GM WORKSHOP REPORT

Production Innovations... People, Processes and Systems

At General Motors' largest car assembly facility in America, state-of-the-art manufacturing processes and relentless improvement efforts lead to gains in product quality, productivity, and employee job satisfaction.

By Lea Tonkin, contributing editor

No longer will past performance in manufacturing quality be acceptable to the restless executives and plant workers at the Buick-Oldsmobile-Cadillac (B-O-C) plants in Lansing, MI. They have seen what a total commitment to product and production excellence can do for the current lineup of GM20 cars. Now they're combining efforts to make sure that the revolution continues. As General Motors executives explained to participants in AME's workshop at B-O-C Lansing in October, 1985, the importance of a new technology and work ethic and commitment to excellence cannot be underestimated. The automaker's future, and their jobs, depend on quality and cost competitiveness in tough world markets. The following report reflects workshop presentations.

What GM20 is all about

"GM20 was a major General Motors undertaking," explained Donald R. Downie, Director of Planning and Industrial Engineering at B-O-C Lansing. "On June 18, 1984. . . the first of the 1985 model GM20 cars . . . the Oldsmobile Calais, Pontiac Grand Am and Buick Somerset Regal. . . came off our assembly lines. Millions of dollars in investment and many hours of work by thousands of hourly and salaried employees at both (Lansing) locations took form and came alive in new processes and equipment." Innovation is not new to Lansing, Downie said. Yet B-O-C Lansing's combined efforts reflect a revolutionary way to build and bring new cars to the marketplace.

For more than 85 years, Lansing has been a car-building town. Now the long-standing association with Oldsmobile production has been extended to Buick and Pontiac as well. Another change: A single line of cars will be built here, compared to the variety of cars turned out simultaneously in past years.

Key points of the GM20 program outlined by Downie are:

All major sheet metal parts are made at B-O-C Lansing's stamping plants and sent next door to B-O-C Lansing body assembly facilities. "At body assembly, sheet metal parts are assembled into bodies, painted, trimmed, and sent immediately to the chassis assembly plants less than two miles away," Downie said. "It's an 'all under one roof' concept called *integrated manufacturing* that contributes significantly to the basic quality of the GM20 cars."

Downie cited a direct relationship between this new manufacturing concept and the advantages of Just-In-Time (JIT) inventory management. "Materials move shorter distances and in smaller quantities between the various operations that are required to work on them. In addition, people involved in GM20 are located in close proximity with each other and function much more effectively as a coordinated team," he said.

More robots are used in the GM20 program than in any other GM location in this country. Body assembly uses 220 robots in its operations, and chassis has another 7 for a total of 227. Uniformity in assembly processes is boosted by these robots.

A unique automatic guided vehicle system (AGVS) at B-O-C Lansing's chassis assembly allows assembly techniques unmatched elsewhere in North America, the executive continued. "The AGV's will allow major portions of our GM20 cars to be built in station," Downie said. "Each operator is able to stop the product if difficulties arise and is able to take the time necessary to make corrections. This technique adds to the quality of our cars."

Vendor relationships are essential to the success of the GM20 project. "From the beginning of this project, we have met with and involved our suppliers to be certain they will be able to produce high-quality parts and components all the time, just-in-time. . . Our vendors ship 100 percent to specification, and we do not have receiving inspection," Downie stated. "Ninety percent of B-O-C Lansing's suppliers are within 250 miles, permitting truck shipment to our build schedule.

"Finally, and perhaps most important, B-O-C Lansing has involved our people. . . hourly and salaried . . . in all of the details of the GM20 program from the very beginning. Our employees are highly trained. They are committed to producing a quality product," said Downie.

Quality strategies

The real power of the new Oldsmobile Calais, for example, lies in quality concepts in its design and manufacture, according to the B-O-C executive. "Our quality strategies for GM20 were built around four basic elements in product development. . . product design, people, manufacturing processes, and parts sourcing," he said, adding:

Design: "Our design had to be right for the features our market was looking for, and at the same time, provide for top quality in assembly operations."

People: "Our people had to believe in our quality objectives and be thoroughly trained in their responsibilities, many of them different from anything they had done before."

Manufacturing processes: Our manufacturing processes had to take full advantage of promising new concepts such as 'team build,' ergonomics, 'sociotechnical systems planning,' and of course, our whole approach to quality of work life and participative management."

Parts sourcing: "Our parts sourcing had to be based on doing business with quality vendors and on allowing them to participate in the entire program."

Close cooperation between engineering, manufacturing, materials management, and reliability staffers drove the basic GM20 design effort. Studies of existing cars and their field experience resulted in an action plan to assure that GM20 would be an even better car. Sixty-one test vehicles, some built with the help of assembly plant hourly personnel, were assembled. "This is double innovation. Sixty-one is a large number of vehicles, and prototypes are usually built by engineers, not by assembly plant people," Downie said.

Evolution and innovation: People, facilities, and materials

Thorough preparation is essential to the success of the new GM20 era, according to Herbert T. Mattis, Superintendent, LCA-Body (Lansing Car Assembly), at B-O-C Lansing. Changes in people, facilities, and materials are needed as well, he said. For example, a series of training and development programs "informed, prepared, and motivated our first-class workforce for the changes that would be coming with the new product," Mattis said.

"In the materials category, special events and communication systems were created to get our suppliers on the GM20 team with us as partners in the process of building a total vehicle, not just a part," he continued. Mattis also described facilities changes "of formidable proportions."

Conversion to GM20 body assembly reflects the investment of millions of dollars at the Lansing body plant. Included are 25 buildings, housing 2.6 million square feet of floor area, on 75 acres of land. Much of the revamping process took place during the 1984 model year. Among the challenges facing GM20 planners: converting two 60-job-per-hour production lines under one roof to new assembly technology, with no more than four and a half months' downtime in any area.

Each production line has three major departments: body, which produces the metal shell; paint; and trim. Changes in these areas include:

Installation of underbody press lines, body framing equipment, and other equipment began in February 1983—after previous modifications such as excavation, structural changes, and floor resurfacing. All major automated systems needed to build pilot vehicles were ready to run by November 1983.

"It is in the body shop that automation and other technological developments are most evident," Mattis said. "One hundred and sixty hydraulic and electrical robots perform spotwelding, migwelding, screwdriving, and part handling operations. By comparison, we utilized only six robots in 1984 model production." Body shop systems also include 18 presswelders to assemble GM20 underbodies, more than 60 non-robotic automatic welders, 50 mechanical handling devices, and two precision stop-and-go conveyor systems.

Several subassemblies for the GM20 program are produced in tooling that is unique among GM plants and in some cases unique in the industry. Example: Each body side assembly is built in a fourteen-stage automatic shuttle line, Mattis said. "Once parts are loaded into this shuttle system, a body side assembly is untouched by human hands," he said. "It is automatically transferred to a delivery conveyor that carries it to the framing line. From there, another automatic system places it onto the underbody, and bends down the metal tabs which hold it in place on its way to the automatic framing operation."

Automation also plays a key role in the production of underbody and motor compartment components, rear wheel housings, and roof and shelf subassemblies. Approximately 77 percent of the 1660 spotwelds required to build a GM20 body shell are done by robots or other automatic welding equipment.

Lansing is the first GM facility in which automatic body framing stations are an integral part of the stop-and-go conveyor system. Reduced equipment cost and decreased potential downtime associated with transfers to and from the framing station are among benefits.

The assembly of door glass frames, or headers, to the lower door in the assembly plant is another significant process innovation. This operation traditionally took place in a metal fabrication plant, far from the point where doors are assembled to the body.

"For GM20, a five-stage automatic shuttle system probe-checks the lower doors and headers for incoming quality, assembles the headers to the doors, bolts hinges to the door, trims flanges, migwelds the headers, and probe-checks the finished assembly," Mattis said. "All coupe doors for both production lines come from a single shuttle system, which is designed for a capacity of 360 doors per hour."

Doors are transported to an automatic guided vehicle system (AGVS), for delivery to the point of use, a short distance away. Each vehicle in the AGVS is preprogrammed with an on-board microprocessor; the self-propelled vehicles' movements are controlled by a wire embedded in the plant floor.

Automatic tools pierce attaching holes in deck lids and front end sheetmetal. Precise coordination with body piercing equipment makes it possible to fit these panels on the line without manual adjustment.

"Net build" is a concept that was applied consistently in the design to GM20's body assembly process. It simply means that "oversize holes and slots are eliminated," Mattis said. "The body is built so precisely that most holes used to attach other panels and hardware need not be any larger than the fasteners used to attach them."

The master cube system is another essential ingredient in the quality-driven GM20 program. Mattis explained, "This is an important first step toward integration of computers in manufacturing (CIM) which bridges the gap between computer aided design (CAD) and computer aided manufacturing (CAM) in our fabricating systems."

There are three basic elements in the master cube system, which was developed to enhance sheetmetal fits and build quality. First, the entire GM20 car is represented in mathematical data—the reference for every stage of production. Second, a computer-linked scanner checks metal surfaces and compares them to the master mathematical data base. This scanning step ensures that each part, as well as the entire car, reflects the same master. Third, the cube itself is a full-size, three dimensional representation of the perfect GM20 car. This giant "jigsaw puzzle" enables B-O-C Lansing people to check parts in relation to one another—eliminating the possibility of later problems that would be difficult to resolve.

"The other design principle that engenders process control in body assembly is the one-tool concept," Mattis continued. The traditional use of multiple gates, or part-holding fixtures, accompanied by the use of tie-bars to lock parts in place, led to a measure of unpredictability in the body framing operation, for example. Nowadays, the GM20 tool system reduces the number of body framing process variables. One set of tools is used for each body style, for each step in the process. Most fit-sensitive components in the body will pass through systems that build all of each day's production, Mattis said. The results: More than 90 percent of door opening points checked on a representative sample of pilot bodies are within two millimeters of perfection.

A new grinding technique developed by Lansing personnel assists surface coating technology. Its effectiveness depends on the craftsmanship of trained metal finishers.

Major changes in the paint operation resulted from the replacement of low-dispersion laquer topcoat with multi-coat, high-gloss enamel. Bodies can be sent to closed-loop repair systems, if necessary. "Other changes include the addition to a partial-dip body washer ahead of phosphate, facilities for two-tone painting, electrostatic spray machine installation, oven changes, lighting improvements, and perhaps most significantly, 'clean-room' architectural modifications to isolate dirt-sensitive areas of the paint shop," Mattis said.

Robots now can perform several trim operatings at Lansing. A seven-point AGVS is the focal point of this innovative setup. As explained by Mattis, "Adjacent to the AGVS line, robots prep and apply urethane sealant to the windshield, back window, and quarter windows. On line, twelve AGVS carriers will position each body precisely for a series of robotized operations. Six robots will install glass components to the body in two separate stations; four more robots will place moldings into the front and rear wheel openings, and hold them while driving screws to secure them."

Also new in the trim shop: "Hot knife" presses are used for smooth cutting of door trim panels and headlinings. And multi-axis programmable tools carve through carpeting with a high-velocity jet of water.

Improved coordination between body and chassis is reflected in a new scheduling, or broadcast, system. The build sequence is set before the start of trim operations, in support of chassis just-in-time programs. Monitoring and reporting functions advise which jobs are coming several hours in advance of chassis operations.

Additional changes have resulted from "exchange team" discussions between B-O-C Lansing body assembly and chassis process planners. The best build sequence, rather than tradition, was the basis for recommended moves in body plant trim shop and chassis final assembly line.

Meeting objectives

Conversion of Lansing facilities to build the all-new 1985 "N" cars was launched with three major objectives in mind, added Donald Downie.

These targets:

1. Achieve maximum integration of fabrication and car assembly operations by locating as many of the fabrication operations as possible at one contiguous site.
2. Base the technology plan on new operating systems such as team build and build in station—essential to meet productivity goals.
3. Meet or surpass corporation goals for quality, productivity, investment, and timing.

"The final cornerstone of program planning was a management philosophy to utilize the skills and abilities of all employees to build a high-quality car at a competitive cost," Downie said.

Downie noted that the integration of "fab" and assembly operations has resulted in freight savings, quality improvement, inventory reduction, and improved communications. Ninety-eight sheetmetal parts, including 15 major appearance panels, were allocated to the Lansing contiguous stamping plant instead of various locations around the country.

"Quality-wise, Lansing has become the recognized leader in the use of the master cube and math data to insure sheetmetal quality," Downie said. "Productivity-wise, we addressed ourselves to implementing a quick die-change program, to get more productive time out of our presses. Technology-wise, our initial thrust was the first major panel robotic welding system in General Motors—the GM20 fender welding robot. We followed that up with four robotic racking systems for major appearance panels, which are the first such applications in the world."

The use stop-and-go systems versus continuously-moving monorail conveyors has several benefits, Downie added. This concept enhances team build, build in station, and operators inspecting their own work. Ergonomics and an easier link to stationary automation robots are other plus factors.

In the AGVS chassis build-up area, initial brake system fill and testing is done on three parallel work paths—each one has buffer capability. This system allows the vehicle to remain in-station up to seven minutes, improving the odds for a perfect job.

A new dynamic vehicle test system at the end of the assembly line analyzes the performance of each vehicle. Test roll drivers used to judge characteristics such as transmission shift points, cruise control operation, and torque converter lock-up. The new, computerized analysis eliminates subjective elements in testing.

Improved ergonomics contribute to high-quality, consistent operations. New knowledge in this area enhances operator performance by minimizing fatigue; in extreme cases when ergonomics could not assure consistent manual operation, operators were replaced with robots.

Materials management steps

Lansing's GM20 materials management strategies range from just-in-time material delivery to material receiving and movement innovations, modern material systems, inventory reductions, and innovative final car shipping systems. "GM20 provided us the environment to build material processes from the ground up. The cornerstone of this strategy has been just-in-time (JIT) systems, which is much more than an inventory control tool. . . but rather an integrated production system. . . ," said David J. Pallas, Director of Material Control and Transportation at B-O-C Lansing.

Dependable quality—receiving good parts from external and internal suppliers—is the first and most important element of just-in-time, Pallas said. He added, "Quality control and manufacturing efforts are being focused on improving and controlling the production process by utilizing statistical process control (SPC)."

A second JIT element is supplier selection. Suppliers are involved early in the design and engineering process. In this coordinated effort, family-of-parts sourcing encourages volume efficiencies. Supplier commitment to SPC and JIT delivery also supports improved performance.

Stable supplier schedules support JIT progress as well. "By utilizing target build concepts, eight days of orders frozen in assembly sequence, and mechanized systems. . . we are communicating detailed material requirements to our just-in-time suppliers, including online broadcast directly into one supplier facility," Pallas said.

Manufacturing flexibility is another JIT element cited by the executive. The more traditional economic order quantity (EOQ) method of ordering material is replaced with suppliers' flexible manufacturing. Together with quality improvements, this area is most challenging, Pallas said.

Transportation is also essential to effective JIT operations. Standards are set for transit times, arrival times, unloading delays, and other factors; controls ensure that these standards are met. Rail volume in chassis assembly has been reduced from 40 to one car per day. More specialized vehicles such as "supervans" and smaller delivery vehicles also are used. Inventory and material handling savings top the related freight penalty resulting from conversion of rail to truck.

Material is received as close to the point of use as possible, Pallas said. Material is no longer received at one location and disbursed to other points. Receiving and material handling gains have resulted from this change.

New receiving docks were needed in some areas to allow deliveries near using locations. For example, engines and transmissions are now received at a new dock; annual material handling savings amount to $500,000.

In other cases, assembly processes were moved closer to existing docks. Wheel and tire subassembly operations, for example, were relocated near an existing dock, leading to an annual savings of $280,000.

Key commodities

More than two years' planning preceded the startup of the JIT Program. After statistical analysis of the 5600 part numbers required to build the new car, a JIT commodity definition was developed. It's based on high-dollar and high-bulk items. This effort encompassed 100 commodities, or 1600 part numbers, which represents 85 percent of daily volume.

These key commodities were the major focus of JIT planning. They involve more than 80 supplier locations. Approximately 50 percent of chassis and 40 percent of body suppliers are within 100 miles of the B-O-C Lansing complex. Another 40 percent of chassis suppliers and 33 percent of body suppliers have operations within a 100-250 mile range.

"In order to further define our target commodities, we created data elements for each of the 100 items," Pallas said. "The data elements are very similar to an engineering specification, but instead of describing the part, they describe over 60 elements which are important to processing that particular commodity. . . From this data, we are able to calculate floor space, manpower requirements, inventory and transportation costs, and facility requirements. We were also able to simulate the flow of material across our docks, enabling us to develop a workable dock schedule."

Controlled truck deliveries at the assembly plant require carriers to arrive within a specified "window" of time. Docks are responsible for unloading a truck as soon as it arrives. This system levels personnel needs at the docks, and it helps carriers utilize their equipment and drivers more effectively.

The use of gull-wing trailers allows sheetmetal delivery from the B-O-C Lansing Plant III stamping area to Plant II for weld assembly and later delivery to body assembly. These side load/unload vehicles drive through the plant. In turn the need for new receiving facilities is eliminated and unloading is done at point-of-use.

Railroads have responded to B-O-C Lansing's move to truck with innovative proposals of their own. Conrail and Grand Trunk provide two-hour rail service from the main plant stamping facility to body assembly. The trip is about 3½ miles long.

JIT deliveries and point-of-use receiving have decreased storage space requirements. In chassis assembly, for example, material storage space was reduced from 550,000 square feet to 250,000 sf.

New systems startup

New materials management operating philosophies led to development of new systems. In December 1982, Oldsmobile and Fisher Body materials managers pooled their talents to develop a common in-plant material system. Results of this computerized system: fewer receiving documents and more up-to-date information on parts as they are received. Management of minimal inventories is enhanced.

The foundation for this system is the receipt of electronic ship notification before material arrival. "We have focused much effort in this area over the past several months, increasing supplier performance to 82 percent by November 1984," Pallas said. He noted that JIT suppliers also receive short-term schedules that detail GM20 material shipments in build sequence, by day, or by increments within a day, for the next eight days.

This computerized system was developed in Lansing to the Automotive Industries Action Group (AIAG) standards. It allows data to be teleprocessed to suppliers, or the data can be accessed real-time by suppliers connecting directly into B-O-C Lansing computers. Key information needed to control material flow is provided, including year-to-date requirements, build requirements in appropriate increments, and flags for special conditions such as breakpoints and final quantities.

Inventory turn performance has improved significantly as a result of these efforts. Chassis assembly inventory turns rose 51 percent since 1982, and body assembly inventory turns increased 46 percent during the same period. Material handling labor reductions amounted to 11 percent since 1982.

Shipping: A better way

Lansing people also developed an innovative process for vehicle shipping. Cars used to be driven from the end of the assembly line to a holding area where they were scheduled into a railcar, or they were driven 1½ miles to another holding area where carriers sorted and made up loads for final dealer delivery. This time-consuming, expensive way to deliver cars has given way to direct conveyance of the finished product to a new rail shipping complex. Driving, holding, and sorting cars for final delivery have been virtually eliminated. Faster delivery and less shipping damage have resulted from the unique process.

By the spring of 1986, truck haulaway operations will be moved to a site that's adjacent to the assembly plant—trimming the time needed to move and sort cars for carrier shipment. These rail and carrier vehicle shipping systems will account for more than $6 million in annual savings, when they're fully implemented.

"While we are proud of the new concepts we have developed and implemented. . .and of the relationships we are developing with our suppliers and carriers. . .we are continually searching for new and better ways of carrying our materials management responsibilities," Pallas said.

Seminar participants toured body assembly and chassis assembly areas at B-O-C Lansing. Small group discussions focused on production innovations. ■

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