< Articles >

# HRM Practices for Japanese Cell Production

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**Abstract**

Cell production is a human-centric production method featuring team activities that has been employed by some Japanese manufacturers since the mid to late 1990's. Case study research provided a wealth of information on the human or organizational and HRM (human resource management) aspects of this manufacturing method. To ensure the success of cell production, managers adopted HRM practices to extend the range of an operator's skills, to ensure task and goal interdependence among workers, to encourage operators to take part in continuous improvement activities, and to extrinsically and intrinsically motivate operators. A set of HRM practices like these—what I call the perfectly-tapping-potentiality HR system—was likely to generate high levels of QCD (Quality, Cost, and Delivery) manufacturing performance measures. To maintain cell production in Japan, managers needed to adopt this HR system together with the corresponding manufacturing strategy; that is, small-lot manufacturing of the latest high value-added products.

## INTRODUCTION

Cell production is a new manufacturing method adopted by Japanese manufacturers, especially in the electronics industry, since the mid to late 1990's. The number of Japanese manufacturers practicing cell production has increased in recent years and many more Japanese manufacturers have plans to introduce this manufacturing method in the near future (Isa & Tsuru, 2002). While mass production is still dominant among Japanese manufacturers, cell production is slowly replacing the conventional manufacturing system.

There are several reasons why Japanese manufacturers have adopted cell production. First, they aim to make high-end products, not commodity-type products, and to deliver them to the domestic market quickly. Second, Japanese manufacturers have introduced cell production to reduce work-in-process inventories and shorten manufacturing lead-times, and consequently improve capital turnovers. Third, they have introduced cell production simply to reduce costs

and improve productivity. Fourth, cell production has been adopted as a means of SCM (supply chain management) aimed at linking demand and supply. As these reasons illustrate, cell production has been introduced with the expectation of gaining a competitive advantage and improving manufacturing and financial performance.

Because cell production is known as a production system that is dependent on people (Shirai, 2001), the human aspects of cell production are sometimes emphasized as follows. Cell production is not just a technological system—the role people play is more important in cell production than in conventional mass production systems. Operators are expected to become skilled or multi-skilled workers since cells are composed of a lower number of operators than in mass production regimes. Operators have more opportunity to make managerial decisions since each cell is considered an autonomous and self-sufficient unit possessing a high degree of authority in order to complete the wide range of work tasks assigned. People play a critical role in implementing cell production, and therefore the success of cell production hinges on how committed and motivated the operators are.

Japanese researchers, journalists, and consultants discuss how to manage people deployed to cells to ensure the success of cell production. They argue that training systems aimed at developing multi-skilled workers are crucial for the success of cell production. They also believe that cells should direct themselves with the supervisory and engineering jobs delegated to them, and that a pay-for-performance policy should be adopted, abandoning the seniority-based pay system practiced by most Japanese companies since each individual operator's efforts are clearly linked to the success of cell production.

These arguments provide us with the impression that the success of cell production hinges heavily on HRM (human resource management) practices. Therefore, to gain an understanding of cell production, a focused study of the HRM practices used is imperative. Not only would such a study provide managers at cell production plants with prescriptions for the success of cell production, but also it would contribute to HRM research generally, especially the field of SHRM (strategic human resource management), which has an interest in examining the relationship between HRM practice and performance. By investigating HRM practices for cell production a study could answer questions in SHRM research such as 'what are "high performance work practices" like?'; especially in a manufacturing context.

However, many descriptions about managing people or HRM practices in cell production are "anecdotal", that is, without grounded evidence. Some Japanese scholars and consultants present intriguing accounts of the human or organizational and HRM aspects of cell production (e.g., Isa & Tsuru 2002; Iwamuro, 2004; Sakazume, 2004; Shinobu, 2003; Shinobu & Mori, 2003; Shirai, 2001). However, there have been no studies providing systematic statements about

these aspects based on rigorous theoretical and empirical research. In this paper, I examine those HRM practices important to cell production that are likely to generate high levels of QCD (Quality, Cost, and Delivery) manufacturing performance measures. To this end, since there is no systematic research on HRM practices for cell production and their effects on manufacturing performance, I conduct case study research. Prior to this study, I published an article on HRM practices and cell production (Sakikawa, 2005). As an adjunct to my previous research, I commenced this present study. HRM is composed of several activities—HRM philosophies, HRM policies, HRM programs, HRM practices, and HRM processes (Becker & Huselid, 1998). In this paper, I focus specifically on HRM practices.

## RESEARCH BACKGROUND

### Definition of Cell Production

Cell production is employed by Japanese manufacturers, especially in the electronics industry. It is spreading among machine tools, large-scale machine industries, etc. However, the production methods used are not always the most recent. Cell production is said to have evolved out of *U-shaped production lines* operated in just-in-time (JIT) production environments including pull production, piece flow, and multi-process handling (Tamaki, 1996). Machines are arranged around a U-shape line in the order in which production operations are performed. Operators work inside the U-line, with one operator supervising both the entrance and the exit of the U-line. Product flow and operator movement may be clockwise or counterclockwise.

*Cellular manufacturing* being used at U.S. and European manufacturing plants may also be an original form of cell production. This manufacturing method—usually based on a team of operators responsible for all work tasks necessary to complete a family of products—is a replacement for job shop production methods that consist of a functionally organized production unit assigned to specific operations, e.g., milling, drilling, soldering, etc. Cellular manufacturing is not just related to physical layout; people are central to the manufacturing system (Hyer & Wemmerlöv, 2002). Human factors such as multi-skilling and the presence of visual controls promote the success of cellular manufacturing.

In the same vein, Shirai (2001) sees Japanese cell production as a form of production that is dependent on people, especially their motivation and skills, to promote flexibility. People play central roles in cell production and cellular manufacturing, however, groups or teams of operators are characteristic of these production methods. Hyer and Wemmerlöv (2002) suggest that cellular manufacturing is sometimes synonymous with terms such as "group production", "modules", or simply "teamwork"—although one-operator cells are sometimes seen on the shop

floors at plants performing cellular manufacturing. They argue that it is possible to have cells without teamwork and teamwork without cells; however, cells that combine teamwork are a common and powerful combination.

It can be difficult to define a team or a group. Hackman (2002) identifies four essential features of "real" work teams in organizations: team tasks; clear boundaries; a clearly specified authority to manage their (teams) own work processes; and membership stability over a reasonable time-period. As Hackman states, authority or autonomy, an important aspect of any team, is said to be the most distinctive aspect of cell production. Shinobu stresses the importance of autonomy in her definition of cell production:

> Cell production originated from team production, lean production system, and FMS (Flexible Manufacturing System), and in a cell operators are allowed the latitude and autonomy to handle and control a certain range of tasks as a self-contained unit; an organized system of these cells is called a cell production system (2003: 104).

Based on the views and accounts shown above of cell production and related manufacturing methods such as U-shaped production lines and cellular manufacturing, when I use the term cell production I mean *a human-centric production method featuring team activities in which workers are expected to be highly committed, and exercise skills and knowledge.* A cell, cell line, or work cell—terms often heard at plants carrying out cell production—comprises operators (usually a small number) and machines arranged around a U-shaped line, a straight line, or some other layout. Cell production is a replacement for mass production, and cell lines are used as final assembly lines.

**SHRM and Cell Production**

As indicated above, cell production is not just related to physical layout—people are central to the manufacturing method. The human or organizational and HRM aspects of cell production can be analyzed using certain organizational or HRM theories. For example, the STS (socio-technical systems) approach can help to unravel HRM aspects in cell production (Emery & Trist, 1960; Trist & Bamforth, 1951). However, it places too much emphasis on "responsible autonomy". More importantly, this approach has a major interest in the social and psychological consequences of technology, such as employee satisfaction and working life. On the other hand, it has been reported that cell production improves manufacturing performance measures such as lead-times, inventory levels, productivity, and so forth. The STS approach might be useful for investigating one HR aspect, i.e., the responsible autonomy of cell production, but it might not be sufficient for examining the comprehensive HRM aspects of cell production, and more importantly, whether and how these HRM aspects are associated with manufacturing performance. In this paper, rather than the STS approach, I use insights or perspectives gained

from SHRM (strategic human resource management) research. This is because this research focuses on those HRM practices that are posited to boost performance, that is, what are called "high performance work practices", and it addresses not just autonomy but also other human and organizational aspects including team activities, skills, knowledge, and commitment—all of which are related to cell production.

Using the resource-based view (RBV) of the firm in strategy literature, SHRM theorists posit that high performance work practices represent a source of intangible and firm-specific resources, such as skills, knowledge, desired behaviors or attitudes, and so on. These resources both create value and are difficult to imitate, and high performance work practices are socially complex and intricately linked in ways that make it difficult for competitors to copy them (Wright, Dunford, & Snell, 2001).

Based on such an assumption, three perspectives have been developed in SHRM research (Delery and Doty, 1996; Dreher and Dougherty, 2002). The first one is the *universalistic perspective*. Researchers taking this perspective argue that there are particular HRM practices that generate high performance across organizations. These HRM practices are called "best practices". For example, Pfeffer (1998) proposes a set of seven HRM practices as best practices. They are: employment security; the selective hiring of new personnel; self-managed teams; remuneration contingent on organizational performance; extensive training; reduced status distinctions; and information sharing. The second perspective is the *contingency perspective*. Theorists taking this perspective state that individual HRM practices should be consistent with the specific behavioral requirements mandated by the context of an organization, such as strategies, technology, etc. According to the contingency perspective, high performance work practices are dependent on the organizational context. The third perspective is called the *configurational perspective*. This posits that unique and often complex HRM patterns or systems enable an organization to effectively achieve its goals. Not only does this perspective require HRM practices to be a set consistent with each other—to maximize a *horizontal fit*, but also it emphasizes the alignment of HR systems and behavioral requirements mandated by strategies, technology, etc—to maximize a *vertical fit*. This configurational perspective suggests that in order to achieve desired results, firms must "throw the kitchen sink at the problem" (Staw, 1986). In other words, they must employ a system of HRM practices that are aligned with behavioral requirements mandated by the context of an organization.

Thus, given that there are the three perspectives in SHRM research and that there are several HRM practices to be considered when evaluating high performance work practices, I must be careful in addressing those HRM practices that are associated with successful cell production. Of several studies in the field of SHRM research, the work done by Appelbaum,

Bailey, Berg, and Kalleberg (2000) was the starting point for my research on HRM practices for cell production. This was because their work focuses on high performance work systems used by U.S. steel, apparel, and medical electronic instruments manufacturers and provides a better foundation for my work addressing HRM practices in a cell production manufacturing context. This relates to the contingency perspective, which points out that HRM practices should be congruent with behavioral requirements for a specific setting.

Appelbaum et al. argue that effective high performance work systems require three basic components: the opportunity for substantive participation or autonomy characterized by self-managing teams, off-line problem solving, etc.; appropriate incentives for motivation; and skill and selection policies that guarantee an appropriately skilled workforce. They posit that it is through the effective elicitation of discretionary efforts that HRM practices positively influence a plant's performance. Discretionary efforts are expected to mediate the relationship between a high performance work system and a plant's performance. Discretionary efforts mean the contribution of workers above and beyond what is called for in their job description. HRM practices that promote and sustain autonomy, skills, and motivation are necessary to elicit discretionary efforts from workers.

Based on Appelbaum et al. and some Japanese researchers and consultants who mention the human or organizational and HRM aspects of cell production, I present below some research questions about HRM practices used for cell production—followed by my case study research.

***Autonomy.*** Here, autonomy is related to "job enrichment"—which means that operators are allowed to make supervisory or managerial decision that was previously made by supervisors or technicians. Appelbaum et al. argue that one important feature of high-performing work organizations is autonomy—characterized by self-managing teams, QC (quality control) circles, etc. STS theorists also advocate autonomy, arguing that it is an important characteristic of a work organization and that autonomy affects employees' motivation (Berggren, 1992; Emery & Trist, 1960; Trist & Bamforth, 1951). Likewise, some Japanese scholars and consultants place emphasis on cells as autonomous or self-contained work units. For example, Shinobu (2003) and Shinobu and Mori (2003) argue that autonomy is a distinguishing aspect of cells. They mention that a cell is so self-sufficient as to bear responsibility for a broad range of work tasks, from arranging work-processes, maintaining equipment, and setting production schedules to contacting customers or suppliers, since it is assumed that an autonomous or self-contained cell will be adaptive or flexible to contingencies outside as well as inside a plant. Therefore, I put forward the following research question:

*Research Question 1. Are HRM practices fostering autonomy important to cell production?*

***Skills.*** Appelbaum et al. argue that HRM practices that upgrade skill and knowledge are also important and are being adopted by high-performing manufacturing companies. Shirai (2001), a Japanese researcher, states that one HRM aspect of cell production is developing multi-skilled workers. This is because in cell production a small number of operators are responsible for handling multiple work-processes, whereas in mass production individual workers are assigned to a limited range of work tasks. Likewise, other Japanese researchers such as Kumazawa (2004) suggest that for the success of cell production, cross-training and job rotation are necessary to aid the development of multi-skilled workers. This leads to my next research question:

*Research Question 2. Are HRM practices that upgrade skill levels crucial in implementing cell production?*

***Motivation.*** Appelbaum et al. mention that for high-performing work organizations, HRM practices focused on motivation are necessary. Likewise, Japanese researchers and consultants suggest motivation is important when implementing cell production. For instance, Iwamuro (2004) mentions the importance of highly motivated operators to cell production. This is because the work pace in cell production is determined by an operator's capabilities, and their motivation or commitment is directly linked to cell performance, while the work pace in automated mass production lines is usually determined by belt-conveyors, even if operators can manufacture products faster than the speed set by the belt-conveyors. Thus, there have been suggestions that a meritocracy or a pay-for-performance policy should be introduced for cell production systems rather than the out-dated seniority-based pay system that has been espoused by many Japanese companies (Noguchi, 2003). This leads me to ask:

*Research Question 3. Are HRM practices related to motivation, especially pay-for-performance policies, important in carrying out cell production?*

***Impacts of HRM practices on manufacturing performance.*** Appelbaum et al. found that a system of HRM practices that enhance autonomy, skill or knowledge, and motivation affected plant performance measures such as productivity and quality. Iwamuro (2004), a Japanese cell production consultant, suggests that cells can improve manufacturing performance measures such as cost and lead-times, and financial performance measures such as capital turnovers, cash flows, sales, and profits, and that the management of people is the key to generating high performance. As such, Japanese researchers, consultants, and journalists discuss the impact of managing people on performance, but do not examine whether HRM practices used in cell production actually yield high performance. Here, I focus on QCD (Quality, Cost, and Delivery) manufacturing performance measures since they are usually considered to be important performance indicators for cell production (Iwamuro, 2004). The units of analysis for this study are shop-floor organizations, i.e., cell lines, not plants or enterprises.

*Research Question 4. Do HRM practices affect QCD manufacturing performance measures if these HRM practices are important to cell production?*

## METHODS

I chose to conduct case study research aimed at finding facts inductively and centered around specific research questions since there is no rigorous theoretical and empirical research on the comprehensive HRM aspects of cell production (Eisenhardt, 1989; Yin, 2003). I visited 20 plants in Japan that employed cell production, including factories manufacturing PCs, copy machines, printers, air conditioners, lighting products, electrical appliances, electronic components, game consoles, machine tools, large-scale machines, automotive parts components, etc. Of the twenty plants, I selected 16 plants where sufficient evidence was gathered to support case study research. I selected multiple cases in an attempt to generalize findings from the case study research (Eisenhardt, 1989).

In this case study research we used direct observation, interviews, archival records, and public documents as sources of evidence. In addition to these sources, I handed out questionnaires at a few plants. Among these sources, interviews were particularly important because respondents provided deep insights into and intriguing views of many aspects of cell production including technological characteristics, organizations, cell operator management, and so on. Respondents included plant managers, personnel managers, production managers, and other people in charge of cell production.

Before entering the field sites, I created a checklist of interview protocols as an interview guide. The interview guide was designed to ask questions not just on HRM matters but also on every aspect of cell production including production volume, product items, manufacturing strategies, workforce, the history of cell production, cell forms, organizational structures, the role of supporting staff, etc. This was because I wanted to gain a deep understanding of cell production without overlooking factors affecting manufacturing performance that were separate to HRM practices.

Every time I visited a plant, while maintaining the majority of questions, I modified questions, added new questions, or eliminated the questions that I'd found to be ineligible in previous visits to the plant, since each time I visited field sites, I discovered new evidence. Therefore, I did not ask all respondents the same questions.

After visiting field sites and gathering data and information, I made the field notes while my memories were fresh so that I could review and compare them in the future. I exchanged my opinions and impressions with graduate students I had brought in as multiple investigators

(to avoid biased assessment). These students recorded interviews and made observations.

## RESULTS

### Overview

In addition to HRM practices that enhance skills and motivation, HRM practices that promote interdependence and continuous improvement were also found to be important to cell production. Meanwhile, autonomy and its related HRM practices were not essential to cell production. Table 1 shows a list of HRM practices (perhaps not exhaustive) for cell production, in association with behaviors and skills or knowledge required for implementing the manufacturing methods. Furthermore, the case study found that the higher the number of these HRM practices were, the better the QCD manufacturing performance measures were. A manufacturing strategy supported by a set of these HRM practices and aimed at providing the latest high value-added products in a small-size lot was necessary for maintaining cell production in Japan.

**TABLE 1**

**HRM Practices Relevant to Behaviors and Skills or Knowledge Required for Japanese Cell Production**

| HRM Practices | Desired Skills or Knowledge and Behaviors | | | | | |
|---|---|---|---|---|---|---|
| | Multi-skilling | Motivation | | Interdependence | | Continuous improvement |
| | | extrinsic motivation | intrinsic motivation | task interdependence | goal interdependence | |
| **Staffing: internally labor market oriented** | | | | | | |
| • High percentage of regular workers | ✓ | | | | | ✓ |
| **Training: aimed at multi-skilling and problem-solving skills** | | | | | | |
| • OJT for training multi-skilled workers | ✓ | | | | | |
| • Systematic training for multi-skilled workers | ✓ | | | | | |
| • Within-plant qualifications to facilitate multi-skilling | ✓ | | ✓ | | | |
| • IE education | | | | | | ✓ |
| **Work design: team-based** | | | | | | |
| • One-team task | | | | ✓ | ✓ | |
| • Line company system | | ✓ | | | ✓ | |
| • Off-line improvement activities | | | | | | ✓ |
| • Promoting inter-group competition | | ✓ | | | | |
| • Horizontal learning among cells | | | | | | ✓ |
| **Participation in decisions: great opportunities for continuous improvement activities** | | | | | | |
| • Suggestion system | | | | | | ✓ |
| • Direct contact with R & D staff | | | | | | ✓ |
| **Remuneration: emphasizing both extrinsic and intrinsic motivation** | | | | | | |
| • Seniority-based pay | | ✓ | | | | |
| • Praising and publicizing targets achieved to satisfy need-for-achievement | | | ✓ | | | |

## Important HRM Practices for Cell Production

***Autonomy and HRM practices.*** Based on evidence from case study research, the level of cell autonomy was not high. Cell operators were assigned to some supportive and administrative tasks such as inspection and maintenance, but they were not allowed to set production schedules, contact suppliers and customers, select team members, and so on. Before cell production, in other words when the mass production regime was still in place, operators could not change the work pace; conveyer-belts set the work pace. Even after introducing cell production, cell operators were not allowed to determine the work pace; only production engineers had the right to do so. It is assumed that one-operator cells are self-managing in that they would control their own work pace (Hyer & Wemmerlöv, 2002). In fact, the case study found that even one-operator

cells were not allowed to determine the pace of their own work. It was clear that cells were not self-managing teams.

There were particular reasons why cells were not autonomous. For example, in some plants, trust between employees and managers was lacking. Production workers did not have the capabilities required. Managers feared that the whole plant would fall into chaos if cell operators were allowed to change the production schedules already set by production managers. In most cases, cells were not autonomous for this very reason.

Even though cell operators were not given much authority in most of the plants I visited, cell operators did participate in improvement activities—although how often or to what extent they took part in these activities varied from plant to plant. Operators were involved in off-line improvement activities (e.g., QC circles, TPM (total productive maintenance), etc.), suggestion systems, cross-functional teams, concurrent engineering, and so on.

***Skills and HRM practices.*** At most plants I visited, cell operators were expected to become multi-skilled workers. This was because they were required to handle a broader range of work tasks in their cells than on the mass production lines. For example, at a plant making electrical appliances, automated mass production lines about 100-meter-long had previously run, but cells composed of around five operators were now responsible for handling all whole tasks within the cells. In a copying machine plant, operators had been in charge of a limited range of work tasks on long mass production lines that used automated belt-conveyors. Since introducing cell production, however, production workers at the plant had tackled many challenging tasks. For example, workers attempted to assemble many complicated parts components alone. As a result, very talented operators could handle all work-processes—made up of 600 work tasks and taking around 3 hours—by themselves. A manager at the plant mentioned, "At first, I did not think they (the talented operators) could assemble all parts components by themselves. But, in fact, if they tried, they could. Now I think that people have more capabilities or potential than we expected". On the other hand, in that plant, as operators worked more than before cell production was introduced, they felt more fatigued with work tasks in their cells.

There were ways to develop multi-skilled workers. For example, through OJT (on the job training) operators learned to do work tasks in cells from more skillful and veteran workers. Managers provided systematic cross-training, where skill levels required were clearly defined and operators were expected to upgrade their skill levels. In the copying machine plant I previously referred to, managers made a within-plant qualification system that encouraged cell operators to become multi-skilled workers. If operators were recognized as having a certain skill level, they were awarded a corresponding qualification. The most talented operators at the plant, who were acknowledged as having the highest skill levels, were awarded the highest qualification ranking.

They were promoted to cell leaders and presented a badge stating that s/he was the most talented operator. They were extolled by managers and colleagues and seemed to be "charismatic operators". In that sense, the within-plant qualification system was not just part of a training system—it had an intrinsically motivating effect on operators. Furthermore, hiring a high percentage of regular workers—in other words, internal labor market oriented staffing—pertained to developing multi-skilled workers since regular workers could be trained to become multi-skilled workers from a long-term perspective.

While there were cell operators who were working to become skillful or multi-skilled workers, at most plants I visited there were unskillful contingent workers deployed to cells—who were rarely expected to become skillful and multi-skilled workers. Thus, HRM practices meant to train and develop skillful workers were not always important to all cells at plants carrying out cell production. At a PC plant, (contingent) workers were assigned to cell lines after taking a mere two-day training program off the production lines. At a game console plant, managers tried to make "skill-less", or de-skilled cell lines where anybody could easily assemble parts components and manufacture products. These unskilled contingent workers were hired so that managers could respond to changes in demand. When demand increased, unskilled workers were hired, and when demand decreased, their contracts were terminated; in a sense, they were literally contingent workers. In general, unskillful contingent workers were deployed to cell lines composed of a large number of operators—where these operators were responsible for a limited range of assigned work tasks. They manufactured products with simple designs, that is, products with a high level of modularity, e.g., PCs and game consoles. This relates to particular strategies for building a complex product from small components that can de designed independently yet function as a whole (Baldwin & Clark, 1997).

***Motivation and HRM practices.*** Most plants I visited still maintained a seniority-based pay system, which is espoused by the majority of Japanese firms. A few plants had a pay-for-performance policy, but they had already adopted it prior to the introduction of cell production. Only one plant introduced a pay-for-performance policy at almost the same time it started cell production. I could assume that seniority-based pay, which is linked to the life-time employment system also espoused by Japanese firms, is suitable for developing skilled workers from a long-term perspective. More importantly, I could also assume that existing conventional reward systems are well established or thought of as institutionally legitimate by Japanese firms (Scott, 1995).

Interestingly, competition among cells related to cost, output, etc., caused rivalry among the cells and encouraged cell operators to work more. Inter-group competition was created by managers or naturally took place among operators. It could be said that seniority-based pay and

inter-group rivalry are concerned with extrinsic motivation or rewards.

In addition to seniority-based pay and inter-group competition, managers at plants I visited emphasized non-monetary or intrinsic rewards. For example, managers at some plants endeavored to praise and recognize operator's efforts and contributions—whether worthy or trivial—so that managers could satisfy operators' need for achievement. They posted operators' achievements on a board near the cell lines to publicize them. They did this because the amount of effort operators contributed had a direct effect on cell performance. On the other hand, even if operators on a conventional mass production line were motivated, they were not able to affect performance, since the pace of work was controlled by belt-conveyors. As indicated above, within-plant qualifications were also associated with intrinsic motivation. Thus, managers made meticulous efforts to extrinsically and intrinsically motivate cell operators.

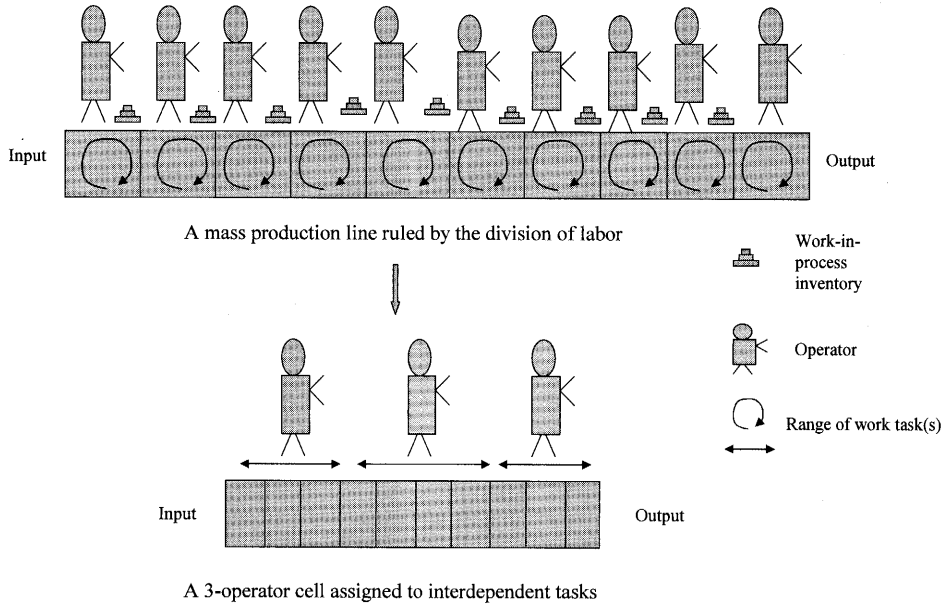
**HRM Practices Emerging from Case Study Research**

As I continued my case study research, behavioral and HRM aspects important to cell production emerged that I had not previously imagined. These HRM practices related to enhancing interdependence and continuous improvement.

***Interdependence and HRM practices.*** As mentioned above, multi-skilling was one human aspect important to cell production. A group of workers in a cell who were dexterous enough to handle multiple work-processes were assigned to interdependent tasks and were responsible as a team for the results. In other words, multi-skilling focused on interdependence among cell operators. Here interdependence concerns what Wageman (1995) and Van der Vegt, Emans, and Van de Vliert (2001) call task interdependence and goal interdependence.

In previous mass production dominated by the "division of labor", some operators assembled parts components quickly while others worked slowly, resulting in increased idle times and work-in-process inventories between operators and workstations. Some managers I interviewed called this situation "partial optimality". On the other hand, operators in a cell were required to be dependent on each other to achieve shortened lead-times, diminished work-in-process inventories, and to achieve line-balancing. As such, each operator in a cell was required to exercise efforts towards achieving the cell's goals, not the individual operator's ones—which some managers called "total optimality". At times, operators were required to help adjacent workers in the same cell who were having trouble so that they could achieve and sustain line-balancing. Figure 1 shows a conceptual representation of a how a cell—in this case a 3-operator cell assigned to interdependent tasks—performed line-balancing and, as a result, how the cell diminished the work-in-process inventory by replacing a mass production line ruled by the division of labor.

**FIGURE 1**
**A Conceptual Representation of How a Cell Can Become More Efficient than a Mass Production Line**




To sustain balance and harmony in the work among operators and workstations, a cell is formed with operators of the same skill level. For example, if some specific workers were especially dexterous, a cell was formed that consisted of these operators. In this case of course, such a cell sustained line-balancing and manufactured more products more quickly than a cell made up of operators with a lower level of skills. However, in some cases, to avoid a very slow work pace or "my pace" in cells made up of less skilled operators, a very skilled worker was deployed to that cell. In many cases, the work pace was determined by managers or technicians, which indicates that cells were not autonomous.

As indicated above, interdependence was important to cell production since cell operators affected manufacturing lead-times and work-in-process inventories by working interdependently with and helping other operators in trouble in the same cell—which Wageman (1995) and Van der Vegt et al.(2001) call "task interdependence". And cell operators were responsible not only for their own work tasks but also for the consequences—which Wageman (1995) and Van der Vegt et al.(2001) call "goal interdependence".

One of the HRM practices for enhancing task interdependence was the one-team task, which is a task cell members work interdependently to achieve and take responsibility for. HRM

practices concerned with goal interdependence included the one-team task, and a control system called the *line company system*. Under the line company system, cells were regarded as "pseudo mini profit centers", and supervisors in charge of cells were "presidents". In one sense, the line company system was also concerned with ways to extrinsically motivate people. Cells were expected to generate profits by increasing sales, which were calculated by prices set at a plant multiplied by the number of products manufactured, and by decreasing labor costs, inventory costs, space rents, expenses incurred in outsourcing components (not manufacturing them in-house), and so on.

***Continuous improvement and HRM practices.*** Here, improvement relates what Argyris and Schön (1978) call "single-loop learning", that is, detecting and correcting problems without alternating basic assumptions and values. Specifically, continuous improvement in cell production concerns sustained learning about work process and products. Cell operators learned to and continued to learn to reduce costs, improve quality, shorten lead-times, etc. Appelbaum et al. think of participation in improvement activities as a process of autonomy. Autonomy is closely intertwined with continuous improvement. The authority delegated to operators creates opportunities for continuous improvement. However, continuous improvement may not necessarily mean a high level of autonomy since autonomy is characterized not only by opportunities for continuous improvement but also by setting schedules, contacting suppliers and customers, etc. Therefore, I would argue that continuous improvement is a different dimension to autonomy.

One reason why continuous improvement was important to cell production was that cell lines were mutable and not as fixed as mass-production lines, and more likely to evolve into efficient systems by reflecting the suggestions and ideas provided by operators. A Japanese cell production researcher Sakazume (2004) argues in his latest article that the impact of continuous improvement after introducing cell production is significant.

Continuous improvement was supported and enhanced by HRM practices including off-line improvement activities, e.g., QC circles, TQM, and suggestion systems. In addition to these "formal" practices, there were "informal" practices or daily activities that encouraged continuous improvement, such as inter-learning among cells, or "horizontal development (of learning)", in which operators exchanged know-how and solutions not only with co-workers in the same cell but also with operators in other cells. Furthermore, in some plants, operators provided ideas to improve product design by making direct contact with R & D (research and development) staff on the shop floor or attending concurrent or simultaneous engineering. At these plants, operators were expected to acquire a higher level of skills, such as problem-solving skills necessary for improvement activities, and they took IE (industrial engineering) and QC classes off the job. Operators with a higher skill-level or knowledgebase were usually regular workers—which

indicates that internal labor market-oriented staffing was important to developing these people.

**Relationships between HRM Practices and Manufacturing Performance**

Multi-skilling, motivation, interdependence, and continuous improvement were all necessary for implementing cell production: at the same time, these human factors are constraints on the success of cell production. If cells improved QCD manufacturing performance measures after human factors such as constraints were removed by HRM practices, it could be said that these HRM practices affect QCD manufacturing performance measures. If such reasoning is permitted in explaining the relationships between HRM practices and manufacturing performance in cell production, I can provide three representative cases to examine these relationships. Table 2 presents these three cases. Here, the cost performance measurers are concerned with labor productivity (output/operators) and the level of the work-in-process inventory. The quality performance measure presents the percentage of product defects. The delivery performance measure means manufacturing lead-time or throughput time.

**TABLE 2**

**Three Representative Cases Demonstrating Relationships between HRM Practices and Manufacturing Performance**

| Cell Lines | Electronic Device Producing Cells at Plant A | Electronic Device Producing Cells at Plant B | PC Large-Lot Manufacturing Cells at Plant C |
|---|---|---|---|
| Overview | Plant A made electronic devices for digital cameras and started cell production in 2001, with the aim of building an efficient plant that could compete against Chinese manufacturers. Since then, managers had made efforts to develop skillful people, and successfully combined these efforts with the success of cell production. However, with a digital camera maker, one of plant A's principal customers, transferring production facilities to China, cell lines at plant A were being transferred to the affiliated Chinese plants. | The cell lines, which were introduced in 2000, provided electronic devices for PC manufacturers. Managers had not had intended to employ cell production; it was this manufacturing method that they happened to discover while searching for an optimal production method for production-to-order. Therefore, unlike other plants, plant B engineers and "workers" built their original cell lines without advice from consultants. Plant B competed against global companies manufacturing large-size lots, such as Korean, Chinese, and Taiwanese manufacturers. Under such competitive pressure, plant B played a critical role as the mother plant to the affiliated overseas plants located in East-Asian countries; the cell lines ran as "pre-production lines", or pilot-run lines, and cell operators worked together with R & D staff. | The cell lines at plant C, a PC plant, were introduced in 1997. This plant had the cell lines for small-lot and large-lot manufacturing. The large-lot producing cell lines were longer relative to the small-lot producing cell lines and looked like "mini-mass production lines", with the result of a certain level of work-in-process inventories taking place. All of the operators were contingent workers with a limited range of skills. |

**TABLE 2**
**Continued**

| | | | |
|---|---|---|---|
| **Multi-skilling and HRM practices** | When the plant started cell production, workers were not used to working certain tasks in the cells since they had been accustomed to tasks on mass-production oriented assembly lines. That was why managers started education aimed at developing multi-skilled workers. Unskillful workers learned work tasks from cell leaders through OJT. | Plant B had a systematic training program for developing multi-skilled workers, under which workers were supposed to upgrade their skill levels, which were clearly defined and targeted by managers. | The large-lot producing cell lines did not necessitate a higher level of skills; therefore, all workers on the lines were the contingent workers. Before they were assigned to tasks on the cells, they had to take a mere 2-day training program necessary for completing the tasks. A cell was composed of around 10 workers. Even if the unskillful contingent workers voluntarily quit their job, a replacement—usually an unskilled worker—could be easily found within the same workplace or outside the plant. |
| **Interdependence and HRM practices** | After introducing cell production, the way workers did jobs changed from individual-based jobs to team-based jobs. Not all workers attained the skill levels required to become multi-skilled workers. Consequently, the cells did not succeed. As operators gradually extended their range of skills, they came to feel responsible for team tasks, not for individual assignments—that is, they came to seek "total optimality", not "partial optimality", aiming at team-based output. | Plant B adopted a line company system. Each cell bore responsibility for quality, cost, delivery time, etc., which was linked to plant-level profit and loss. However, cell operators were not evaluated based on the cells' performance. | Operators were not allowed to help adjacent workers in trouble in the same cell. |
| **Continuous improvement and HRM practices** | Workers were left to handling multiple work-processes, and as a result, they came to understand other workers' tasks and problems and prevent these problems. Since operators took part in cell production, their quality awareness had definitely increased. | After introducing cell production, managers were able to find who made which products since the names of the workers were inscribed on the products they made. This practice was performed under the line company system. As a result, operators increased the feeling of responsibility for quality, which resulted in significant improvement of product quality. | Cell operators were not admitted to trouble-shoot. Instead, supervisors or technicians bore that responsibility. |
| | | Off-line improvement activities through QC circles were energetic. However, the number of ideas operators contributed was not unlimited, therefore, operators were supposed to take classes in Industrial Engineering and Quality Control at a within-plant training room, called "Techno-School". | |
| | Workers were obliged to provide solutions under the suggestion system. | Cell operators had direct contact with R & D staff on the shop floor and provided suggestions on how to manufacture products more easily. Close work between cell operators and R & D staff was crucial for plant B since the plant was a mother plant and the cell lines were pilot-run lines. | |

**TABLE 2**
**Continued**

| | | | |
|---|---|---|---|
| **Motivation and HRM practices** | When the plant had used mass production lines with belt-conveyors, even if workers had exercised great efforts, their effort or contribution had not reflected the line's performance, since they had been involved in highly specific tasks. In cell production, however, since a cell was formed by a few people, their individual efforts and especially their integrated effort as a team were clearly linked to cell performance. Therefore, it was critical to extrinsically and intrinsically motivate people.<br><br>To intrinsically motivate cell operators, managers attempted to praise the workers who contributed to cell performance. Even if cell operators did not achieve targets, managers recognized their efforts. Managers attempted to satisfy operators' need-for-achievement in different ways, e.g., by posting operators' achieved goals on a board near the cell lines. | Managers understood how important it was to motivate workers when implementing cell production. Cell leaders and operators studied the importance of teamwork and work with the aim of motivating themselves.<br><br>Even if cell operators did not achieve targets, managers took care of the poor-performing cell by showing higher levels of performance than the cell had actually achieved.<br><br>Managers nurtured competition or rivalry among cells to "extrinsically" motivate—even though cell operators were not aware of this. | Managers had a plan to promote even contingent workers to a leader's position if they were excellent.<br><br>Managers suggested to temporary staff agencies that excellent contingent workers should be paid more. |
| **Manufacturing performance measures** | Compared to previous mass production lines with belt-conveyors, manufacturing performance measures for cells improved significantly; productivity (output/workers) increased 163%, manufacturing lead time improved 66%, and work-in-process inventories decreased 13%. In addition, the current work space was 60%, compared to the past one. Operators' quality awareness increased. HRM practices following the introduction of cell production certainly improved manufacturing performance in cells. However, as the principal customer, i.e., a digital camera manufacturer, was shifting production facilities to China, cells at plant A were being transferred to the affiliated Chinese plants. | Plant B had seen manufacturing lead-time and work-in-process inventory improve since employing cells. Especially, cells at plant B achieved a higher level of product quality compared to cells at the affiliated plants. The cells played critical roles as pilot-run production lines and made a significant contribution to the mission of plant B as a mother plant. Meanwhile, managers and engineers were developing the latest high value-added products that global competitors could not emulate and that were to be shipped to the Japanese domestic market so that they could maintain cell production in Japan. | Since introducing cell production, plant C had improved the level of inventory and work space utilization. However, this improvement was due to efforts from managers and engineers. Cell operators cut costs only because the cell lines were designed to manufacture small variety products in a large-size lot. |

The case of cells at plant A demonstrates that since introducing cell production to replace mass production, it had encountered several problems with the cells, most of which were about human or organizational factors, including skill levels, interdependence, and motivation. To remove these obstacles, managers at plant A introduced HRM practices including training for multi-skilled workers, team-based and interdependent jobs, offering several ways to satisfy need-for-achievement, etc. Consequently, the cells improved their manufacturing performance measures and HRM practices definitely enabled the cells to improve in this way. Plant B also demonstrates that, as pilot-run production lines at the mother plant to the affiliated overseas plants, the cells performed well in the area of product quality—which was definitely associated with introducing suitable HRM practices such as QC circles, direct contact with R & D staff, IE education, etc. The large-lot production cell lines at plant C were aimed at enlarging manufacturing capacity. The cell lines seemed to be "mini-mass production lines". There were few of the HRM practices listed in Table 1. The effect of the cells at plant C was a reduction of costs, as a relatively high number of operators in the cells manufactured a moderately large size-lot of small-variety and commodity-type products. However, the use of this type of cell would be transferred to countries where labor costs are low; in fact, at other plants I visited, these cells were transferred to overseas plants after I visited.

These three cases indicate that the decision to use HRM practices affected manufacturing performance. It is clear that the use of HRM practices as listed in Table 1 improved not only cost, but also quality and delivery times. If plant A and B had not adopted these HRM practices, the cells would not have achieved superior performance in these areas. Large-lot production cell lines at plant C, although not sophisticated in terms of HRM practices, achieved cost reduction through enlarging production capacity and enjoying the economy of scale; however, these cells might be transferred to overseas plants in countries with low labor costs.

In case study research, I cannot analyze "how much" each of the HRM practices affects manufacturing performance measures. This kind of question is more suited to survey-type research using a statistical method (Yin, 2003). Regardless of such shortcomings, the case study research revealed that the higher the number of HRM practices used, the better the manufacturing performance measures were. As Staw (1986) states, the cells at the plants where managers "throw the kitchen sink at the problem" to change "sticky behavior" achieved superior performance in cost, quality, and delivery times. In other words, not individual HRM practices but a system or bundle of these practices was powerful enough to elicit the behavior and skills required for cell production and subsequently to elicit superior manufacturing performance. The list of HRM practices used for cell production in Table 1—although not exhaustive—presents HRM practices that are congruent with each other; that is, HRM practices that are inseparable

from each other in ensuring the success of cell production. This concerns what SHRM scholars call a "horizontal fit".

My case study revealed that cells were more effective than previous mass production lines that used automated belt-conveyors. However, are the cells bolstered by the appropriate HRM practices a panacea? According to a manager of plant A, the cells were more efficient than previous mass-production lines, but nowadays the cells at Japanese plants were not as competitive as Chinese mass production lines. The plant A manager said:

> "The average wages for Chinese workers are one-twentieth to one-thirtieth less than the average wage for a Japanese person. This is a big incentive to manufacture at Chinese sites. If we are to maintain cell production in Japan, our cells must be more productive than the Chinese plants. The level of productivity could be increased two or three times, however it cannot be raised twenty or thirty times...Our customer, a digital camera maker, has shifted production facilities to China. We cannot help but accompany the customer to China in order to shorten total lead-time, or the time span between procuring parts components and shipping complete products to the customer. Thus, we have no choice but to shift manufacturing facilities to the affiliated Chinese plants. In addition, parts suppliers have gone to overseas sites with our customer, and therefore we must go to China and procure parts components from the suppliers locally...That is why we are transferring some of the cell lines to the affiliated Chinese plants."

As these remarks from the manager of plant A suggest, the cells are not a panacea. To maintain cell production in Japan and generate high performance through HRM practices, managers or technicians at some plants, e.g., plant B, researched and developed the latest high value-added products that global competitors could not emulate and that were to be shipped to the Japanese domestic market. The cells manufactured small size-lots of these products. This relates to what SHRM theorists call a "vertical fit", that is, the alignment of the HR system and organizational contexts such as competitive strategies or manufacturing strategies. At the same time, the cell operators at plant B were required to acquire a higher level of skills and knowledge because they were expected to assemble many complex products and to provide R & D staff who came to the shop floor with solutions or ideas on product design and on how to manufacture products more easily. To give them the skills to suggest these ideas, they were supposed to take IE and QC classes.

## DISCUSSIONS

My case study revealed many facts about cell production in terms of HRM practices. In this chapter, I discuss these findings, using two of the three perspectives from SHRM research: the contingency and configurational perspectives I explained earlier. Below, using the contingency perspective in relation to behaviors and skills or knowledge required for cell

production, I first discuss the HRM practices that were found to be important to cell production. Second, using the configurational perspective, I discuss these HRM practices as bundles, systems, or configurations, which are related to a horizontal fit. Finally, again using the configuration perspective, I discuss these HRM systems in the external context of cells, i.e., manufacturing strategies, which have a bearing on a vertical fit. I do not use the universalistic perspective—one of the three SHRM perspectives—in these cases since in this paper I focused on and discussed HRM practices used "for cell production".

**Contingency Perspective: HRM Practices and Desired Behaviors and Skills or Knowledge**

The case study research identified what behaviors and knowledge or skills were required in implementing cell production and what HRM practices fostered the desired human factors. The desired behaviors and knowledge or skills were multi-skilling, (task and goal) interdependence, (extrinsic and intrinsic) motivation, and continuous improvement—all of which were crucial for carrying out cell production.

As mentioned by many Japanese scholars and consultants, my research showed that multi-skilling was an important behavioral factor for cell production. Previous mass production lines offered operators single or specific tasks, but operators on cell lines were required to handle multiple work-processes. As a result, they were more fatigued with their work tasks in the cells. In general, the required skill levels were dependent on the level of modularity (whether product design was simple or complex) and the form of the cell lines (whether cells were composed of a few operators or many). To develop multi-skilled workers, OJT, systematic training, and within-plant qualifications were important. Within-plant qualification systems at the plants were not just part of training system, but were also concerned with ways to intrinsically motivate workers. In addition, hiring a high percentage of regular workers, or internal labor market oriented staffing was also important to multi-skilling since it took a long time to develop multi-skilled workers.

As expected, motivation was also important to cell production. However, seniority-based pay was still the principal monetary or extrinsic reward since it may possibly be institutionally embedded into Japanese business society. The line company system and inter-group competition were also important ways to extrinsically motivate people. Intrinsic motivation, such as satisfying an operator's need-for-achievement, was also important. This was because the amount individual workers or a team of operators contributed was clearly linked to cell performance, and operators wanted to be recognized by managers and their colleagues for their efforts and achievements. For example, to intrinsically motivate people, managers praised operators' effort and contributions even if their achievements were not superior. Managers also visually lauded operators' achievements by posting them on a board near the cell lines so that their efforts, contributions,

and capabilities could be recognized by everybody. Within-plant qualifications also served to satisfy intrinsic needs.

Contrary to STS theorists' and Japanese scholars' expectations, autonomy was not important to cell production. Cell operators were not permitted to set production schedules, make contact with suppliers or customers, or set their own work pace. The reason for this was because in manufacturing settings, delegating too much authority could impair a plant's efficiency. Nevertheless, cell operators had a limited level of autonomy. Cell operators were expected to take part in many improvement activities. Here, it is noted that autonomy as a concept was not a behavioral objective managers targeted. Furthermore, no one I interviewed said that autonomy was linked to motivation, as STS theorists argue. This corroborates the assertion made by Adler (1993) that "autonomy is not a critical motivating characteristic of jobs", based on case study of NUMMI (New United Motors Manufacturing, Inc.), a joint venture between General Motors and Toyota.

Although autonomy was not particularly important to cell production, as the case study research continued, two other important behavioral factors emerged. One was interdependence and the other was continuous improvement. These findings on interdependence are not surprising since the importance of interdependence in team-based jobs has already been advocated by Wageman (1995) and Van der Vegt et al. (2001). In cell production, interdependence based on multi-skilling among operators was important. The production system aimed for "total optimality", that is, achieving a cell's goals while achieving a result of no waste between operators or workstations, for example idle times and work-in-process inventories. Therefore, operators needed to harmonize their operations and sometimes help adjacent workers in the same cell so that they could avoid idle time or work-in-process inventories, and so they could achieve line-balancing—the indicator shows the extent to which operators efficiently work without interrupting work-processes and causing idle times and work-in-process inventories. There were two aspects of interdependence: task and goal interdependence. Task interdependence was enhanced by the one-team task. Goal interdependence was concerned with line company system and the one-team task.

As I have already explained, continuous improvement concerns what Argyris and Schön (1978) call "single-loop learning". It was important for a number of reasons. For example, cell lines were built without a large amount of investment, and, as a result, they were not as fixed as conventional mass production lines. To enhance continuous improvement, managers used suggestion systems and off-line improvement activities such as QC circles and TPM activities. In addition to these "formal" practices, there were daily or "informal" practices to drive continuous improvement, such as horizontal learning among cells in which operators exchanged ideas or

solutions, not only with co-workers in the same cell but also with operators in other cell lines. Furthermore, in some plants operators were supposed to make direct contact with R & D staff that came to the shop floor and to present ideas on product design. These operators, who were generally regular workers, were expected to possess a higher level of knowledge and skills such as problem-solving skills. To facilitate this, they took IE and QC classes off the job.

In summary, cell production was not aimed at satisfying people by offering an autonomous work environment, as STS scholars stated. Even if cells were teams, they were not as autonomous as had been expected. Rather, cell production required people to exercise greater effort—that is, to extend the range of skills, to be interdependent in order to achieve "total optimality", and to make continuous improvement. Consequently, operators seemed to be more fatigued than before the introduction of cell production. Regardless of these shortcomings, operators had the opportunity to stretch, exercise their capabilities, and the success of cell production hinged on how to elicit from people the desired behaviors and skills or knowledge.

**Horizontal Fit: HR Systems Perfectly-Tapping-Potentiality versus Imperfectly-Tapping-Potentiality**

My case study showed that some managers, e.g., the ones at plant A and B, attempted to fully elicit and utilize the capabilities and skills of people to ensure the success of cell production, whereas others, for example, the managers at plant C, tried to build up "skill-less", or de-skilled cell lines where people were rarely expected to exercise their capabilities or skills. The plant A and B managers tried to adopt as many of the HRM practices shown in Table 1 as possible whereas the plant C managers did not. Roughly speaking, some managers attempted to employ as many suitable HRM practices as possible in order to fully elicit the potential from people while others did not. Therefore, there were the two sets of HR practices for cell production. This relates to what SHRM scholars call a horizontal fit. I call the set or system of HRM practices aimed at fostering multi-skilling, (extrinsic and intrinsic) motivation, (task and goal) interdependence, and continuous improvement the "perfectly-tapping-potentiality HR system". I call the system of HRM practices not aimed at fostering these behavioral factors or supporting only part of these behavioral factors the "imperfectly-tapping-potentiality HR system". Below, I make a comparison between the two HR systems in the light of the staffing, training, work design, participation in decisions, and remuneration that seemed to be the important HRM dimensions for cell production. Table 3 shows the two sets of HR systems for cell production.

**TABLE 3**
**The Two HR Systems for Cell Production**

| Imperfectly-Tapping-Potentiality HR System | HRM Dimensions | Perfectly-Tapping-Potentiality HR System |
|---|---|---|
| Externally labor market oriented | Staffing | Internally labor market oriented |
| No extensive training provided | Training | Aimed at multi-skilling and problem-solving skills |
| Individual-based | Work design | Team-based |
| Limited | Participation in decisions | Great opportunities for continuous improvement activities |
| Emphasizing only extrinsic motivation | Remuneration | Emphasizing both extrinsic and intrinsic motivation |

In terms of staffing, cells with the perfectly-tapping-potentiality HR system were composed of regular workers since it took a long time to develop workers with multi-skilling and problem-solving skills. Therefore, staffing was internally labor market oriented, with an emphasis on regular workers. Training was aimed at developing multi-skilling and problem-solving skills. The work process was designed to be team-based in order to ensure task and goal interdependence and to facilitate group-based learning and competition. Participation in decisions was often concerned with continuous improvement activities. Remuneration placed emphasis on both extrinsic and intrinsic motivation or rewards.

On the contrary, on cells with the imperfectly-tapping-potentiality HR system, operators were rarely expected to exercise their capabilities or skills. Managers attempted to make "skill-less", or de-skilled cells where operators were not required to upgrade their skill levels. Staffing was externally labor market oriented; there were many contingent workers from temporary staff agencies and subcontractors. Such cell operators were rarely expected to acquire multiple-skills and problem-solving skills. Thus, their training was not extensive; these operators attended a mere two-day training program before entering cell lines. It seemed that they were expected to become "multi-tasking" operators, who extended their range of work skills in a single area. Work design could be said to be individually-based since these operators, e.g., operators at plant C were not as interdependent in their achievements and consequences as the operators at plants A and B. Operators did not play an important role in improvement activities; instead supervisors or engineers took responsibility for continuous improvement. Regarding remuneration, most operators in cells with the imperfectly-tapping-potentiality HR system were from temporary staff agencies or subcontractors and their compensation was determined by these external agents and subcontractors. Managers had no right to determine the level of payment for these contingent workers. However, they suggested to temporary staff agencies and subcontractors that excellent contingent workers should be paid more than average ones. Therefore, remuneration would be

concerned with just extrinsic rewards.

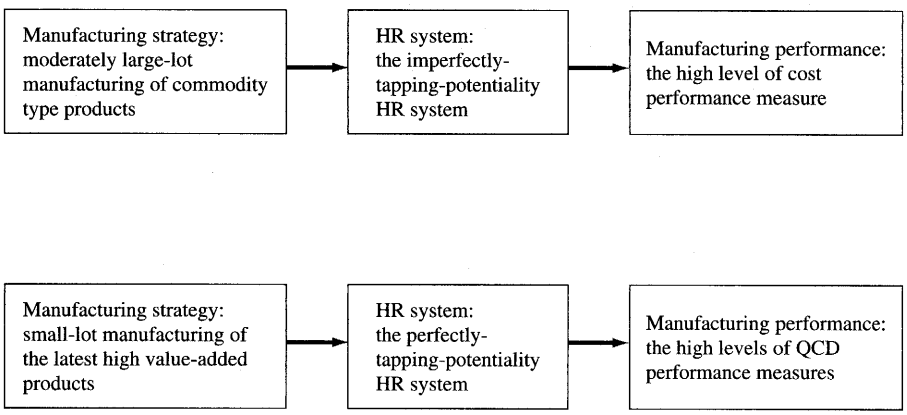
The two HR systems affected manufacturing performance, however, cells, supported by the perfectly-tapping-potentiality HR system, had more effect on manufacturing performance than did cells run by the imperfectly-tapping-potentiality HR system. That is, the former cells improved all of the QCD manufacturing performance measures, while the latter cells improved only cost performance through enjoying the economy of scale.

**Vertical Fit: Aligning HR Systems with Manufacturing Strategies**

The case study revealed that cells supported by HRM practices achieved higher QCD manufacturing performance measures than the previous mass-production lines with automated belt-conveyors. However, cells were not a panacea. Plants performing cell production could no longer compete against manufacturers located in countries with low-labor costs, especially for cost performance. Japanese cells were productive and efficient—however Chinese manufacturing sites were more cost-advantageous. The average wages for Chinese workers were one-twentieth to one-thirtieth of the average wage for a similar Japanese worker. Even cells aimed at small-lot manufacturing (e.g., the cells at plant A) were transferred to overseas sites because they were not competitive in terms of total lead-time or parts procurement. To maintain cell production in Japan, some managers (e.g., those at plant B) adopted a manufacturing strategy aimed at providing the latest high value-added products in a small-size lot.

As such, the case study indicated that HR systems seemed to be congruent or aligned with manufacturing strategies. This relates to what SHRM theorists call a vertical fit. In such cases, it is imperative to consider what HR systems are congruent with what manufacturing strategies. As stated in the previous section, there were roughly two HR systems for cell production—one was the perfectly-tapping-potentiality HR system and the other was the imperfectly-tapping-potentiality HR system. The case study suggested there were the two types of manufacturing strategies that seemed to fit these HR systems. One was a manufacturing strategy aimed at the small-lot production of the latest high value-added products that global competitors could not emulate and that were to be shipped to the Japanese domestic market (e.g., the manufacturing strategy adopted at plant B). The other manufacturing strategy was aimed at moderately large-lot production of old type or commodity type products (e.g., the manufacturing strategy for plant C). Figure 2 depicts the relationships among manufacturing strategies, HR systems, and manufacturing performance.

**FIGURE 2**
**The Manufacturing Strategies-HR Systems-Manufacturing Performance Linkages**




If a manufacturing strategy is aimed at moderately large-lot manufacturing of old type or commodity type products, then the cells, which may be composed of a large number of people, would be used with the imperfectly-tapping-potentiality HR system. This would generate a high level of cost performance measure through enjoying the economy of scale. If a manufacturing strategy is aimed at small-lot manufacturing of the latest high value-added products, then the cells, which may possibly be composed of a smaller number of people, would be used with the perfectly-tapping-potentiality HR system. This would result in high levels of QCD manufacturing performance measures through literally educing potential from people. To maintain cell production in Japan, as the case of plant B demonstrated, it is better to employ the perfectly-tapping-potentiality HR system together with the corresponding manufacturing strategy, i.e., small-lot manufacturing of the latest high value-added products.

## CONCLUDING REMARKS

In this chapter, I first summarize the main points in this paper and then close this paper with a discussion of my future work.

Cell production is a human-centric production method focused on team activities that has been employed by some Japanese manufacturers since the mid to late 1990's to compete against global rivals—whether foreign manufacturers or Japanese affiliated overseas plants—and to gain a competitive advantage. The purpose of this paper was to examine the HRM practices used in this manufacturing method, which might generate high manufacturing performance, based on

evidence from the case study research of 16 plants performing cell production in Japan.

Cell production was not a manufacturing method aimed at satisfying operators by offering an autonomous work environment, as some STS scholars state. Rather, cell operators were required to exert a great deal of effort, that is, to extend the range of their skills, to work interdependently to achieve work tasks and take responsibility for the consequences, and to make continuous improvement. Consequently, they felt more fatigued by their work tasks than before cell production was employed. Regardless of these shortcomings, however, the success of cell production hinged on how to elicit the desired behaviors and skills or knowledge from operators. Operators had many opportunities to exercise their capabilities. Managers used HRM practices to extend the range of operators' skills, to ensure task and goal interdependence among workers, to get operators to take part in continuous improvement activities, and to extrinsically and intrinsically motivate operators. As such, the case study found that in relation to behavioral requirements in cell production, individual HRM practices were desired. These findings relate to the contingency perspective in SHRM research, which suggests that HRM practices should be consistent with behavioral requirements in a specific work setting.

A set of HRM practices promoting desired behaviors and skills or knowledge—what I called the perfectly-tapping-potentiality HR system—was likely to generate high levels of QCD manufacturing performance measures. On the other hand, there was a HR system that was not aimed at fostering these desired behaviors or that supported only parts of these behaviors—what I called the imperfectly-tapping- potentiality HR system. This HR system did not have a significant effect on manufacturing performance. Cells based on this HR system only reduced cost through enjoying the economy of scale. These findings concern the configurational perspective in SHRM research, which posits that unique HRM practices patterns enable an organization to effectively achieve its goals. This is called a horizontal fit.

However, cells supported by the perfectly-tapping-potentiality HR system were not a panacea. Even if cells were productive and efficient, the average wages for workers at overseas plants, e.g., Chinese plants, were substantially lower, compared to the average wages for Japanese counterparts. In addition, Japanese plants were not competitive in terms of total lead-time and parts procurement overseas. To maintain cell production in Japan, managers needed to adopt the perfectly-tapping-potentiality HR system together with the corresponding manufacturing strategy, i.e., small-lot manufacturing of the latest high value-added products that global competitors could not emulate and that were to be shipped to the Japanese domestic market, not moderately large-lot manufacturing of commodity-type products. This also relates to the configurational perspective, which posits that HR systems should be aligned with alternative strategies. This is called a vertical fit.

This paper increases understanding of cell production by examining its human or organizational and HRM aspects. In addition, it contributes to HRM research, especially SHRM research, by investigating HRM practices or HR systems that can generate high manufacturing performance through their implementation in a production system—especially ones based on team activities like cell production. This paper helps SHRM scholars to gain a deep insight into why HRM practices are crucial and what high performance work practices are, especially in a manufacturing context. In this paper I answered "why" HRM practices were crucial in relation to behavioral requirements, "what" HRM practices were important to cell production, and "whether" these HRM practices actually affected manufacturing performance. Based on the results of case study, I presented my view on high performance work practices.

However, I could not examine "how much" these HRM practices affected manufacturing performance. This requires survey-type research using statistical techniques that case study research cannot address (Yin, 2003). Therefore, my next work is to estimate the impact of the HRM practices used in cell production on manufacturing performance by conducting survey-type research.

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