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**ORIE 5100 Manufacturing Systems Design – Final Executive Summary**

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**Suggested Improvements in Production and Distribution Systems for Llenroc Plastic to Become the Market Leader**

**Introduction**

The Llenroc Plastics Corporation (LP) produces high-pressure decorative laminates (HPDL) in the United States and holds 17% of the market share, which is less than half of the market share of Wilson, who holds 39% of it. One key factor of this 22% difference is the customer delivery service. While Wilson ensures an average 78% off-shelf warehouse fill rate with promised 10 days from order to shipping to the customers, LP only has an average 67% fill rate and needs 20 days from order to shipping. Meanwhile, because of insufficient production capacity, only 8% of LP business comes from commercial specification orders, which occupy 43% of the U.S. HPDL market and have the highest profit margins.

To receive more orders, expand market share, and become the market leader, LP has four strategic imperatives. The first one is to increase production capacity in the press room by 20%. The second is to improve customer delivery performance to meet or exceed the level of Wilson Plastics. To be specific, LP needs to reduce the time from order to delivery. The third is to reduce freight and distribution costs by 20% by arranging logical transportation routes and storing feasible inventories. The last is to finance all capital improvements through inventory reductions. However, there are three main challenges that LP needs to solve to achieve these goals. Generally, they are quality issues of laminates in the manufacturing plant, the lack of discipline in production processes, and the disconnection between the production and distribution systems. All three challenges interact, so solving one will also improve another.

**Quality Issue**

           The first obvious challenge for LP is the product quality issue in the manufacturing facility. Due to inefficient production, the press machines work six days per week, sometimes seven days, so there is no time for maintenance. The deferred maintenance leads to leaking platens, resulting in 3% yield loss. To be specific, the leaking ruins laminates, such as stained and poorly cured laminates. Meanwhile, the operators must use one shift to fix the overworking machines, which causing 11% capacity loss. One way to solve this problem is to replace the original platens. This way, LP can eliminate 3% of product yield loss from leaking. Moreover, if operators can finish work on weekdays and leave weekends for machine maintenance, LP can save 11% time from breakdown. Thus, LP can replace new platens with a $350,090 cost to obtain a 16% increase in press daily throughput, theoretically improving production capacity from 17 to 20 press loads per day. Moreover, with new platens, LP would save $230,000 in the annual cost of material loss.

           There are other quality issues with products, such as scrapped and dirty papers. Since treated paper is brittle, the corners and edges of the paper may break when handled. However, managers will only detect this problem once assembling the books of paper. Also, dust on the exposed edges of the paper rolls in the inventory gets into the treatment resins and contaminates the whole lamination process. These two quality issues are related to unorganized production processes. Specifically, LP needs more inspections in each production procedure so that managers find obvious flaws, such as scrapped paper, on time. 56 loads work-in-process inventories (WIP) that is almost 8,500 laminates bring dust on inventories and production delays. Therefore, reorganizing the production system and setting disciplines are necessary to solve the scrapped and dirty paper.

**Lack of Integration in Production Processes**

           The manufacturing plant has unorganized production operations, so LP has the insufficient production capacity. The operators do not maximize machines' utilization, so there were many idle times. For example, the production work ceases 2.5 hours daily when operators take breaks. The build-up stage in the press room has the longest cycle time, which equals a bottleneck that only produces 15 press loads per day. Then, machines in other steps have to wait for production from the build-up. To solve the 2.5-hour idle time, managers should reasonably arrange for operators to take turns to rest. Then there will still be workers operating the machines when some workers are in the rest. Thus, 19.5 hours of efficient working hours a day will turn into 22 hours. Another way to solve the bottleneck is to enhance equipment in the press room. Solving the synchronization problem between build-up and presses can enhance build-up performance. After spending $93,000 on new equipment, press 7 will achieve synchronization and improve the daily throughput of build-up from 15 to 22 loads per day. Then the new bottleneck will be the press stage, with 20 press loads produced daily, which will satisfy the current daily target. After these improvements, LP increases the production capacity by 45%. Moreover, with synchronization, workers will not need to work overtime, which saves $207,000 in annual labor costs.

           Besides idle time, the unorganized production procedure also includes irrational matches between products and machines, so there are many changeovers in the fabrication room. At the same time, this irrational arrangement resulted in a lack of synchronization between the different steps in the fabrication room, such as trimming and sanding steps, which resulted in the accumulation of 53 loads of WIP, which is half of the daily going rate. The method to solve the problem is to match product sizes. Managers could assign products with the same width, 3', 4', and 5', into each of the two sanding machines to reduce change over time. Meanwhile, operators can use only four carts to move productions to control the WIP. Once the cart is full, the machines in the last stage will stop producing. This way, the fabrication room's lead time will change from 11 hours to only 38 minutes, so LP reduces the time from order to delivery.

**Disconnections Between Production and Distribution Systems**

           The production system and distribution system of LP lack communication with each other, so the orders, productions, replenishment stocks, and delivery services have information gaps. For instance, orders and replenishment stock from different regional warehouses are hard to match because regional warehouse managers don't know inventory situations in other warehouses and production situations in the manufacturing plant. To solve this disconnection, LP needs to consider the whole supply chain as integrity. To exceed the customer service of Wilson, LP could achieve the 10 days from order to delivery through the following three principles.

The first is to implement a 5-day cyclic Schedule in the production system with the assumption that LP could deliver orders within 3 to 5 days from the central warehouse to customers directly. Managers can assign 1,620 individual products into 18 group products based on products' sizes and thicknesses. Operators can put products of the same size and thickness into one machine without changeover time. Also, the group products have a smaller than 0.1 coefficient of variance, showing a stable demand and implying stable production. The second principle is to apply no B/C policy, which means LP will no longer store B/C products with large variability and low demand predictability in both regional and central warehouses. If LP can produce products within 5 days, there will be no need to use the regional warehouse to store inventories to meet promised delivery days. Then by only storing A products with 98% fill rate, LP will save 89% of annual inventory holding costs, which is $1,850,000. At the same time, LP could avoid storing inventories with $8,800,000 financial value for a long time but without sales. Also, LP can reduce working capital in regional warehouses, which also saves labor costs. Then LP could use savings in inventory holding costs in finance improvements.

The last part is to improve transportation system. The regional warehouses will work as cross-docked facilities due to transportation routes. Managers will send out all products arriving at the facilities as soon as possible. To minimize freight costs from transportation from cross-docked facilities to end-users, LP can use the demand consolidation principle that we want to make every truck has a 100% fill rate so that LP can maximize the utilization of trucks to save operating costs. To be specific, warehouse managers may wait for a couple of days for small cities with low demand until demand can fully fill the trucks instead of sending orders out as soon as possible with available truck positions. By this method, LP can save 20% on freight costs, which reduces the unit cost from 5.2 to 4.1 cents per square foot.

**Summary**

LP should focus on enhancement in customer delivery service to receive more orders and improve its market share. LP would meet 10 days from order to delivery time by implementing a cyclic schedule and redesigning the plant layout of the fabrication room, which is faster than Wilson's promised 10 days from order to shipping. This means LP has a better customer delivery service than Wilson. Meanwhile, reducing inventories in warehouses and applying demand consolidation in the transportation at least saves 1.8 million dollars every year for LP when achieving 98% fill rate. Then, LP can finance all capital improvements. Furthermore, buying new equipment increases LP production capacity by 45%, ensuring LP can finish customers' orders on time without working overtime. And the savings after improvements in new platens and synchronization equipment cancels the improvement costs out. Based on these results, LP can consider taking more commercial specifications orders and use savings to invest in new manufacturing plants to expand its market influence.