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Doré-Doré

1851

As the sun set on the thirty-second anniversary of the Doré family business, Laurent Doré sat on the wooden steps of his factory and reflected on the history of the Doré Society, established by his brother, Jean-Baptiste, in 1819. After the French Revolution, many farmers in the area had knit or woven garments in their homes by hand or with crude and simple looms, either for their own use or to sell on the open market in nearby Troyes. Little profit remained after they replenished their yarn and needle supplies. Witnessing the hardships of his own family and his neighbors, Jean-Baptiste approached those of his neighbors who, like himself, made hosiery, suggesting they pool their resources to buy supplies and sell finished products together. From this humble cooperative, the Doré brothers built a factory equipped with custom-designed looms and knitting machines. They convinced many of the more affluent area farmers to buy hosiery rather than make their own, and had recently taken their wares to sell in Paris, over 150 kilometers away. Now Laurent Doré gazed with pride at the knitting machine he had designed and built (see **Exhibit 1**). Illuminated by a candle placed in front of a glass globe of water that magnified its light, the new machine promised to make socks of an unprecedented quality, with a tight, dense knit suitable for the exclusive milliners and couturiers that dressed the haut monde.

1970

"It was the best of times, it was the worst of times...," Monsieur Barrois, Président-Directeur Général (PDG) of Doré-Doré (DD), muttered to himself. The company, which had evolved from its predecessor, the Doré Society, had achieved the highest level of production in its history and was rapidly becoming a world-famous name in quality hosiery. At the same time, one item of DD's product line troubled him; sales of women's back-seam stockings were plummeting even as the company as a whole was reaching the pinnacle of its growth. Layoffs seemed imminent. Yet to lay off loyal employees would belie the company's prosperity and mock its long-standing commitment to its workers. DD had established housing, a bus transportation system, and health services for its factory employees. Barrois was committed to finding new avenues of growth. One alternative would be to build upon the company's expertise in knitting hosiery by expanding into a separate line of small knitted garments. By year end, Doré-Doré had established a children's knitwear division to produce children's sweaters.

This case was prepared by Research Associate Audris Wong and Professor Janice H. Hammond as a basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation. Data in the case have been disguised.

1990

"La vie s'écrit avec DD" ("Life is written with DD") read an enormous advertisement adorning the walls of the Doré-Doré children's knitwear factory at Mery. "L'école de la classe" ("The school of class") punned another. François Marguet, Director of Operations, smiled as he strolled by the ads. Marguet had served for many years as Director of Manufacturing for DD's hosiery division. Several months earlier, Doré-Doré's PDG, Denis Crescent, had asked Marguet to assume the newly created position of Director of Operations over the company's two divisions (*Hosiery*[1] and *Children's Knitwear*). At that time, Crescent had made his wishes clear. "Our operations have always been a strong source of competitive advantage. Our loyal, highly-skilled workers allow us to offer our customers products of exceptional quality with superior customer service. But competitive pressures are ever mounting—rising labor costs have hurt our cost position; our competitors are improving their service levels. Marguet, what changes could we make in our operations to strengthen our competitive position?" Marguet had a reputation for seeing operations with a fresh and critical eye.

Marguet reflected on some of the issues he had been grappling with recently in the hosiery division. One of Doré-Doré's competitive strengths was its superior customer service for hosiery clientele. A key component of its customer service strategy was the immediate fulfillment of replenishment orders for a large class of basic hosiery items. Typically, 25,000 out of 35,000 different hosiery stock-keeping units (SKUs) were classified as replenishable. Replenishment orders for these products were filled from inventory and delivered by post to French retailers within 2 to 3 days. Although beneficial to DD's customers, such rapid response taxed DD's resources by requiring it to hold substantial inventories of finished hosiery products.

In contrast, like many manufacturers of seasonal apparel, DD did not offer replenishment of children's knitwear products. Retailers placed children's knitwear orders far in advance of the selling season and DD delivered the orders in full at the beginning of the season. Similarly, DD did not promise replenishment for its fashion hosiery, although replenishment requests were quickly filled if DD happened to have the desired fashion product in stock.

In both divisions, product designs were completed, demand forecasts made, and preliminary production schedules established a full year before finished goods were delivered to the selling floor (see **Exhibit 2**). Long lead times such as these were common in the apparel industry, leaving manufacturers vulnerable to the vagaries of consumer demand.

The hosiery division's experiences during the previous two years exemplified the difficulty of forecasting demand for fashion and weather-dependent articles such as hose. In early 1988, for instance, consumer demand for hosiery had dropped quickly with the onset of an unusually hot spring and summer. As a result, inventory levels rarely fell below demand; DD posted a 95% order-fill rate for hosiery replenishment and much of the season's production could not be sold at full price. Accordingly, the fall/winter planned production, partially based on the 1987/88 demand pattern, was curtailed. The end of 1988, however, proved to have markedly cooler weather. To meet anticipated demand increases, the factory hired 70 new workers and worked three shifts, six days a week, from December to Easter. In the end the company produced 20% excess product.

To address this problem, Marguet began to investigate "quick-response" strategies that would more closely link production to actual demand. Quick response was a concept that advocated

[1]The terms hosiery, hose, socks, and stockings are used interchangeably in the case.

linking "upstream" manufacturing operations and retail activities to "downstream" consumer demand in order to create a supply chain with the requisite speed and flexibility to respond quickly to shifting market demand. Operating in a quick-response mode involved making demand forecasts and establishing production schedules closer to the selling season, reducing manufacturing lead times, and basing replenishment on actual sales data, thereby ensuring that the supply chain could meet consumer needs in an efficient manner.

Marguet thought the primary benefit Doré-Doré would derive from introducing quick response in its hosiery operations would be to reduce finished goods inventory levels, since retailers could already replenish DD's basic hosiery items within a few days. Marguet hoped that the greater flexibility afforded by a quick-response strategy might also allow DD to move from its current two collections (Spring/Summer and Fall/Winter) per year to four. Four collections would enhance the company's ability to meet consumer preferences; in particular, if this change were accompanied by a compressed product development cycle, fashion trends could be more readily incorporated into designs. Four collections per year might also reduce seasonal demand fluctuations by giving the salesforce a stream of new products to show its customers.

Company Background

Doré-Doré had established itself as a world-class manufacturer of fashionable knitted products. Its *Hosiery Division* produced socks and stockings for men, women, and children; its *Knitwear Division* produced a line of children's knitwear such as playclothes, sweaters, and nightclothes (**Exhibit 3** shows product samples). The hosiery division accounted for 88% of DD's sales. (Of this 88%, 45% were men's, 20% women's, and 35% children's hosiery products.) The company offered both "classic" items, such as black dress socks and navy knit sweatshirts, and "fashion" items which were closely tied to the latest Parisian fashions. Seventy-five percent of Doré-Doré's knitwear collection changed each year; in hosiery, approximately 50% were "classics."

Doré-Doré focused on the high end of its markets with regard to both quality and fashion. Its hosiery line was characterized by unusual breadth and detail. For example, its sportswear collection was designed to accommodate subtle wear requirements: high altitude skier's wool socks were lined with silk to provide an additional layer of warmth and comfort, and tennis socks were designated by the type of playing court—clay, grass, or hard court—since, for example, tennis players tend to slide more on clay than on hard courts. Its citywear collection featured traditional, elegant men's dress socks and stylish, comfortable women's socks and stockings. Lastly, its fashionwear collection included wildly patterned women's stockings and "self-assertive" socks for men. Doré-Doré produced hose not only under its DD trademark, but also for famous designers such as Yves St. Laurent, Nina Ricci, and Chantal de Thomas. DD quality manifested itself in exclusive yarns such as cotton lisle, silk, and fine wools; stringent quality control; a wide range of sizes; double reinforcement of heels and toes; invisible seams; and impeccable fit. Unlike most hosiery manufacturers, Doré-Doré worked with two different calf shapes for men's and women's hose to achieve the best possible fit.

Doré-Doré served nearly 8,000 French clients, concentrating on specialty retailers and exclusive department stores such as Le Printemps and Les Galeries Lafayette. Although the high-end segment represented only 5% of the French hosiery market, DD commanded a 30% to 40% market share in this segment. Overall, Doré-Doré's hosiery represented 4% to 5% of the French market in units, and 6% to 8% of the sales in French Francs. DD's share of the French children's

knitwear market was a mere 0.5%. In 1990, DD's annual sales were expected to total about 250,000,000FF.[2] Exports comprised 35% of the company's total sales.

Operations

Doré-Doré's operations were divided between two main sites: the Mery plant (20 km from Troyes) encompassed all children's knitwear operations; the Grès complex (10 km from Troyes) housed the company's headquarters and central hosiery factory. Both knitting and sewing plants existed within the Grès complex. One-quarter of DD's hosiery was knit in the Grès plant; the remainder was knit in 11 small knitting shops located near Grès, each run as an individual family business. All hosiery knitting operations fed the Grès sewing plant, where all of the hosiery was sewn, washed, ironed, inspected, and packaged. Throughout the entire factory system, 37,000 pairs of hose and 2,000 children's garments were produced each day.

Each season, DD produced each style in two "campaigns," i.e., the season's production for each style was divided into two separate batches. Early in the production season, when few, if any, retailers had placed orders, a first batch of each style was produced. Later, as information about retailers' initial orders became available, preliminary forecasts were revised and a second production campaign was run to meet anticipated needs for each product. Even with the two-campaign system, forecasts were uncertain; nearly all production took place before end-consumers' demand could be observed. As a consequence, high inventory carrying costs were incurred and many items were left unsold. For example, in fall/winter 1988/89, when 20% of hosiery inventory could not be sold at full price, 90% of the excess stock was sold the following year at cost in Doré-Doré closeout sales or through Zanzi, its discount "second-quality" label. The remaining 10% was sold below cost through discounters and factory outlets. (**Exhibit 4** outlines DD's cost structure for hosiery.) Though some hosiery items suffered stockouts, management's main concern was unsold items: once out of fashion, they became nearly worthless. Across its two divisions, DD held an average of 21,000,000FF of raw material inventory, 13,000,000FF of work in process inventory, and 45,000,000FF of finished goods inventory. Firms in the industry typically experienced inventory carrying costs in the 20% to 25% range.

To forecast demand, Doré-Doré relied heavily on the intuition and experience of its veteran sales representatives and production coordinators. In conjunction with a Materials Requirements Planning (MRP) system, forecasts were used to plan material purchases and schedule production. Forecasting demand was complicated by Doré-Doré's fashion focus—the popularity of different styles was highly unpredictable, and even successful styles often enjoyed only short periods of popularity. Yet fashion items were extremely important strategically, playing a key role in the sale of standard products to both retailers and consumers. DD believed that fashion products lured customers into stores, where they were likely to supplement their fashion purchases with standard items made by the same manufacturer.

Marguet's desire to reduce manufacturing lead times was confounded by his concern that allowing production to closely track seasonal demand fluctuations would conflict with the company's desire to maintain level employment in its manufacturing facilities. Doré-Doré had a social and legal obligation to provide its workers with year-round employment. In addition, since DD, like most French companies, closed during the month of August to allow employees vacation time, production schedules and deliveries from suppliers faced this annual constraint.

[2]In July 1990, the conversion rate for French Francs (FF) to U.S. dollars was 5.3FF = $1.

Cellular Manufacturing Experiments in the Children's Knitwear Division

Doré-Doré's children's knitwear offering had evolved from a modest line of sweaters to a full line of sweaters, sweatshirts, dresses, skirts, trousers, shorts, and t-shirts. Although Marguet was primarily concerned about excessive inventories in the hosiery division, a number of factors led him to begin his manufacturing experimentation in the children's knitwear division. First, it seemed prudent to conduct a preliminary experiment outside of Doré-Doré's flagship hosiery line. knitwear was less dependent than hosiery on expensive, heavy machinery; experimenting with hosiery would likely encounter more equipment constraints. Third, children's knitwear was a more competitive market; Marguet knew that competitors in this area were actively investigating ways to innovate. In addition to any benefits to the children's knitwear division, Marguet expected his experiments to provide valuable clues for potential improvements in the hosiery division's operations.

Doré-Doré's knitwear operations were housed at the Mery plant. Approximately 200 different styles were manufactured in each of two annual collections. Each style was offered in a variety of colors and sizes. Eighty percent of knitwear production was sold under the Doré-Doré label, with the remaining 20% divided between two private labels, Chantal de Thomas and Monde des Enfants. The planning and production cycle for knitwear was divided into five steps (see also **Exhibit 5**):

Yarn and Fabric Suppliers (*2 1/2 months average lead time*) Doré-Doré's select group of yarn and fabric suppliers might need up to three months to deliver ordered materials.

Knitting (*2 weeks average throughput time*) The Mery plant knit both dyed and undyed yarn. Bolts of cloth knit from pre-dyed yarn were sent directly to the cutting room, whereas undyed ("greige") cloth was first diverted to an outside dyer.

Dyeing (*5 weeks average lead time*) Undyed cloth was sent to a dye subcontractor.

Cutting (*1 week average throughput time*) After stacking multiple layers of cloth on a cutting table and topping the layer with a paper pattern, workers used high-speed saws to cut multiple pieces from a single pattern. Workers took care to ensure the integrity of the finished product—that stripes, for example, would match exactly across seams.

Sewing and Finishing (*3 weeks average throughput time*) Workers assembled cut pieces and added final touches such as buttons and buttonholes.

Doré-Doré's average production batch size in sewing was 200 pieces of the same style and color, with an average of eight different sizes within a batch. Doré-Doré management believed its batch sizes, which had been halved in recent years, were small relative to those of manufacturers of similar products. Doré-Doré's products manufactured under designer labels typically were made in larger batches. Workers in the sewing operation were compensated under a piece-rate system, averaging 6,800FF per month including benefits. The knitwear sewing room had 55 sewing machines installed and was staffed by 42 workers. The additional machines were either specialty machines used for occasional operations or extra machines used in periods of peak demand.

Sewing an average knitwear garment took 10 minutes of actual labor. The discrepancy between this time and the three-week period it took a garment to pass through these operations led

Marguet to investigate possible changes in organizational and operational design to shorten production lead times. One option was a **cellular manufacturing system**, in which a group of cross-trained workers operated a small cluster of machines to manufacture a family of similar items (see **Exhibit 6**). A key principle underlying the cell concept was that the groups were autonomous, managing their own time, distribution of work, and work flow.

In contrast, in a traditional batch production system such as that currently used by DD, each worker repeatedly performed a single, specific task on each garment in a large batch of identical items, thereby developing an expertise and a rhythm that fostered high levels of speed, productivity, and product uniformity. The knitwear factory was currently organized by machine type—for example, all button hole machines were located in one area. Batches of partially-completed product were moved in wheeled bins by floor supervisors or material handlers to the next required operation. (**Exhibit 7** shows the traditional layout of the knitwear sewing floor.)

In July 1989 Marguet asked an industry organization, Institut Textile de France (ITF), to design a flexible manufacturing cell for the knitwear sewing operations. After documenting what each worker did at every step of the sewing process for a variety of products, ITF suggested that six workers would be an appropriate number for balancing the process within a cell.

After a team of Doré-Doré managers and ITF consultants met with small groups of knitwear sewing personnel to explain the experiment, twenty out of the 42 knitwear workers volunteered to participate in the first cell. ITF chose six of the volunteers, along with the initial products to be manufactured and the machines to equip the first cell. The first product to be produced in the cell would be a child's sweatshirt, a staple clothing item that was fairly simple to manufacture.

Cell Design

The first cell was designed by ITF with the help of a consultant from EuroLog, a European logistics research institute. Six people and twelve sewing machines were assigned to the cell. Most of the machines had different sewing capabilities. There was some duplication of machinery in the cell, dictated by how long and how often a particular operation would need to be performed. Sewing machines for knitwear cost from 30,000-80,000FF.

If a machine in a cell broke down, it would have to be quickly repaired or replaced; if possible, during the repair period, the worker would move to another machine within the cell to continue working. (In DD's traditional operation, each worker was assigned to a specific machine; thus, if a machine broke down, the worker sat idle while waiting for repairs.) To replace a machine in the cell, the plant's single maintenance worker had to climb a ladder to unplug and move the existing machine and replace it with a new machine. The replacement might also require a set-up period of 5 to 10 minutes while the machine was threaded or had its settings adjusted.

Batches of about 200 pieces of the same style and color were expected to move quickly through the cell. Unlike the batch production system in which each worker completed an operation on every unit in a batch before passing the entire batch to the next operation, in the cell, batches were split and passed from operation to operation as individual units. When a batch arrived at the cell, an operator would perform the first operation on the first piece in the batch and then place the completed piece next to her station where it was accessible to other operators. After completing whatever pieces preceded that piece, the next operator would perform the second operation, and then place the piece between her station and the next operation. Each piece passed through the necessary operations in the cell in this manner. If work began to accumulate in front of any operation, any cell worker cross-trained in that operation could stop her current task and help work through the accumulated pieces. In this way, the workers in the cell balanced their work and

made sure the batch made its way through the cell as quickly as possible. Unlike the traditional production method, in which large numbers of batches were in progress at any time, there would be at most two batches in the cell, with one moving into a cell as the previous batch was completed.

The cell configuration—placement of machines, workers, and batch flow—had originally been designed by ITF in a horseshoe shape. The cell workers soon found this cumbersome for two reasons: first, the horseshoe worked best if the production flow was unidirectional, whereas in the Doré-Doré cell, items were frequently passed back to a previous machine for additional operations or rework; and second, the workers wanted to be able to face each other to facilitate communication. Encouraged to act autonomously with regard to work methods, the workers rearranged the cell in a new configuration (as shown in **Exhibit 8**) one evening after management and other workers had gone home. At first, the team tried to assign work using traditional methods, with each worker specializing by task. This system made the sweatshirts well but was difficult to adapt to the next style assigned to the cell. To help the team become more flexible, Marguet hired a professional trainer to provide additional instruction on cross-training and cellular manufacturing.

Cell Results

The cell quickly showed a number of improvements over the line. The throughput time for a garment dropped from 15 working days (3 weeks) to only one day. The defect rate dropped from 5% to 2.5%; moreover, defects usually were found before the item left the cell and could be corrected more easily due to cross-training and the accessibility of appropriately configured machines.

Management had expected the labor content of an average garment's sewing operations to exceed slightly the existing 10-minute line standard. After six months, however, the labor content of many garments sewn in the cell was as low as (and in a few cases lower than) that of those made on the line. The workers seemed to maintain their motivation; Marguet had several times observed a cell worker under time pressure moving to a vacant line machine when a cell machine needed repair or replacement and the cell had no duplicates. The cell workers also performed additional tasks, such as completing delivery slips and shipment orders, that previously were the supervisor's responsibility. The net result was that output per worker remained roughly the same.

The new system was better suited to handle decreasing batch sizes; although the smaller the batch, the more often machine thread had to be changed. By the same token, the traditional line could handle larger batches with more ease. Marguet wondered if large orders that had clear delivery dates established far in advance might be better suited to the traditional method of production. Also, Marguet had yet to determine an appropriate compensation scheme for the cell workers.

In January 1990, management organized a second cell of six workers. In this case, cross-training was provided by the first-line supervisors. The second cell also redesigned its own configuration to better meet the team's needs, choosing a layout different from that of the first cell group. The two cells were placed adjacent to the traditional line operation (see **Exhibit 8**).

Pleased with the two cells' results, Marguet began to plan for the remaining operators to be divided into cells to create a total of seven cells for knitwear sewing operations. He first classified all workers by their facility with various machines. Batches would be assigned to cells based on each cell's capabilities and the desire to maintain an even workload. **Exhibits 9a** and **9b** show cell planning charts. **Exhibit 9a** shows each worker's ability to perform each operation; **Exhibit 9b** lists the set of operations necessary to produce a few sample garments.

The First-line Supervisors and Cell Decision-Making

Many first-line-supervisor roles were usurped by the cells. In the traditional line operation, the primary role of the supervisors was to keep batches moving between operations and to distribute work among operators. In cells, however, batches "moved themselves." In addition, many of the technical or logistical problems that supervisors had previously solved could now be resolved within the cells. Management sensed that the supervisors felt threatened by the autonomy of the newly formed work groups. DD first-line supervisors began, on their own initiative, to cross-train workers in a variety of sewing operations. Management viewed this as the supervisors' attempt to prove that they still had a role in the factory.

Another traditional supervisory role was the resolution of relationship problems between workers. In view of the autonomous nature of the teams, workers were provided training in solving these types of problems. Conflicts were to be addressed first within the cell. For the first experimental cell, ITF unwittingly chose two workers who were ardent enemies. DD decided to go ahead with the chosen six members, but soon discovered that the two had difficulty working together. On its own, the team decided to address the problem. Since then, Marguet said, "They're still not the best of friends, but they can work together." In the second cell, the team objected to the frequent union activities of a team member who was a union official. As a result of group discussion, she de-emphasized her union role in the cell and spent less work time on union affairs.

Teams remained together unless someone left the factory. When a worker was absent, the rate of output dropped. If the absence was long, the group could decide whether it would accept an outside volunteer. In the first cell, when one team member went on maternity leave, the five remaining members decided not to replace her, as she had promised to return. Emphasizing the tremendous rise in loyalty by cell members, Marguet noted that the worker had curtailed the length of her maternity leave to return to the cell.

Hosiery Operations

The central hosiery factory at Grès was the original Doré-Doré plant, established in 1819. Two hundred tons of raw material inventory were stored on the premises, roughly one-third of total annual production requirements. Doré-Doré hose was made with dyed yarns. The quality control department tested samples of incoming yarn for strength, thickness, and color; a spectroscopic light was used to verify correct coloring. Rejected yarn was returned to the dyer. Before knitting, yarn was completely respooled to verify that every centimeter conformed to DD's thickness, finish, and strength standards.

Doré-Doré offered 365 different styles per seasonal hosiery collection; the differences in size, color, and materials generated a total of 35,000 SKUs annually. Hosiery was produced in batches, each containing approximately 120 pairs of the same color and style, with multiple sizes within each batch. Hosiery manufacturing required four distinct operations (see also **Exhibit 10**).

1) Knitting (*Batch throughput time—1 week; 6-8 min. actual production time per pair*) The highly automated knitting machines produced knitted "tubes" that were open at both ends. Knitting designs were centrally programmed at the Grès factory onto cassettes and sent to either the Grès knitting floor or one of the 11 knitting shops, where they were used to configure the knitting machines for the new design. It took only a few minutes for a technician to reprogram a cassette with a new design, but the manual setup and adjustment time to recalibrate the machine perfectly took from one hour to over two days. At Grès, knitting machines usually ran 24 hours a day, seven days per week. In the smaller shops, machines were run one to three shifts per day, as required.

Knitting machines were supervised by a small number of technicians. Each machine cost approximately 220,000FF and produced about 0.6% defects and 10% second-quality product.

2) Closing the Toe (*Batch throughput time—1 week; 1 min. production time/pair*) Machines in the toe-sewing room were grouped by the method of closing the toe. The room was noisy, crowded and windowless. On one side, workers placed hose made of heavier yarns onto machines that closed the toe automatically. On the other side, workers closed the toes of hose made from fine yarns using a "blind loop" process. A blind-loop operator manually stretched the yarn loops at the knit tube's edge onto a wheel of needles having 30 needles per inch. The continuously rotating wheel passed the loops under threaded needles to close the toe (see **Exhibit 11**).

3) Ironing (*Batch throughput time—1 week; 1 min. production time/pair; 15 seconds labor content/pair*) Hosiery was washed for preshrinking and then ironed in the factory's concrete basement. Waiting batches lined the walls of the noisy, hot, steam-filled room. The ironing machines were 10 to 15-feet high with a series of foot-shaped posts that revolved through a steam chamber (see **Exhibit 12**). Workers stood at one end and stretched the hosiery over the posts as the posts moved into the steaming area; at the end of the circuit each piece was removed mechanically. As in the knitting room, the ironing room was staffed by men, whereas, except for machine repairmen, toe-sewing and quality control employed only women.

4) Quality Control and Packaging (*Batch throughput time—2-3 weeks; 1-4 minutes production time/pair*) After ironing, hosiery was either sent to the quality control/finishing room or diverted to an embroidery room (see **Exhibit 13**), where about a week was needed for insignia or motifs to be embroidered. Quality control and packaging were performed in the quiet, airy, well-lit finishing room located on the second floor of the building. There, two or three workers sat at each wooden table and examined each item, checking for defects and ensuring that pairs were correctly matched. Small defects were repaired by hand at the table. Along one side of the room, workers stamped the hose with the brand name (e.g., DD, Yves St. Laurent). Tissue paper was slipped inside each piece and pairs were encircled with printed cardboard labels before being placed in a box and shipped to the warehouse.

A Proposal for Autonomous Groups in Hosiery Manufacturing

Claude Enfert, Director of Manufacturing of the hosiery division, described the current production system as heavy and rigid. He compared its rigidity to that of a train—inflexibly sequential, with one car required to follow its predecessor, and having an internal momentum that made it difficult to stop, start, or alter. Enfert believed that if total manufacturing throughput time fell to one week, finished goods hosiery inventory would drop 30-40%. To accomplish this goal, he envisioned a one-day throughput time for the post-knitting operations.

In July 1990, Marguet and Enfert began discussing the introduction of cells to hosiery manufacturing. Enfert proposed that cell operations include all operations after knitting—closing the toe, ironing, and quality control/finishing. To form a cell, these three activities would be grouped together in a single room. A key consideration when designing the cell was that ironing required an expensive (350,000-800,000FF per machine), high-capacity, extremely specialized machine. Its steady output rate would set the rate of production in the cell and physically dominate the area; at the same time, however, it could be used for any type of hose.

Enfert's proposed cell design (see **Exhibit 14**) was based on the capacity of two ironing machines. To balance the capacity of the two ironing machines, Enfert planned to assign 36 workers to a cell. The 36 workers would function as two teams of 18 each, and as a whole would be capable of

producing the entire line of hosiery. The full implementation of cells would affect 92 workers in toe sewing, 24 in prewashing and ironing, and 120 in embroidery, finishing, and quality control. Whether these numbers would change after the introduction of cells was unknown.

Enfert believed the teams should not be completely cross-trained. Workers would be specialized for a specific task and then trained in a second task. For example, the workers who treated hose for preshrinking would most likely be cross-trained in ironing, although these were two very different operations. Enfert expected that 80% of a cell worker's time would be spent on his or her primary (specialized) activity, with only 20% of the worker's time spent on the task(s) for which the operator had been cross-trained. At the same time, Enfert proposed that two activities have no cross-training whatsoever: blind-loop toe-closing and quality control. The blind-loop process was a nearly extinct art requiring excellent eyesight, training, and concentration. Enfert also thought that quality control personnel should not be trained in other operations, as he feared that quality standards might be compromised if those controlling quality understood how difficult some of the sewing tasks were.

Next Steps

Doré-Doré's cell experimentation had exposed the limitations of some of its supporting systems. For example, with the current flexibility of knitwear cells, the greatest constraint often was the availability of raw materials. A preliminary supplier-partnership program with two vendors—one for dyed yarn, one for undyed yarn—was under investigation. As an initial move towards a quick-response relationship, these suppliers now informed Doré-Doré of the quantities of yarn that were in stock or would be produced in the upcoming week and allowed DD to reserve desired quantities of the suppliers' output.

Second, Doré-Doré would eventually have to rebuild its computerized forecasting systems. The hosiery division's MRP system was limited in both size and capability, inadequate to handle either the 35,000 SKU references for hosiery or the 12,000 references for raw materials. In addition, the sales force needed to pursue earlier and better indications of sales demand. Marguet was already experimenting with new incentives to encourage sales representatives to negotiate orders with significant clients early. Not surprisingly, retailers and distributors preferred to delay placing orders until as close to the selling season as possible.

Exhibit 1 Photograph of a 1851 Knitting Machine

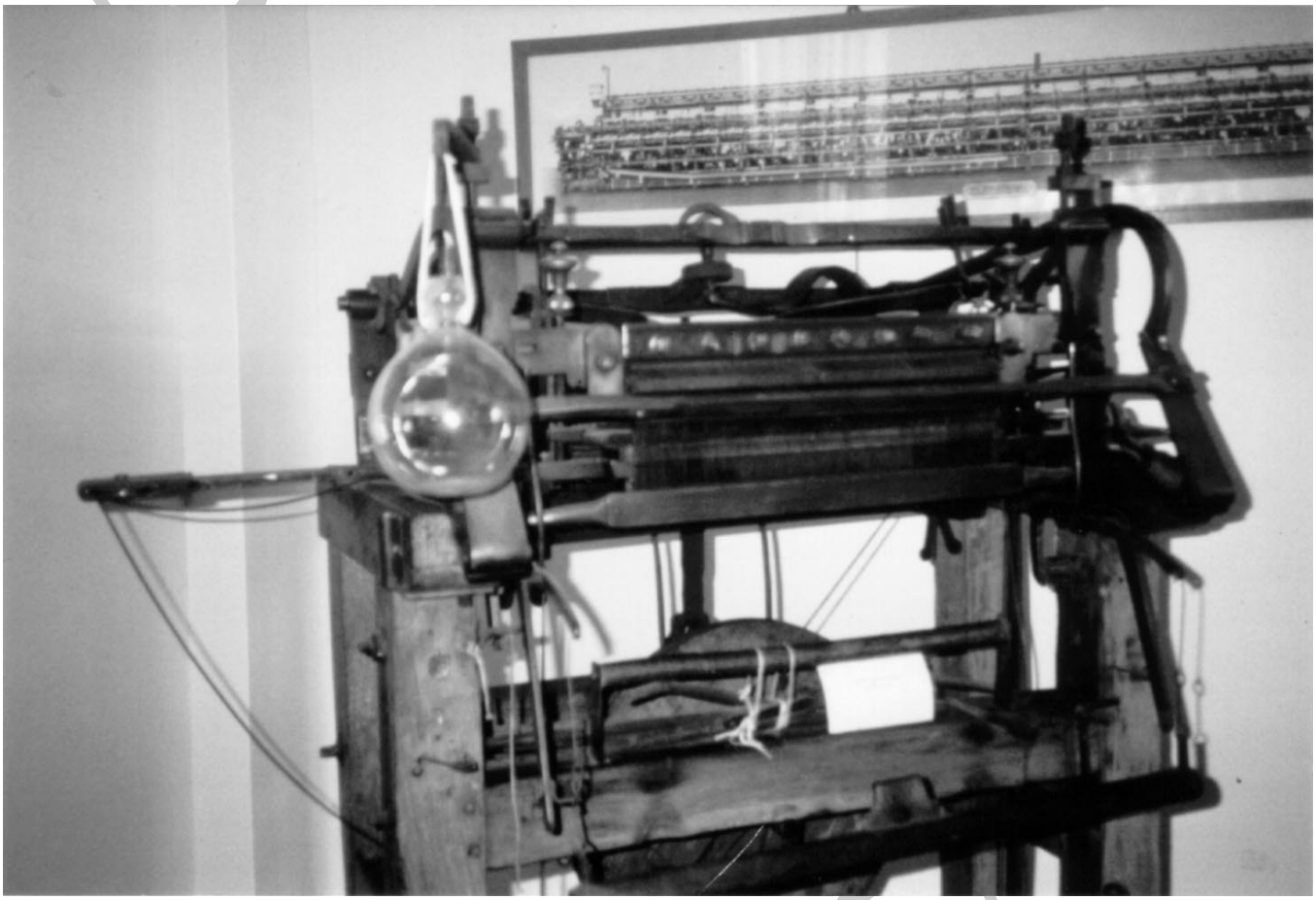


Exhibit 2 Concept-to-Customer Cycle Timeline for History

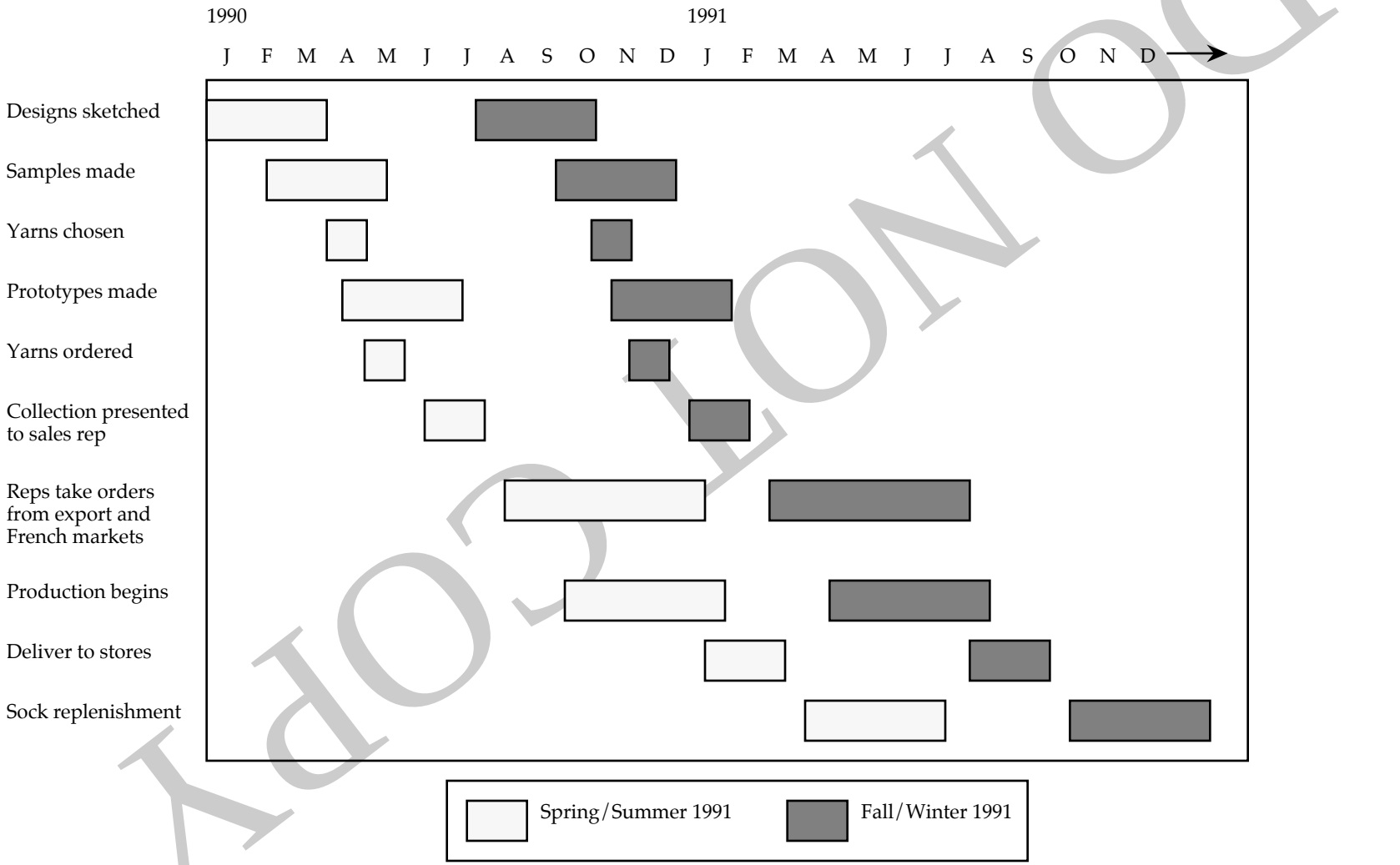


Exhibit 3 Examples of Doré-Doré Hosiery and Children's Knitwear Products

Exhibit 4 Doré-Doré's Average Cost Structure for Hosiery

Raw Material	7.80 FF	
Knitting	0.90 FF	
Sewing	0.95 FF	
Ironing	0.15 FF	
Quality Control and Finishing	0.72 FF	
Factory Overhead	5.80 FF	
Cost for Seconds and Closeouts	1.10 FF	
Total Manufacturing Cost	17.42 FF	per pair
Wholesale Selling Price	30-32 FF	per pair
Retail Selling Price	60-70 FF	per pair

The difference between the wholesale selling price and total manufacturing cost represents DD's selling and administrative expenses and profit margin.

Exhibit 5 Knitwear Production Workflow

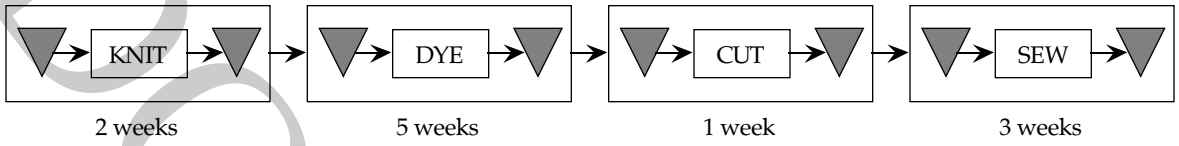


Exhibit 6 Prototype U-Shaped Design of a Flexible Cell

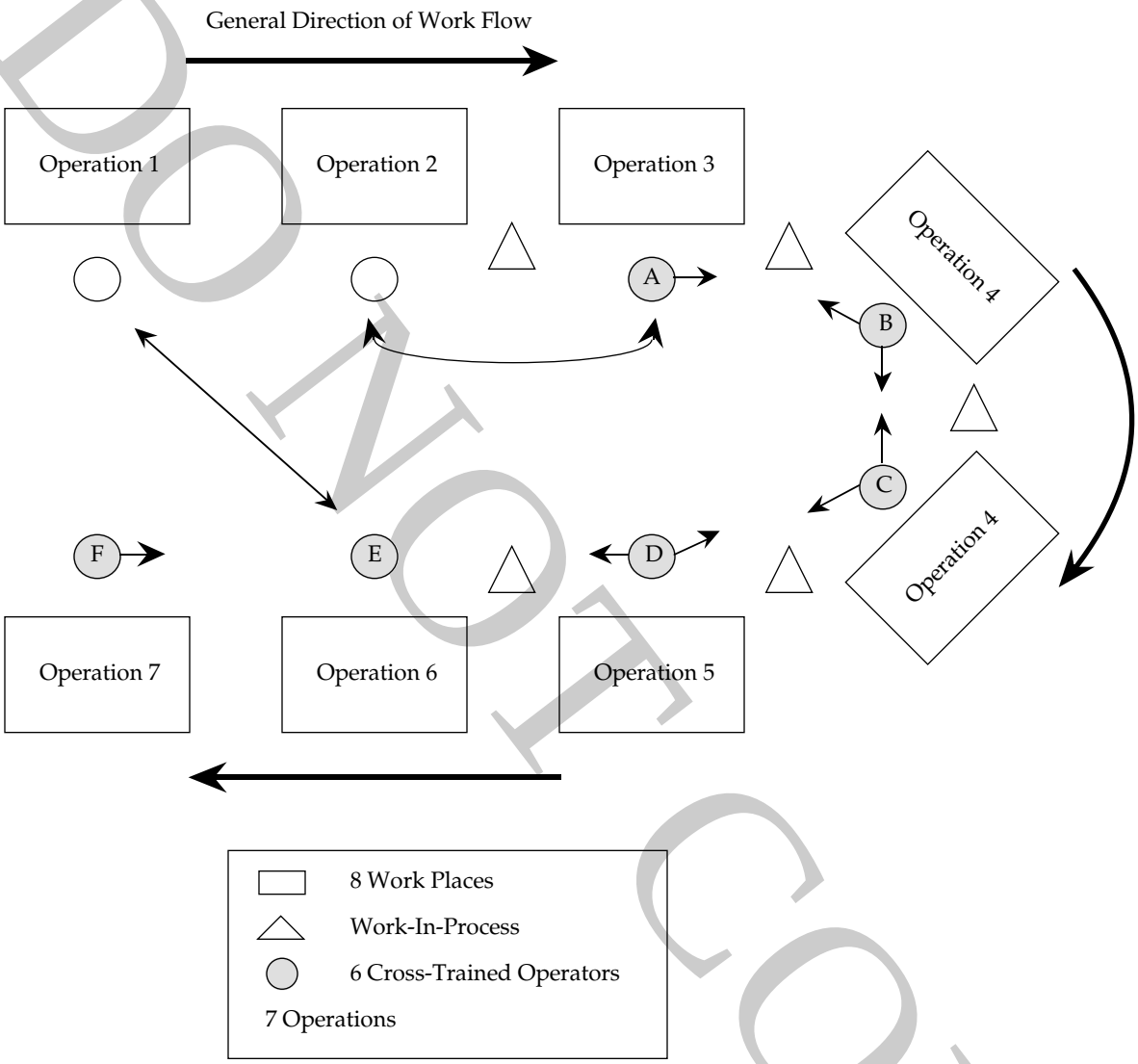
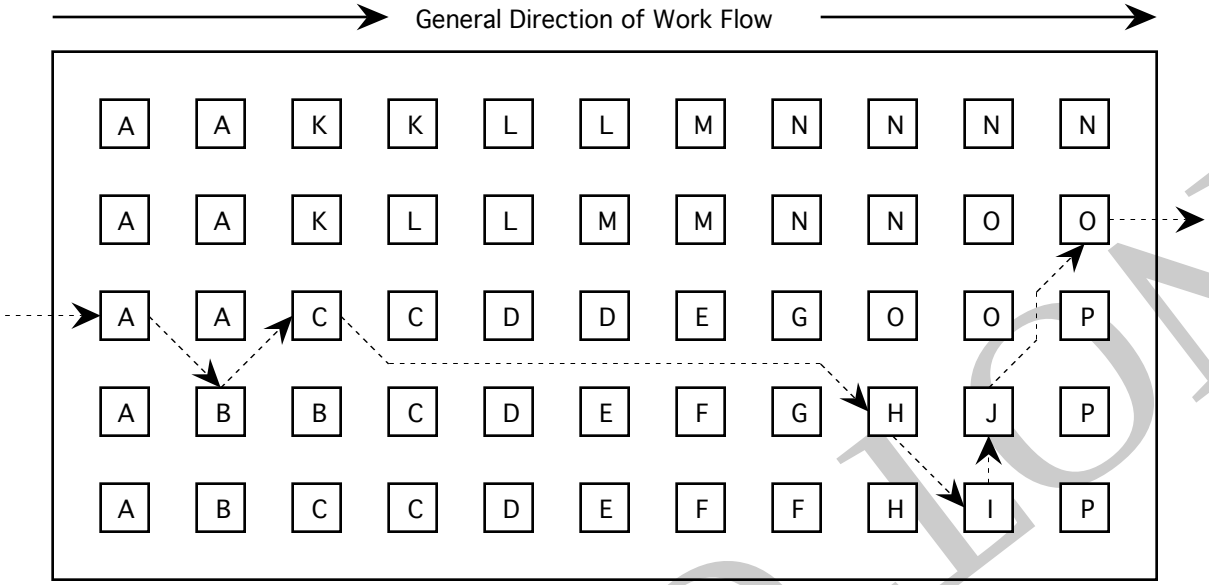


Exhibit 7 Configuration of Traditional Sewing Operations at Mery Knitwear Plant



A	Basic Seam	I	Button Band
B	Stitch Sleeve	J	Attach Buttons
C	Attach Sleeve	K	Zipper
D	Make Cuff	L	Waistband
E	Attach Cuffs	M	Belt Loops
F	Make Collar	N	Hem
G	Attach Collar	O	Pockets
H	Button Holes	P	Hand Finishing

In the traditional system of production in the Mery sewing room,
- 2 supervisors supervised 42 workers working one 8-hour shift, five days per week.
- 55 sewing machines were available on the factory floor.
- 2-3 material handlers (and the two supervisors) were responsible for moving batches of work in process in wheeled bins between operators' work stations. The required set of operations was determined by consulting a routing slip attached to the batch. For example, as shown above, the t-shirt with buttons and pocket required the operations A-B-C-H-I-J-O to be completed in sequence.
- After completing a batch, an operator removed the appropriate sticker from the routing slip and placed it on that operator's work card. The work card was submitted to a supervisor at the end of the day to ensure that proper compensation was awarded for the completion of each batch.

Exhibit 8 Configuration of Traditional Sewing Operations at Mery Knitwear Plant after Implementation of Two Cells

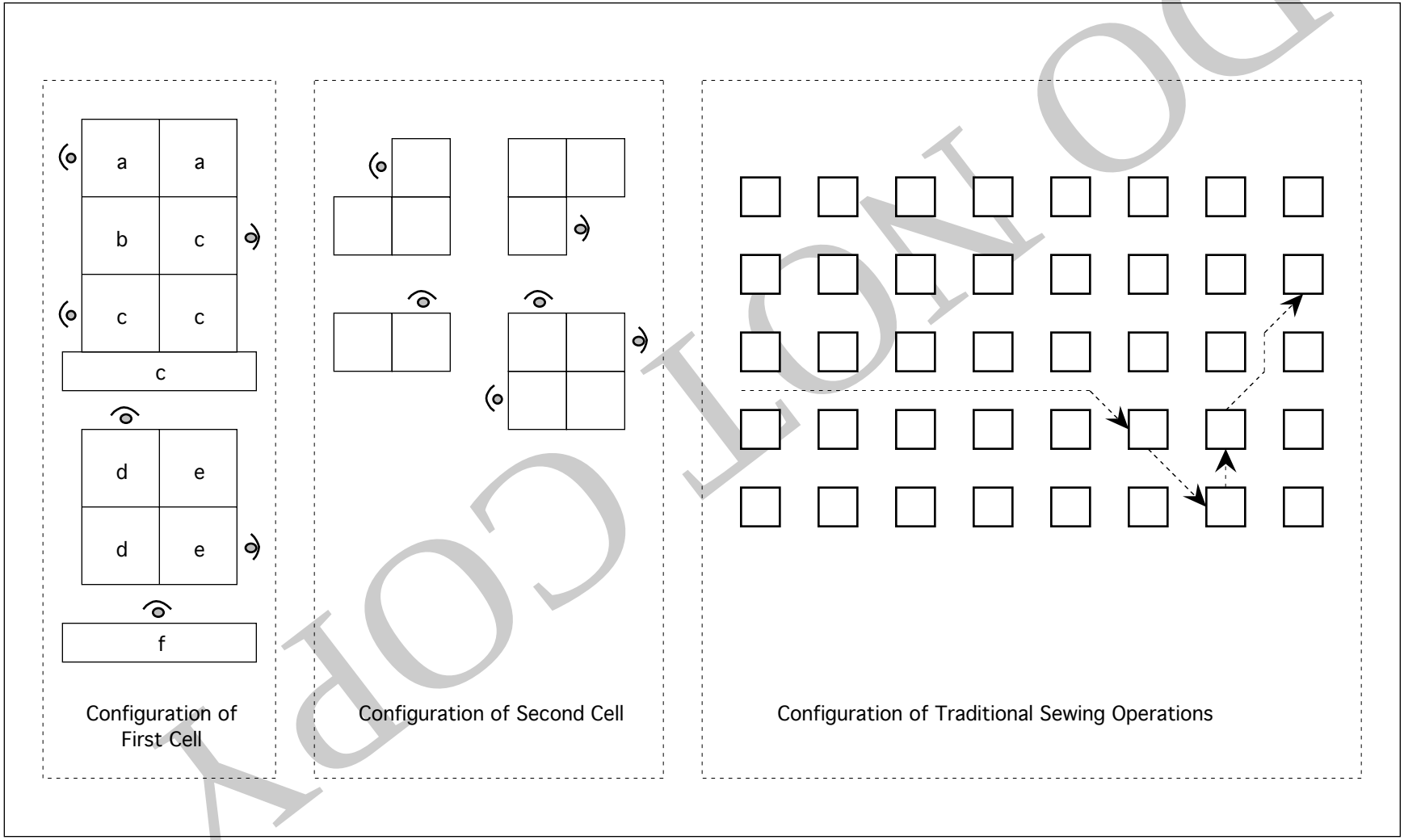


Exhibit 9a Planning Chart for Cell Design: Classification of Workers into Cells

Classification of workers by machine capability

CELL	NAME	MACHINES ---> 1	4	5	6	7	8	9	0	A	B	C	D	E	F	G	H	I	J	TOTAL SKILL SET	NAME
1	VOYE, MC	A	A	A	A	A		A			X	X								145679BC	VOYE, MC
1	BAZIN, C	A			A	B		C				X								1679C	BAZIN, C
1	CHEVALIER, L	A			A	B		C									X			1679H	CHEVALIER, L
1	LEOST, B	A	C		A	B		C											X	14679J	LEOST, B
1	PATENAIRE, N	A			A	B														167	PATENAIRE, N
1	OUTURQUIN, D	A			A	B		C			X									1679B	OUTURQUIN, D
2	DAIRIN, D	A			A	A	X					X					X			1678CH	DAIRIN, D
2	MAISON, M	A	A	A	A	B		A				X				G	X			145679CGH	MAISON, M
2	SCHWARZ, I	A	A	B	A			A												14569	SCHWARZ, I
2	KENIZ, J	A	C					A												149	KENIZ, J
2	BONNIN, S	B	C		A															146	BONNIN, S
2	BAGUET, V	B	C		A							X	X			G				146CDG	BAGUET, V
3	LEFEVRE, N	B																		1	LEFEVRE, N
3	SKRZYNIARZ,C	A								X						G				1AG	SKRZYNIARZ,C
3	PULBY, C	A	A	A	B															1456	PULBY, C
3	LEMAIRE, J	A	A	A	A	A	X	A	X	X										14567890A	LEMAIRE, J
3	CHARPIGNON,A																				CHARPIGNON,A
3	CRIDELICH, E	A														G				1G	CRIDELICH, E
4	PULBY, S	A			A															16	PULBY, S
4	VERJOT, M	C	A	A																145	VERJOT, M
4	REAUX, A	C	A	A																145	REAUX, A
4	ROSNET, M	C	A	A																145	ROSNET, M
4	BOUVOT, M	A	A	A					X											1450	BOUVOT, M
4	FEIRRERA, M																				FEIRRERA, M
5	CLEMENT, MC	A								X										1A	CLEMENT, MC
5	PONSART, J	C			A														X	16J	PONSART, J
5	NACQUEMOUCHE	C	A	A																145	NACQUEMOUCHE
5	SIMON DIT ROY	A	A	A				A												1459	SIMON DIT ROY
5	VALLARCHER,S	C	A	A		B	X									G				14578G	VALLARCHER,S
5	BOULANGER, V	B	A	A	A	A		B												145679	BOULANGER, V
6	FEVRE, M	A	C		C														X	146J	FEVRE, M
6	NEVES, M	A	B		C							X								146C	NEVES, M
6	MIOTTO, C	A			A	A		A					X							1679D	MIOTTO, C
6	PHILIPPON, C	A	C		A	C	X	A		X	X	X	X							146789ABCD	PHILIPPON, C
6	VILNET, B	A	A	A	A	A	X	A				X	X		X	G				1456789CDFG	VILNET, B
6	LEPAGE, E																				LEPAGE, E
7	BAY, G	A	A	A				A												1459	BAY, G
7	PERSILLON, A	A	B		B			C												1469	PERSILLON, A
7	BENOIT, M	A	A	A				A						X	X					1459EF	BENOIT, M
7	FESSARD, C	A			C			C				X		X	X	G				169CEFG	FESSARD, C
7	NIORE, C	A	A	A	A	A	X	A	X	X	X			X		G				14567890ABEG	NIORE, C
7	CHAULET,S	A	B	B	A	A	X	A		X					X	G				1456789AFG	CHAULET,S

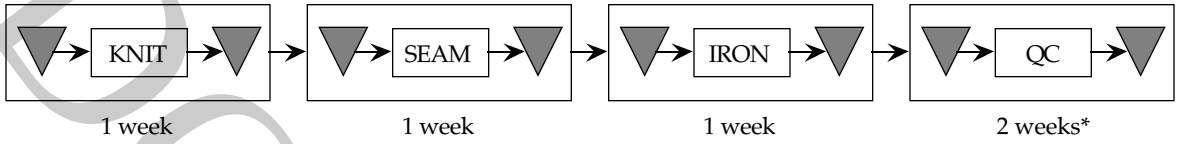
A = excellent ability; B = superior ability; C = good ability; X = proficient

Exhibit 9b Planning Chart for Cell Design: Classification of Product Items by Machine Requirements for Sample Products

STYLE NUMBER	OPERATION ----> 1	4	5	6Y	6Z	6W	7Y	7Z	7W	8	9	0	A	B	C	D	E	F	G	H	I	J	REQUIRED OPERATIONS	STYLE CODE	UNITS FORECAST	EST. MINUTES TO ASSEMBLE ONE UNIT	EST. DAYS TO ASSEMBLE TOTAL FORECAST
M 73013	X	X			X																		146Z	M 73013	950	11.31	23
G 73013	X	X	X		X												X			X		X	1456ZEHJ	G 73013	770	20.50	34
X 75001/2	X	X																					14	X 75001/2	1,370	3.24	9
Y 75001/2	X	X																					14	Y 75001/2	2,310	5.93	29
X 75007/2	X	X																					14	X 75007/2	1,100	5.45	13
X 79001/2	X	X								X													148	X 79001/2	20,330	4.23	183
R 31001	X	X											X										14A	R 31001	500	8.70	9
T 31101	X	X		X							X												146Y9	T 31101	600	9.86	13
G 31101	X	X				X			X											X		X	146W7WHJ	G 31101	500	17.02	18
W 31101	X	X		X							X												146Y9	W 31101	500	17.02	18
C 32009	X	X	X									X								X			145OH	C 32009	7,300	11.92	185
T 32045	X	X		X			X																1467Y	T 32045	1,650	8.84	31
C 32045	X	X	X	X			X													X			14567YH	C 32045	1,250	14.65	39
C 32047	X	X	X	X			X													X			14567YH	C 32047	1,800	14.61	56

For example, Product M 73013 requires operations 1, 4, and 6Z.

Exhibit 10 Traditional Hosiery Production Workflow



* Plus one week for embroidery if necessary.

Exhibit 11 Photograph of Ironing Equipment

Exhibit 12 Photograph of Blind-Loop Toe-closing Machine

Exhibit 13 Photograph of Embroidery Room

Exhibit 14 Hosiery Operations—Traditional and Enfert's Cell Proposal

Traditional Configuration

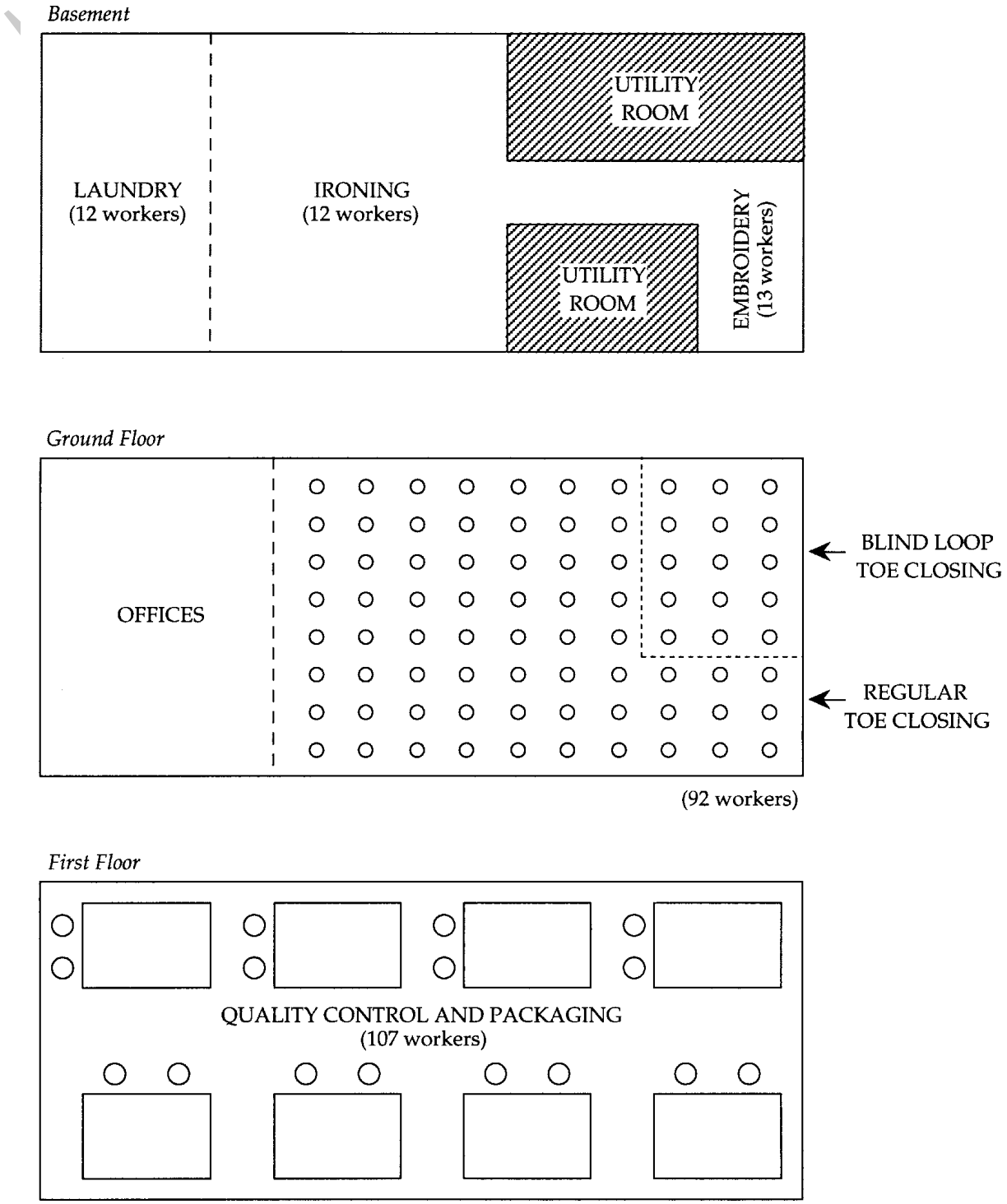


Exhibit 14 Hosiery Operations—Traditional and Enfert's Cell Proposal (continued)

Enfert's Cell Proposal