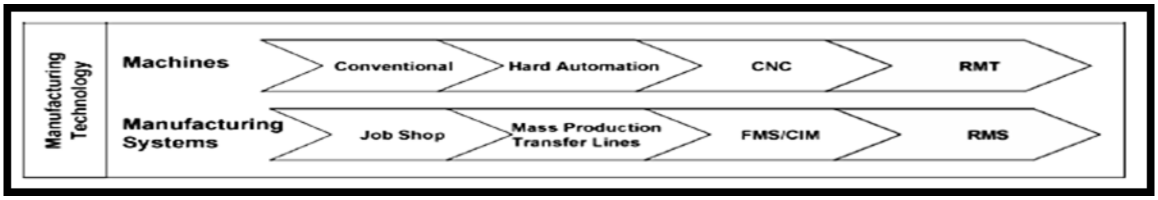

Figure 1. FMS next step
(Rodriguez et al., 2005)

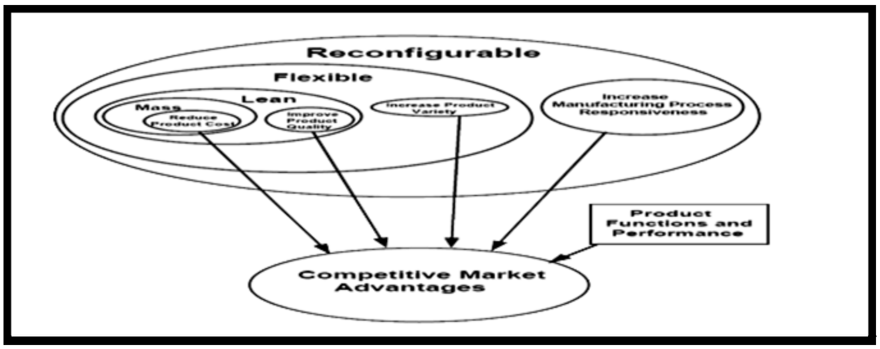

Figure 2. Beyond lean and FMS
(Mehrabi et al., 2000)

Flexible automation is an attempt to combine the advantages of fixed automation with those offered by programmed automation. Using this method, plants are able to obtain simultaneously low costs per unit and a high degree of flexibility. Flexible automation is defined as an advanced integrated system of hardware and software that makes it possible to design and produce automatically a predefined variety of products. There are various types of flexible automation besides FMS, such as automated transport and warehousing, production cells and numerical production, computer numerically controlled (CNC)/direct numerically controlled (DNC) production, etc. Due to its characteristics RMS is considered the next step of FMS, and as such it must be considered as part of flexible automation as well.

As already explained above, from the point of view of technology (FMS), this paper considers RMS best fit as part of flexible automation, which belongs to process technology, and this last itself is one of the most important parts of technology program. This is better illustrated in Figure 3 below.

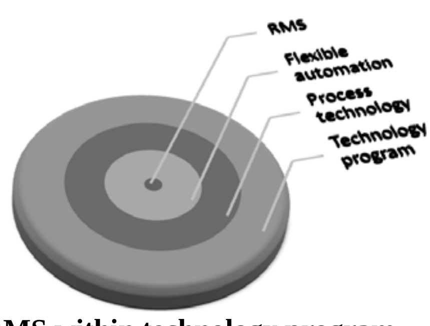

Figure 3. RMS within technology program.

Process/manufacturing technology may be defined as the equipment and the processes for making products. (e.g. Maier, 1997).

In addition, the effectiveness of WCM practices is closely interrelated with technology, and it influences the success of the technological system of a plant: technology and other WCM practices together affect performance. A possible missing link between technology and other areas of a plant is an important cause of failure (Maier and

Schroeder, 2001). Some of these linkages are shown in Figure 4Figure 5, but their detailed discussion is beyond the scope of our study.

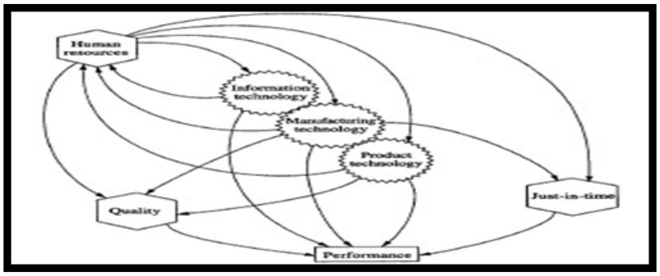

Figure 4. Linkages among technology and other WCM programs (Maier and Schroeder, 2001)

What a plant does (and even what a plant does not do) will reflect on its outcome. Therefore, the decision to use certain technology practices, or others, or none altogether (no action taken) always has an impact on performance. This makes room for some differences that may distinguish world class (WC) manufactures from standard manufacturers. For instance, considering the different technologies that are in use, WC manufacturers are more innovative and are more likely to introduce innovations such as CAD, CNC/DNC, FMS, or soon RMS than the standard ones.

3. FRAMEWORK DEFINITION

Everything up to now has lead to set a stage which may relate some WCM practices, from present lean manufacturing and/or FMS, in order to analyze future RMS practices, using plant contingency, practice linkage and multidimensional performance. There are two main aspects of such a framework in the present study: 1) the techniques and practices of WCM programs; and 2) the effect of these programs on performance. In this section, each component of the framework and the propositions are developed.

3.1. MANUFACTURING COMPETITIVE PERFORMANCE DIMENSIONS

Although traditional thinking has been that high performance in one capability is necessarily traded off for low performance in others, specialized literature shows this perspective is not that general. One reason for this may be the necessities in contexts of global competition and development and dissemination of advanced manufacturing technologies such as flexible automation, where the notion of trade-offs may be irrelevant due to the intensified pressures on plants to improve on all dimensions (e.g. Filippini et al., 1998). Furthermore, some authors, such as Boyer and Lewis (2002), use the term “cumulative capabilities” describing high performance in multiple capabilities simultaneously. Capabilities are described as cumulative because they build upon each other and are mutually reinforcing. The optimal sequence of cumulative capabilities is used here more generically to describe a situation where a plant has a high level of performance in more than one capability (Flynn and Flynn, 2004).

Establishing links between an initiative and performance outcome is, perhaps, the most critical and interesting aspect of a study on manufacturing practices, particularly when studying the situations, described above, where plants need to perform well in a multidimensional level. However, most existing literature often ignores the role of manufacturing goals and uses a one-dimensional performance measure in the models and empirical tests. Ketokivi and Schroeder (2004) argue that in order to do justice to the contingency argument (Dean and Snell, 1996) both the multidimensionality of performance and the strategic goals must be incorporated into the analysis. Their position is that three components must be explicitly measured: (1) goals; (2) practices; and (3) multidimensional performance.

Now that it has been somewhat established the importance of relating the implementation of the manufacturing initiatives to the performance of a plant, and since there are several performance measures, it is essential to recognize that some “order-winning criteria” are not within the bounds of manufacturing (Hill 1985). Therefore, it is suitable to use manufacturing performance to refer to performance outcomes that are relevant at the plant level of an organization and are part of manufacturing.

Following the above, in order to examine the relationship between initiatives and performance, this study focuses not only on the two performance areas from manufacturing, cost and responsiveness, which literature (e.g. Koren et al., 1999) claims RMS will provide but also on quality, where all three are closely linked to plant operations. For the verification of the existing practices being followed by plants to get cost, quality, and responsiveness is necessary to identify the drivers of high performance and sustainability of these competitive performances. Operations management researchers have contributed to the literature by examining the conditions under which specific practices, resources or structural arrangements are valuable.

Following Kritchanchai and Maccarthy (1998)'s arguments that responsiveness supports quality, improves cost performance and can subsume speed, dependability and flexibility, this study uses the set of performance areas of quality, cost, speed, dependability and flexibility. The last three dimensions are being used as the integrated parts of responsiveness. These authors assess that responsiveness not only covers them but addresses how to utilize and manage these performance areas in a purposeful manner. Moreover they noted that the level of responsiveness needed is different in every firm and depends on the individual business strategy, backing up the contingency fundament. All these five basic dimensions of manufacturing performance (cost, quality, delivery/dependability, time and flexibility) represent one of most common approaches for performance measures (Ferdows and DeMeyer, 1990; Skinner, 1969). The five performance areas are briefly summarized in Table 1.~~Table 2.~~

Table 1~~2~~. Performance Dimensions
(Kritchanchai and Maccarthy, 1998)

Performance Dimension	**Internal effects**	**External effects**
1. *Cost*	High total productivity	Low price
2. Quality	Error-free process	On-specification product
3. *Responsiveness* a. Speed/Time b. Dependability c. Flexibility	Ability to respond o fast throughput o reliable operation o ability to change	Desired result o a short delivery lead time o dependable delivery o frequent new product service, wide product range, volume and delivery adjustment

As it can be seen in Figure 5~~Figure 5~~, the present study goes beyond talked about literature, by finally developing ten manufacturing competitive performance scales from the five previous performance dimensions. Performance on costs may be estimated through the unit cost of manufacturing. Quality performance is based on conformance to standards and it may be assessed by evaluating the percentage of scrap or rework. For time performance, three different scales are considered: speed of new product introduction, lead time, and cycle time. The scales of dependability performance are two: on time new product launch and on time delivery. The indicators of flexibility are three: flexibility to change product mix, flexibility to change volume, and the time horizon adopted to freeze planning (this last one on the basis that a shorter time offers more flexibility).

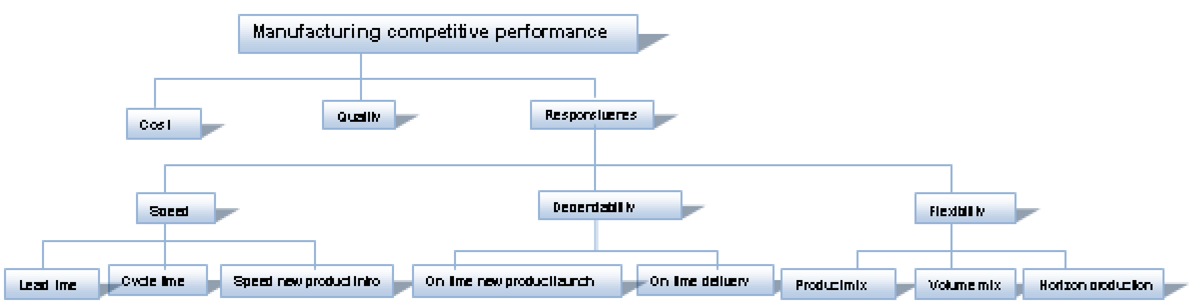

Figure 5. Manufacturing performance

3.2. Manufacturing practices and performance

A good understanding of a plant may help identifying manufacturing practices which meet the performance areas, providing basis for why and how practices have competitive value. In order to do so, this study builds on Ketokivi and Schroeder (2004)’s two key roles in establishing the theoretical argument for why practices matter:

A. The resource-based (routine-based) view of the firm (RBV). Based on the idea that the manufacturing practices (not the resources themselves) are subject to inimitability, causal ambiguity and are context-specific. Therefore, they offer value for the organization that makes use of them.
B. The evolutionary theory. From the literature, they are supported on the proposal that the organizational processes (e.g. routines) are shaped over time and are subject to path dependency and inertia. So, at least in the short term, routines are difficult to imitate. The routines are also embedded in the organizational context, which makes their potential contingent value higher than in any other context.

Taking these two arguments into consideration, the practices are selected and measured according to the specification provided below.

While there are many practices and programs in manufacturing management (Skinner 1969), the next four reasons are followed to choose the specific practices and programs for examination:

i. Practices and programs recognized as WCM (Schonberger 1986, 1996; Schroeder and Flynn, 2001).
ii. Practices recognized as part of lean manufacturing.
iii. World class programs with links to FMS.
iv. Practices which have been theoretically or empirically associated with one or more specific dimensions of operational high performance.

The selection of practices and programs shown in the next three tables is not exhaustive nor is it the only appropriate one. Additionally, these dimensions are not unique to the specific WCM programs, but are representative for the purposes of presenting the theoretical arguments. From the literature review, Table 2~~Table 3~~ contains practices common to both lean manufacturing and WCM; Table 3~~Table 4~~ shows practices, other than flexible automation and group technology, from the three facets of technology discussed above; and Table 4~~Table 5~~ illustrates the literature of linkages between flexible automation (which includes FMS) and the WCM programs JIT, TQ, HR, manufacturing strategy and other practices from its own program, technology.

Table 2~~3~~. WCM and lean practices
(See Appendix A1 and A2)

WCM Initiatives		Lean
Programs	**Practices**	**Literature**
JIT (6,7,18,25,26,57s	Lot size	1,2,4,48
JIT (5,6,7,8*,9,10,11*,17***, 18,25,26,57s	JIT/continuous flow production	1,2,4,16,48
JIT (5,6,7,8*,9,10,11*,17***, 18,25,26,35	Kankan/Pull system	1,2,4,48
JIT (5,7,17***,18,25,26,35	Cellular/layout manufacturing	1,2,4,48
JIT (5,6,7,8*,9,10,11*,18,25,26,35,57s	Setup time reduction	1,2,4,48
TPM (11*,12,13,14,17,18,25,26	Predictive/ preventive maintenance	1,2,15,16,48
TPM (8*,11*,12,13,14,18,25,26	Planning and scheduling strategies	1,2,15,48
TPM (8*,11*,12,13,14,17,18,25,26	New process equipment or technologies	1,2,15
TQM (5***,8*,11*,35,57s	Product design	1,2,4,15,48
TQM (5***,6, 8*,9***,11*,17***,19,25, 26,35	Process Control	1,2,4,15,48
TQM (6,8*,9***,11*,17***	Customer focus	1,2,48
TQM/Common (5***,6***,8*,9***,11*,17***,19, 21***,25,26,35,57s	Feedback	1,2,4,15,48
TQM/Common (5***,6***,8*,11*,19,21***,57s	Top Management Quality Leadership	1,2,4,48
TQM (5***, 6***,8*,9***,11*,19,35	Supplier Quality Involvement	1,2,4,48
TQM (5***,17***,19, 25,26	Continuous improvement	1,2,4,15,48
HR(Common) (5***,,8*,11*,17***,19,21***,25, 26,31,35,57s	Self-directed work teams/Employee involment	1,2,4,16,48
HR(Common) (5***,,8*,11*,17***,19, 25,26,31,57s	Flexible, cross-functional workforce	1,2,4,16,48
Technology (20, 21,35	Flexible automation (CAD/CAM/CIM/ FMS/CNC)	22,23
Technology (35	Group technology-cellular manufacturing	22,23
Manufacturing strategy (9***	Manufacturing-business strategy linkage	27,28
Manufacturing strategy (9***,20	Manufacturing strategy strength	27,28
Manufacturing strategy (57s***	Communication of manufacturing strategy	30
Manufacturing strategy (Common) (8*,11*,20	Formal strategic planning	27,29,30

Table 34. Other technology practices
(See Appendix A and B)

WCM program	Practice
Technology(19*,31,34	Product design simplicity
Technology (31,34,35	Concurrent engineering/phase overlapping
Technology(19*,31,34	Interfunctional design effort
Technology (31,32,33,34	Willingness to Introduce New Technology
Technology(31,32,33,34	Anticipation of New Technologies
Technology(19*,31,32,33,34	Effective Process Implementation
Technology(31,32,33,34	Proprietary equipment
Technology (31	IT

Table 45. Linkages between FMS and WCM programs
(See Appendix B)

WCM programs	Technology : Flexible automation (FMS, CNC, CAD, etc.)
JIT	7,20,35,37,45,46,49,50,51,52,53,54,55
TQ	20,21,35,37,43,44,45,46,47,56
HR	21,35,36,37,38,42,43,45,46
Manufacturing strategy	20,35,36,37,46
Technology: other practices	35,38,41,45,46,47,56

As far as the WCM core programs being considered here, operations management literature agrees that manufacturing strategy, just-in-time (JIT), total productive maintenance (TPM), manufacturing technology, total quality (TQ), and human resource (HR) are conceptually, theoretically, and empirically well established (e.g. Cua, 2000; Flynn et al., 1994, 1995; McKone and Weiss, 1999; McKone et al., 1999; Sakakibara et al., 1997; Schroeder and Flynn, 2001). All six are recognized WCM programs (Schonberger, 1986, 1996; Schroeder and Flynn, 2001). Successful Implementation of these programs is found to improve manufacturing performance and help companies gain a competitive edge.

As of lean production system, many researchers argue that it is an integrated manufacturing system requiring implementation of a diverse set of manufacturing practices (e.g. Shah and Ward, 2003) which are part of different WCM programs. Further, they also suggest that concurrent application of these various practices should result in higher operational performance because the practices, although diverse, are complementary and inter-related to each other. Thus, agreeing with the linkage WCM foundation that simultaneous application of multiple practices has a significant positive impact on operational performance.
Turning to FMS, already recognized in this paper as part of manufacturing technology, the literature seen below asserts that for FMS to give competitive results must have linkages to JIT, TQ, HR, and manufacturing strategy

4. DISCUSSION AND IMPLICATIONS

The finding that each of the bundles contributes to performance may seem intuitive, but in the past such a result has not been reported unanimously in the literature. For instance, Flynn et al. (1995) report that JIT and common infrastructural practices have a positive effect on performance but that TQM has no significant effect. On the other hand, Sakakibara et al. (1997) show JIT by itself has no significant effect on performance. Also, McKone et al. (2001) find that JIT, TQM and TPM all contribute to their weighted performance index. However, Cua et al. (2001) illustrate different results in TQM, JIT and TPM when their practices are disaggregated. For the different practice combinations to get high performance see Table.

These findings provide unambiguous evidence that the synergistic effects of all bundle practices are associated with better manufacturing performance. The implication for managers of plants that are not implementing these practices is also fairly clear. Not to implement the practice bundles is likely to put plants at a performance disadvantage compared to plants that do implement.

Therefore, WCM practices or programs, used to meet some performance dimensions of a manufacturing system, have been generalized. These practices can be used to compare and distinguish lean manufacturing and FMS, as well as a starting point for future implantation of RMS in the search for WCM. The study findings show several bundle configurations from WCM practices and programs (aggregated or disaggregated) to get high performance, endorsing the importance of taking into account the contingency and practice linkage paradigms before selecting and implementing RMS.

RMS seems to be one of the most effective initiatives to help improving some key performance dimensions such as cost and responsiveness in some contexts, but there are two important issues to consider when implanting it in the right context: 1) it must be linked to other practices in a plant to be in the right path to WCM; and 2) it is not the complete solution to meet all, or even most, of manufacturing performance dimensions, to simply substitute current manufacturing practices and systems. In practical terms, it may well be said that there may be many RMS prototype systems already developed, most of them machine-level systems, but the specialized literature does not show any specific attempt made to operatively link an RMS to other manufacturing practices.

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Appendix A. Shared legends from tables

* Both aggregated and disaggregated; ** Combined with practices from other programs; *** As infrastructure practice; + When integrated with many programs; ++ with infrastructure practices; +++ Better when integrated with other programs; x program; xx program both by itself and with other program(s) ; d directly; i combined; s disaggregated

Appendix B. Shared literature for tables[1]

(1) Shaha and Ward (2003), (2) McLachlin (1997), (3) Tu et al. (2004), (4) Sahin (2000), (5) Sakakibara et al. (1997), (6) Flynn et al. (1995), (7) Sakakibara et al. (1993), (8) Cua et al. (2006), (9) Sohel et al.(2003), (9) Sohel et al. (2003), (10) Nakamura et al. (1998), (11) Cua et al. (2001), (12) Milling et al. (1998), (13) McKone et al. (1999), (14) McKone et al. (2001), (15) Borda J. (2003), (16) Yusuft and Adeleye (2002), (17) Flynn et al. (1999), (18) Morita and Flynn (1997) (19) Matsui (2002), (20) Dean and Snell (1996), (21) Boyer et al. (1997), (22) Salzman (2002), (23) Kilpatrick (1997), Milling et al. (2003), Milling et al. (2001), Milling et al. (2000), Koenigsaecker (2006), (28) O'Rourke (2005) , (29) Deluzio and Hawkey (2006), (30) Berg and Ohlsson (2005), (31) Maier (1997), (32) Maier (1998), (33) Maier (1998), (34) Maierand Schroeder (2001), (35) Filippini et al. (1996), (36) Parthasarthy Sethi (1993), (37) Dean and Snell (1991), (38) Suarez et al. (1995), (40) Cordero (1997), (41) Gowan and Mathieu (1996), (42) Chenet al. (1996), (43) Youssef and Al-Ahmady (2002), (44) Youssef and Al-Ahmady (2002), (45) Filippini et al. (2001), (46) Filippini et al. (1998), (47) Flynn et al. (1994), (48) Forza (1996), (49) Monden (1981a), (50) Monden (1981b), (51) Monden (1981c), (52) Monden (1983), (53) Monden (1986), (54) Schonberger (1982), (55) Schonberger (1986), (56) Matsui and Sato (2001), (57) Flynn (1994), (58) Forza et al. (2001).

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[1] Due to paper page limitations many of the references in this appendix are not included. We will provide them upon request.

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