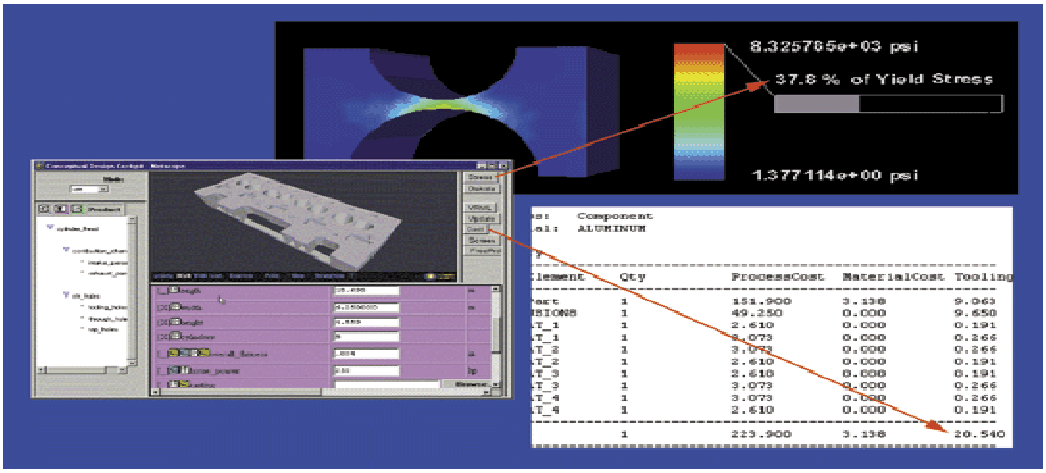
https://str.llnl.gov/str/Burleson.html

Agile Manufacturing: Gearing Up to Meet Demand



Using Web-based integration manager tools developed by TEAM (Technologies Enabling Agile Manufacturing), a nonspecialist can transparently modify a product design, run cost and product simulations, and produce a tradeoff study.

WAR has broken out somewhere in the world, and the U.S. becomes involved. Suddenly, all branches of our armed forces need more conventional munitions-and they need them immediately. How can suppliers meet this kind of unpredictable, high-volume demand?

A project under way at Lawrence Livermore aims to help manufacturing companies do just that. Known as Totally Integrated Munitions Enterprise (TIME), it is being funded by the U.S. Army to handle several munitions manufacturing issues. Not only does the Army need to obtain munitions quickly in national emergencies, but munitions productions facilities are being downsized at the same time that a variety of highly complex, "smart" munitions are becoming available. Supplying these munitions on a timely basis while keeping them affordable has become a challenge.

Livermore is one of eight participants in the TIME project. Most other participants, including Raytheon, General Motors Powertrain, Aerojet, and Primex, are in the private sector. Together, project participants are developing and demonstrating a distributed, flexible manufacturing capability that is cost-effective and can be rapidly reconfigured as needs change.

Implementing an integrated manufacturing base means changing a basic practice that is pervasive in manufacturing today. Contractors use subcontractors, who in turn use other subcontractors, and minimal information is shared among them. A contractor typically shares with subcontractors only enough information for the subs to get their job done. But if knowledge, experience, and risk are commonly shared among all partners, so that the manufacturing process can be more widely viewed as a total, integrated process from concept to delivery, then money and time can be saved as quality increases.

Changing the Entire Process

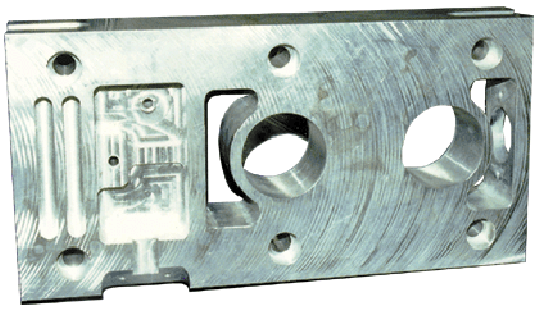
To support this fundamental change, TIME addresses the entire process-from concept to finished product-as a system, integrating design, engineering, manufacturing, administration, and logistics. In the manufacturing industry, this process is called product realization. To facilitate the flow of information among various functions, TIME is using a host of Internet-based software tools. Many of these tools were developed during an earlier Department of Energy project known as Technologies Enabling Agile Manufacturing (TEAM). Livermore engineer Bob Burleson was technical manager for TEAM, which started in 1994 and wrapped up work in late 1998. Burleson is technical manager for the TIME project as well.

TEAM's 40 participants were remarkably diverse. Participants from the private sector represented many

industries, including aerospace and defense, automotive, machine tools, robotics, consumer electronics, and software. Federal facilities and agencies included Lawrence Livermore, Los Alamos, and Sandia national laboratories, the Oak Ridge Centers for Manufacturing Technology, and the AlliedSignal Kansas City Plant.

The Internet-based software tools developed by TEAM support not only an open flow of information but also modeling of all phases of the work, communication among computing systems for geographically distributed facilities, concurrent engineering and production for teams that may be using different standards, and state-of-the-art methods for controlling manufacturing processes. An integration manager on the World Wide Web pulls together all product realization functions, including product design, process planning, process simulation, and fabrication controls.

Other activities, equal in importance to these software tools, support a generic infrastructure and overall planning and management. These integrative elements are what make the TIME project possible today.

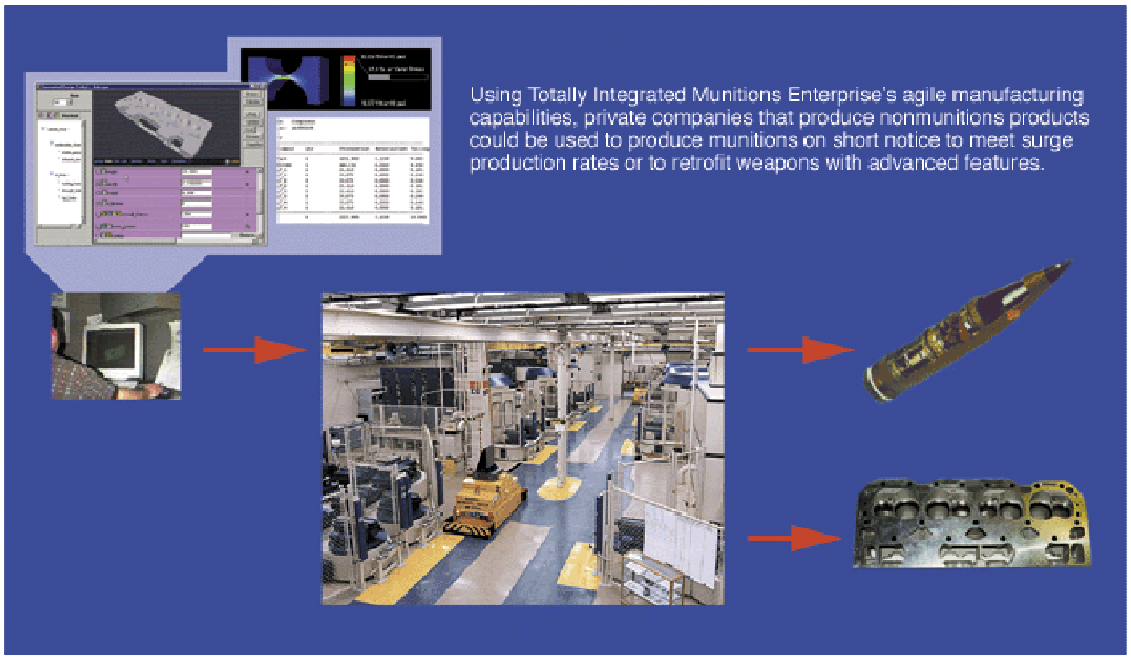


This automobile cylinder head is an example of the products machined by the intelligent controller developed under Lawrence Livermore's leadership.

Manufacturing facilities of TEAM partners served as the proving ground for these models and software tools. The Internet-based tools allowed a large number of facilities to work together quickly and easily. In one instance, project requirements were analyzed at GM in Pontiac, Michigan; design was done collaboratively between a DOE site in Kansas City, Missouri, and Raytheon in Tucson, Arizona; the product analysis was performed at Livermore and ISX Corp in Atlanta, Georgia; DOE sites in Oak Ridge, Tennessee, and Kansas City completed process design; and process simulation was performed by the University of Illinois and a DOE site in Los Alamos, New Mexico. Tradeoff studies between product, process, and resources were performed wherever the product manager happened to be. Then parts were manufactured at GM in Pontiac and inspected at Ford in Dearborn, Michigan.

The real payoff for bringing together these Internet-based tools was in the way they enabled real change. In one instance, a critical machine was down, and the other available machine wasn't as accurate-and even if it were, the entire process design, process simulation, and tradeoff studies would have to be redone. The TEAM project worked across 10 different facilities, making the changeover in less than an hour instead of days or even weeks. That is truly integrated product realization.

Livermore was the leader for development of an intelligent controller for machining products such as the part shown at the left. Machine tools and robots that cut and shape parts for everything from safety pins to computers receive their instructions from a device known as a controller. The controller is programmed to know where to cut, drill, and turn on a particular part and typically serves the machine tool for its entire life. But if a part comes down the conveyor belt slightly crooked, then holes will be drilled at the wrong angle, forcing an inspector to throw that part away. In contrast, an intelligent controller can sense the angle of the part and correct the angle of drilling, reducing waste and saving time and money. An intelligent controller can also be reprogrammed quickly for production of different parts, making it a key player in an agile manufacturing setting.



Meeting Surge Rates and Retrofitting Weapons

The Army was so impressed with the results of the TEAM project and the controller effort that it wanted this collection of tools put to work at its munitions manufacturing facilities. Currently, after having produced a stockpile of m2munitions for potential conflicts, all of these facilities produce munitions at a sustaining rate that just keeps up with the Army's ordinary needs. But the Army also needs facilities to be able to produce at a surge rate, without the necessity of creating a larger stockpile. With agile manufacturing, private companies that manufacture other products could be put to work to produce munitions on short notice. And with agile manufacturing, existing plants could quickly produce entirely new munitions or retrofit "dumb" weapons with new, "smart" features.

Integrated production had already been demonstrated generically, but a demonstration at a munitions manufacturing site was in order. Last fall, the TIME team went to the Scranton Army Munitions Plant in Pennsylvania to show how quickly and easily a manufacturing facility could begin to make something entirely new. There, in just a few days, they were able to produce the part shown above.

In 2000, another type of demonstration will take place in which production data from a munitions production plant will be used to almost immediately begin production at a nonweapons manufacturing company. The plan is for GM to manufacture components for small grenades using data from Primex, which routinely manufactures these and other conventional weapons. Burleson notes, "This is an almost unheard-of event in the manufacturing world, where proprietary data are zealously protected."

Work on agile manufacturing to date has focused on material removal processes-milling, drilling, turning, and so on-but agile manufacturing can easily be extended to assembly and other repetitive manufacturing activities.

Tom McWilliams, program leader for the TIME project for the U.S. Army in Picatinny, New Jersey, is enthusiastic about successes to date. "These new control systems could allow existing facilities to change production modes quickly. They could, for example, switch back and forth between `dumb' bullets and `smart' ones, even on a day-to-day basis. Agile manufacturing will give us a flexibility we have not had before."

-Katie Walter