Workshop Report:

Cincinnati Milacron-Electronic Systems Division

Implementing JIT for Survival In the Machine Tool Market

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As a leader in the machine tool industry since 1884, Cincinnati Milacron and the Electronic Systems Division (ESD) developed many firsts in their industry, including the use of integrated circuitry as early as 1964, and the use of mini computers to control machine tools by 1969. The ES division manufactures machine-dedicated controls for all of Cincinnati Milacron's many varieties of machine tool products and robots, and also sells some products to outside OEM manufacturers.

The story of foreign competition in the machine tool industry is well documented. By the early 1980s, the ES division had learned that to succeed in the world marketplace for dedicated machine tool controls, *technology alone would not be enough.*

The ES division learned that its competition had definite price advantages and things were not improving. Attempting to remain competitive, ESD maintained a technically competitive product and implemented several state-of-the-art manufacturing techniques. One was an MRP system for materials management and shop floor controls. Another was an expensive materials storage carousel, right in the middle of the shop floor, to store work in process. The carousel was in addition to the large parts storage stockroom plus another 12,000 feet of space rented across town to store materials.

By 1984, the division had an all-time high payroll and inventory level with high-technology materials handling equipment for storage. Their manufacturing leadtimes had increased to 13 weeks for product delivery. Customers wanted a much shorter leadtime, and the frozen 12-week master schedule designed to stabilize production and parts control didn't work out. With only an eight-week customer backlog, a production forecast had to drive material requirements for the remaining five weeks of leadtime. While the ES division manufactures machine controls to customers' specifications, many of the subassemblies and component parts are standard configurations. The division can therefore begin manufacture ahead of the customization of the finished product.

Searching for a better solution, the ESD managers decided to look into alternative business strategies. In late 1984 and early 1985, several ESD managers attended two workshops on Just-In-Time manufacturing. The possibilities of JIT appeared to be just what they had been looking for: simplicity versus complexity on the shop floor; reduction in throughput time; reduction of total quality costs; total employee involvement for problem solving; and reduction of layers of management, for cost and quality competitiveness in the world market.

During the next 12 to 18 months, the conversion to JIT produced results that even the ESD managers would not have thought possible. For example, they had spent $100,000 for a work-in-process storage carousel only the year before and it appeared that they would have to tear it out.

While in the beginning it was apparent that some radical changes were required on the shop floor, ESD management was not ready to implement such a turnaround from convention as JIT without careful planning. ESD has many design engineering executives in management positions, and planning before implementation is a design engineer's stock in trade.

Six Month's Planning And Design

What happened over the next six months and three days was an unusual step in the direction of implementing the JIT journey.

1. The division took six months to design and plan the JIT program.
2. It reduced the work force and rearranged the shop floor over a three-day weekend and launched JIT.

The ES division is quick to point out that their JIT journey is continuous and that while their many improvements are satisfying, there is still a long way to go.

Once the division management had decided to go ahead with JIT, they assigned a full-time project manager to plan and design the work. Fig. 1 shows a project overview. During the six months of detailed planning, many key projects were identified.

1. **Work-in-process reduction** The ES division had moved and transacted subassemblies in and out of parts storage after each subassembly operation, planning a week between subassemblies. This process stacked excessive leadtime, caused high work-in-process inventories, and eventually resulted in the in-plant storage carousel to store materials. One key project was to change the subassembly bills to phantom bills with zero leadtime and in-

clude the phantom bill with the parent assembly. This step eliminated handling, storage, and counting, and reduced leadtime for subassemblies.

2. **Point of use storage**
Previously, the division kitted all parts to a shop order from a central stockroom, resulting in extensive materials handling and extending leadtime by a week for order filling.

The central stock room was replanned and eliminated. In its place, the company handles inventories by three methods:

A. Class D low-cost parts are stored on the shop floor and replenished twice monthly by the supplier on a visual, as needed basis. The ESD control planner meets the supplier at the stocking location, observes the stock replacement, and signs for the replenished materials. The signed document is the basis for paying the supplier's invoice.

B. Bulk items such as electrical wire previously had been measured and kitted per shop order from the central stockroom. Such material was moved to the point of use on the shop floor and measured out by the operator as needed. The bill of material for each day's completed assemblies posts (decrements, backflushes, or deducts) the used quantity to update the inventory records.

C. Other larger items are stored in a small, 1000 square foot stockroom and issued to the pan stock at the operator's work station at the request of the operator. No subassemblies are stored there, only purchased materials averaging two to three weeks' supply. The division is working toward further reductions in this quantity.

Requirements for purchased materials and other assemblies such as PC boards are generated from the MRP system at this stage. Shop floor Kanban is one of ESD's future projects. They have actually started a Kanban system for chemical supplies in the PC fabrication subplant.

However, the shop floor control dispatch system is no longer required. MRP planning calls for subassembly at the appropriate manufacturing cell on the shop floor.

Project Implementation Status

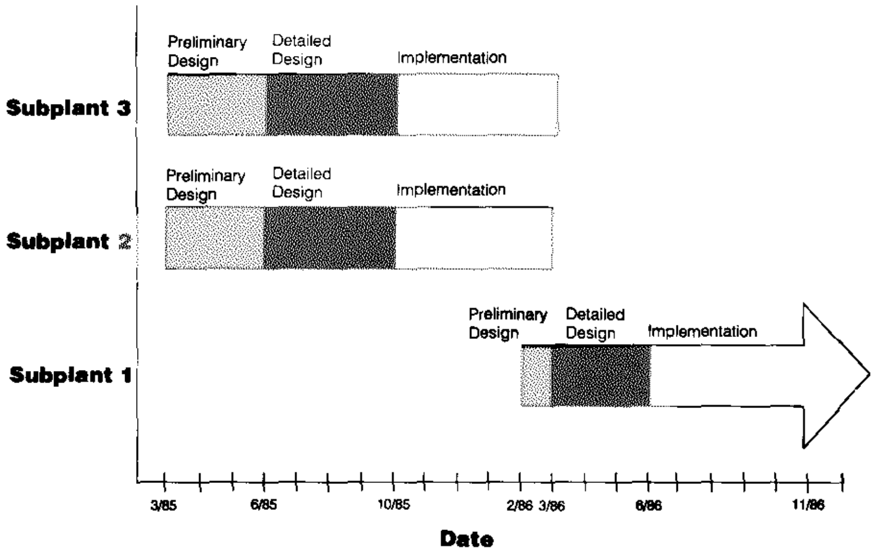

Fig. 1. Project overview for ESD.

3. **Cell production and progressive assembly**
ESD did a lot of work planning and designing manufacturing cells. A single operator previously completed an entire assembly or subassembly. ESD experimented with U-cells and learned that straight line cells work better for their product lines and that it is probably the balancing of the work content by the operators which is important rather than the shape of the cell. U-cells appear advantageous if an operator is required to move between machines, and the U configuration of machines results in shorter travel distances for the operator. At ESD, operators sit at their work stations and pass work to the next station.

In the cable assembly work cell, the previous assembly method required 1.5 hours per assembly. The cell approach currently in use requires 0.78 hours per assembly as a result of the cell configuration. Improvements result from:

- Fewer tools for the operator to handle.
- Fewer parts to handle.
- Operators catching each other's errors and correcting them on the spot.
- Efficiency from a cell team working together.
- Higher product reliability.

Progressive assembly reduced leadtimes so that ESD eliminated levels in the planning bills of materials. Fig. 2 illustrates the concept for one of the product lines at ESD reducing leadtime from 10 hours to four with no change in the labor input.

4. **Training**
Very early in the design stage, ESD scheduled every member of the organization, including hourly people, to view training films with group discussion. In two years to ▷

date the total hours spent in training sessions are:

- Management quality, 3700 hours
- SPC, 8000 hours
- Manufacturing skills, 4000 hours
- Engineering skills, 13,000 hours

Not every employee participated in the same courses, but the average employee has received nearly 60 hours' training.

Training started with a set of commercially available videotapes on JIT. These sessions, followed by discussion and teamwork, developed JIT-type problem solving in several projects. Two of them are:

A. SAM—Save A Million is a cost reduction and operations improvement project which has saved the division over one million dollars in each of the two years the program has been in operation.

B. CAR—Corrective Action Request is an employee suggestion system which is posted on the shop floor. Suggestions are displayed in three stages: 1) new projects, 2) in-process of implementation, and 3) projects completed. Individuals or groups suggesting an improvement can see the progress of their project.

5. Focusing the factory

To control their product design flexibility and quality, the ES division has a vertically-integrated factory. They manufacture their own printed circuit boards, assemble their own PC boards, and assemble other controls before fore the final assembly of the product. Early in the detailed design of the JIT layout, the project team recognized that they should focus their factory into three functional groups they called subplants.

Subplant #1—Printed circuit board fabrication.

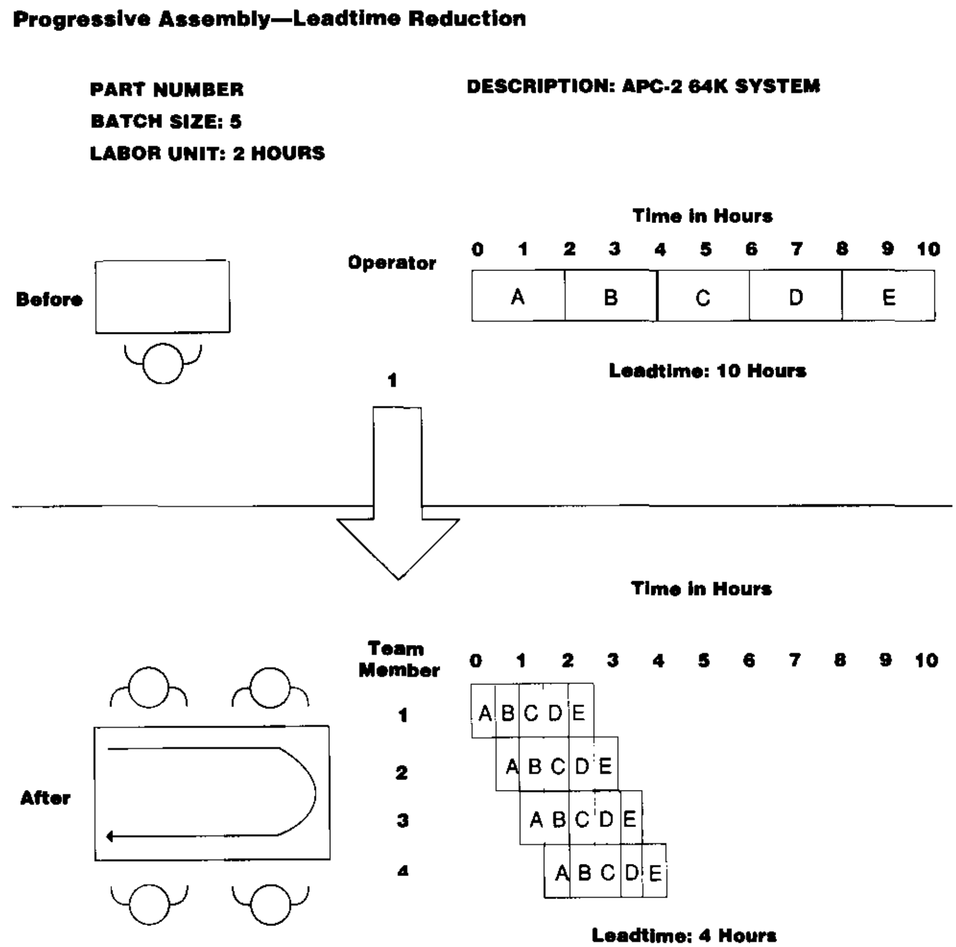

Fig. 2. Leadtimes are reduced from 10 hours to four hours on a product line, with no change in labor input.

(plating, drilling, solder mask, finishing)

Subplant #2—Printed circuit board assembly.

Subplant #3—Final product assembly.

In effect, the team has three large cells or subplants focused around the process output of each cell. Within each subplant are operator cells organized by product output. Subplant #2, for example, has a cell for integrated circuitry orientation, a cell for integrated circuit machine insertion, and a cell for PC assembly. Subplant #2 is considered the customer of Subplant #1, and Subplant #3 the customer of Subplant #2. Prior to JIT, materials flowed around the departments and in and out of the storage carousel and the finished parts stockroom. By focusing the factories into subplants, the clear movement of the product modules allows shorter travel distances and simplifies visual control of the product flow.

Weekend Implementation Of JIT

1. Reorganizing the factory

With companies such as ESD which have substantial inventories and long leadtimes, one of the initial problems is that more people are required to maintain the high inventory level than to operate straight production at the sales throughput rate. Such companies spend excess labor on high lot sizes and production of materials which do not match customers' needs. The ES division had too many direct labor personnel for the output needs of the factory.

The division implemented the JIT solution in an unusual way. After adjustments to the work force, they shut down for a long weekend, and Tuesday morning started up with a new plant organization and layout. With less than 60,000 square feet in manufacturing and an electronics product environment, moving work benches into cells is not as difficult as moving heavy machinery which would require weeks. The ES division moved Subplants #2 and #3 during this long weekend, not the plating tanks and other processing equipment for PC board fabrication. This approach avoided as much as possible the inevitable morale and efficiency problems when such moves are implemented over a long period of time.

The ideal approach is not to lay off any workers. But when a company is striving to remain competitive, one of the most difficult issues is too many people who are adding no value to the product. EDS's plan is to recall excess people when the competitive advantage results in increased business. To expect not to reduce the staff in the short run is not realistic, nor even conceivable when survival is the issue.

The real success of the ES division approach resulted from the six months of detailed planning and training which preceded the weekend plant rearrangement. Division management says that in the subsequent weeks they worked overtime to get production back up, and they did have their problems.

One of the fresh things about the visit to the ES division was the managers' willingness to discuss the problems along with the successes. Practitioners benefit from such case studies, learning what to expect and what to avoid.

Staff Reassignment

Over 80 staff people have been reassigned. The staff level was reduced from seven reporting levels to five between the general manager and the hourly employee. One entire level of assistant supervisors on the shop floor was eliminated. The JIT objective of moving staff people to

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the shop floor resulted in a saving of 2000 square feet of space in the engineering offices. The following functions moved to the shop:

- Production control
- Industrial engineering
- Test engineering
- Process engineering

Job Classifications

ESD began the program with 70 job classifications on the shop floor. Reducing that number is a major objective. The thinking that led to that number of job classes is difficult to reverse. At the time of AME's visit the ES division had reduced the number to 40. The subplant managers are working diligently to train the hourly people to become 100 percent flexible in the work cells if possible. The ESD managers know that this task will take time as will further reduction in the number of formal job classifications.

Undercapacity Scheduling

The division is striving to implement a 7½ hour average daily work schedule as part of the JIT program. The remaining half hour can be spent either planning the workplace for the next day's production or in discussion and problem solving. Some days, this time must be used to make up production due to problems. However, ESD management is committed to the principle of worker involvement and has set aside the expense of the last half hour of the scheduled shift as problem-solving time.

Elimination Of the Incentive System

The division previously had an individual incentive system with the usual detailed requirements of reporting and accounting for payroll purposes. Part of the JIT cutover was to eliminate the incentive system. At ESD, a non-union shop, the employees accepted this change. The key point, as can be seen in Fig. 3, is that the overall labor efficiency has increased despite the incentive system's elimination.

2. **Lot sizing in an electronics assembly environment**

The division previously had a standard lot size of 25 units. This policy was derived from historical experience and was everyone's best estimate.

With the introduction of JIT, the lot size was reduced to 12. So far, the overall efficiency of the factory throughput has increased, and handling costs have decreased. In electronics assembly it can often be perceived that

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more is better, even when a changeover for insertion machines is no more than three to five minutes, as ESD struggles to hold it. The thinking, no doubt, is a holdover from the previous generation which equated large lot sizes with efficiency.

The division did increase the number of purchase order releases through lot size reduction. The number of shop orders, on the other hand, decreased because

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many subassembly structures in the product flow were eliminated.

One of the next steps is the Kanban signal and a wider use of contract purchasing so that purchase orders do not need to be written for each material release. At this stage of development, the purchasing group has been effective at cost reduction through supplier contract negotiations.

3. **Quality Cost Improvement**

The cost of quality has been improved from 19 percent to 14 percent of cost of goods. Statistical Process Control has been implemented on the shop floor. SPC charts are posted on the floor for process engineering and operators' viewing. Quality activity is in three areas:

A. Prevention at the shop floor level
B. Appraisal by shop inspectors
C. Final test of the end product.

The ES division's quality approach is to improve problem solving, to move quality activity from areas 3 and 2 to area 1

Future Plans

The Electronic System Division says that they have just started their journey with JIT. They expect additional leadtime reductions when they implement Kanban signals on the shop floor. They also expect to reduce lot sizes in months to come and move closer to mixed model production.

They are working to expand the use of Kanban-type purchased material deliveries similar to the system used for class D hardware items.

The cost accounting system has not yet been substantially revised, but the factory cost accountant is working on the objective of simplifying the cost system. The Electronic Systems Division has come a long way in a short time. However, they tell visitors that they have a long way to go and that JIT is a continuous management process of improvement.

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Cincinnati Milacron Electronic Systems Division Results To Date

Since the weekend implementation of October 1985, the ES division reports the following improvements:

Leadtime savings—Worst performance product 13 weeks to 7
Best performance product 13 weeks to 4

Space savings—27 percent square foot reduction

Overall inventory reduction—68 percent

Work in process reduction—84 percent

Direct labor reduction—14 percent

Indirect labor reduction—32 percent

Units produced per full time employee (overtime added) from headcount reduction and efficiency—36 percent

Cost of quality improvement—26 percent

Lot size reduction—50 percent

Inventory write-off improvement—25 percent

Fig. 3. *Significant improvements have been recorded since ESD launched its program.*

Point of Use Storage and Record Accuracy

The ES division has learned something about stockroom control which can be useful to the materials practitioner. The practitioner used to think that a lock and key and a steel wire fence constituted a locked stockroom, never mind that whoever wanted material would find a way with regularity into the stockroom. At ESD, material is located at the point of use and the pan stock at the operator bench is a part of the inventory-on-hand balance. Inventory record accuracy is 97.3 percent, with a tolerance of 0 percent for A items, 3 percent for B items, and 5 percent for C items as part of their accuracy criteria. There is no longer a need for the annual physical inventory.

The lesson is that the so-called locked stockroom is a matter of employee understanding, training, assigned responsibility, and ownership—knowing that the whole organization depends on the accuracy of parts transaction reporting. A shut down production line is the consequence of failing to do the assigned job. When top management requires that inventory be handled with such a philosophy, and enforces the philosophy, the locked stockroom becomes a locked system of transaction control and the physical security of the materials becomes an irrelevant issue.

The point of use storage environment never was effective without such an inventory philosophy—and neither was a fenced-in stock room.