Powerful Strategy at Westinghouse ESG: Concurrent Engineering and Teamwork

Multi-discipline teams break with tradition on an Advanced Tactical Fighter project.

Lea A.P. Tonkin

Total Quality (TQ) management provides an opportunity for involvement of all employees at Westinghouse Electronic Systems Group (ESG), Baltimore, MD. This means team participation in project phases from planning through system deployment and logistics support for a wide variety of systems including fighter and strike avionics, electronic warfare (countermeasures), command and control, space systems, ocean systems, missile launching and handling, and others, according to Chris Hopmann, ESG's manager of advanced development operations. He described how a break from the traditional design-to-production approach cut cycle time 50 percent and cost 36 percent from the Advanced Tactical Fighter (ATF) and other programs while maintaining or improving quality.

Concurrent Engineering Speeds Development, Production

Starting in the mid-80s, ESG management realized that the old "design a system and toss it over the wall to manufacturing" approach simply cost ESG — and its customers — too much time. "We used to serially design a program where you have a systems engineer come up with a concept, then a design engineer produce a design, then a mechanical engineer put it
into a drawing, and then have manufacturing try to build to that drawing, and the user try to support it," Hopmann said. "But when engineering, manufacturing, and support teams work in parallel, this concurrent engineering effort reduces the leadtime of a development program and enhances its supportability characteristics when it is deployed."

Speedier development-through-high-level production performance was needed to win the contract for the radar avionics developed for the ATF F-22 program. ESG is a subcontractor to Boeing, which is part of the Lockheed-Boeing-General Dynamics team for the F-22.

Concurrent engineering is implemented through Integrated Product Teams (IPTs). Simply put, an IPT brings new electronics systems from the concept phase through development, production, and into operational deployment and support phases. These teams include all disciplines (systems, design, manufacturing, test, quality, and logistics support engineering), which in turn have "ownership" in the product design. Team leadership can change as the product moves from one phase to another, but the disciplines continue their representation on the team to assure that their expertise influences the products and that team ownership continues. Similar IPTs are used for software and other products.

**PAC/TAC Attack on Cycle Times, Costs**

ESG produces systems from highly complex designs through concurrent engineering, supported by its Producibility Assurance Centers (PACs) and Transition Assurance Centers (TACs). PACs and TACs are dedicated physical areas of concurrent product/process development established for specific technologies. The PAC/TAC approach began in 1986 in ESG's Advanced Interconnect Technology lab for the development of printed wiring assemblies.

The IPT works together in the PAC, jointly designing the product and process. Design iterations accommodate desired processes. Teams use actual production equipment to test methods and parameters. Joint staffing from various design and development functions enhances design flexibility and creativity.

Then the product design is refined further by TAC IPT members. Also representing various engineering functions, they emphasize "production hardening" the product and process designs developed by PAC staffers. In TACs — again on actual production equipment — pilot production lines test the manufacturing process before full-rate production begins. The objectives are stability and repeatability. A product may remain here for several months to two years, and it can return here if further refinements are needed. Another time-consuming hand-off from one discipline to another is reduced through several TAC team members' training of production employees.

The ATF systems, along with light weight helicopter systems and Very High Speed Integrated Circuits (VHSIC) printed wiring assembly technology, went through the PAC/TAC process starting in 1988. In these centers, design producibility is analyzed using both an established design process and concurrent engineering.

"On the ATF program, we have a goal of decreasing the cost of an approximately $8036 transmit-receive module in the development phase down to a $400 module in full-rate production," Hopmann said. "We've been able to see an improvement from the $8306 level down to about $3000 over a three-year period."

**Targets Through 2015**

Cost reduction goals will challenge ESG design/manufacturing teamwork as they move through the EMD (Engineering Manufacturing Development) phase of the ATF program. By the time low-level production begins in 1998, they must be at the $1381/unit level. When they're into high-rate production by 2003, they must hit the $400/unit level. Process yield improvements rising from 80-90 percent to 96-97 percent for projects such as automatic wirebonding and vacuum pressure soldering drive cost reductions.

The production cycle of the ATF program runs until about 2010. ESG will be supplying hardware and supplying support services far beyond that date.

A major challenge is moving from building 1000 units a month in 1992 to 16,000 modules a month in the year 2000 — one module every minute. "This rate is something the aerospace industry doesn't generally do, because the volumes aren't there — usually those quantities are encountered in a commercial environment," Hopmann said.

ESG's concurrent engineering teamwork cut development times for new products from the four to five-year span experienced in the mid-80s to two-three years. Hopmann predicts development time will continue to shorten.

**More Challenges**

"We're looking at not only bringing cycle time down but cost as well so we can be more competitive," Hopmann said. "We can take this technology and apply it to other programs and designs. Reliability performance will continue to improve. We already have confirmation that everything we produced here, such as the AWACS advance warning system and the F-16 radar, performed as it should in the Mid East conflict."

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*Target*
ESG counts on concurrent engineering for reliability and maintainability gains. Spurred by an Air Force challenge to reduce fixed costs by developing a triple-digit radar — one that would perform more than 100 hours without failure — ESG developed and produced a system for the F-16 with more than 130 hours MTBF (mean time between failures). This rate compares to the previous 15-40 hour MTBF. "SPC and concurrent engineering — getting people to work as teams — allowed us to achieve these numbers," Hopmann said.

An additional aspect of the Air Force challenge is to move to two, versus three, levels of maintenance, with the commensurate reduction in personnel demands and support costs. Innovative, well-conceived partitioning of functions within the electronics systems, coupled with the high MTBF, will enable two-level maintenance achievement and sustain high operational availability of entire weapons.

**Paperless Production**

ESG continues to work on paperless production, defect control, piece part control, and other means of reducing investments in materials in the storeroom. Paperless production of machined parts, for example, is a reality. Designers send required information for their three-dimensional solid model of a part straight to the machine shop. No print is needed unless it’s required for contractual reasons, and then it is generated at the same time the computer model is created.

The image of a part can be transmitted to a machine shop which sets up a machine file, and then this file can be routed to various cutting machines — or to machining subcontractors. Because the system uses the scaled International Graphics Exchange Specifications (IGES) format files, better parts are turned out on the first pass — cutting cycle time.

**Use Money for R&D, Not WIP**

"Through use of Kanban and JIT production, we want to use that money in R&D instead of having it tied up in the storeroom or as WIP on the factory floor," Hopmann said. JIT assembly is being implemented on the ASR-9 airport radar system, for example.

There are no drawings associated with this two-stories-tall antenna on the factory floor. "We basically built the part ID and assembly codes into the piece parts themselves," Hopmann said. "We use aluminum sheets in the assembly, configured to eliminate the need for inspection. We can do an antenna a month now." This contract is to the FAA (Federal Aviation Administration). IPTs are looking for even more easily-producible antenna designs.

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More improvements are needed. "We need to continually work at identifying the roles of people in our concurrent engineering teams," Hopmann said. "In the beginning, we didn’t do that. I’d be lying if I said we didn’t have any problems with these teams. But as we learned to identify each others’ role, we started to work out things more easily. An Integrated Product Development Team guide was developed to provide a reference for the IPT team leader to use as the team progresses through the various phases of a program. It provides the team leader with a checklist guide to help focus on the functional outputs necessary to execute a successful program. The result is better design with less cost, in less time."

**Leadership**

The drive to reduce cycle time, improve design quality, and reduce cost will continue in defense as well as non-defense business groups within Westinghouse, according to Aris Melissaratos, director of the corporate Productivity and Quality Center in Pittsburgh, PA, and until mid-1991, director of ESG operations.

Westinghouse began to focus on state-of-the-art improvements in manufacturing, including concurrent engineering and multi-functional teams in the late 1970s through the mid 80s, he said. Melissaratos believes that the next generation of significant improvements in cycle time and product/process quality will require strong business group leadership and a sharper customer focus within a government contractor organization — and commercial manufacturing.

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Westinghouse Electronic Systems Group (ESG) provides research, development, production, and support services for electronics systems and subsystems. These systems are produced for the U.S. Department of Defense, the National Aeronautics and Space Administration, the Federal Aviation Administration, U.S. Postal Service, and U.S. allies. ESG has facilities in California, Ohio, Florida, Texas, Ireland, Mexico, and Puerto Rico, in addition to the Baltimore, MD area headquarters. Its several divisions support systems including fighter and strike avionics, electronic warfare (countermeasures), command and control, space systems, ocean systems, and logistics, missile launching and handling, marine, and missile systems.

A September, 1989 Best Manufacturing Practices (BMP) survey at Westinghouse ESG in the Baltimore area identified best practices, reviewed manufacturing problems, and documented the results. For more information about the BMP study here, contact the BMP Program, Office of the Assistant Secretary of the Navy (Research, Development, and Acquisition), Attention Ernie Renner or Adrienne Gould, PI, Washington, DC 20360-5100; fax 703/602-3129.