The Challenges Of The Three-Day Car

Robert W. Hall

Agile manufacturing is a vision. A vision can never be a precise forecast; no two people ever "see" it exactly the same way. But if we consistently evoke the vision for guidance, it becomes the driver of major change.

Agile manufacturing comes in three versions: one from the Agile Manufacturing Enterprise Forum, a U.S. group that coined the term "agile," an earlier version from Japan, and a modified version by the author. Technically, agile manufacturing is more realistic than Star Wars. Behaviorally, it poses even bigger challenges. The most severe of 12 major human challenges recognized here are to our business and organizational thinking.

The three-day car challenges all industry, not just the automotive sector. The surviving enterprises will be totally different in form and practice. Excellence as we know it now is but an entry fee to this new world.

"Agility" is a rigorous interpretation of the term "flexibility" in manufacturing: Deliver what the customer wants, including design changes, when wanted, where wanted, at reasonable cost, with no quality glitches and no environmental degradation. At a ridiculous extreme, agility means meeting any need for change instantly. It's a 21st century ideal for manufacturing excellence — if such a different milieu can still be called "manufacturing."

Scenarios, starting with the Manufacturing 21's "three-day car," bring this vision to life. The three-day car began with the Japanese Manufacturing 21 Project reported in AME's *Manufacturing 21 Report.*[1] The Agile Manufacturing Enterprise Forum embellished the "three-day car" as one of four scenarios in their 1991 projection of 21st Century manufacturing.[2]

The first Agile Forum scenario is "Ultra-Comm:" multi-media, modularly-designed computers networked like mobile phones and available everywhere. The devices themselves would be built to customer order by a "virtual company" — a networked coalition of about 60 partners. Although it is expensive, equipment much like the electronics that drive this scenario is already available. The databases and the human organization to use its full potential will take much longer to develop.

The second scenario is small-scale production of specialty chemicals in a zero discharge environment, with high-yield, computer-controlled processes in small plants positioned close to markets. All chemical businesses will move in this direction, and even big oil refineries will try to be more flexible. The third scenario is the Application Specific Integrated Circuit (ASIC). After a few more generations of development and a thousand or more times improvement over today, the size and speed of integrated circuits will be adequate for most day-dream applications. At some point, further miniaturization will cost more than it is worth; then circuit competition will shift to software that allows customers to design their own application specific circuits, thus changing the character of the industry. It's a stretch, but the industry can see it coming.

The three-day car implies a great deal about the direction of all industry.

But the scenario that captures the most attention is the "three-day car." Automotive technology integrates many technologies, and everyone can relate to cars. The industry is big, old, and traditional, so this scenario starkly contrasts the new with the old. It has sparked elaboration and expansion through successive versions because the three-day car implies a great deal about the direction of all industry.

Japanese Projections for the Auto Industry

By 2001, the Japanese auto industry expects to have four major bases of production: Japan, North America, Europe, and the Newly Industrializing Countries (NICs). Much auto production will transfer overseas, so over the next decade annual unit production in Japan will decline by 20 percent or more. To offset the loss of volume revenue, higher-priced models must be produced domestically. As the United States experienced, a mature Japan cannot compete against low-cost areas making "econobox" cars. In the 90s, the Japanese domestic industry must learn how to profitably build higher-value, special-niche models selling fewer than 20,000 units over a lifetime. The Mazda Miata is an example of one step in this strategic direction.

Changes in the North American market will drastically affect the nature and speed of changes in the automotive production system in Japan. Overall, the North American market is expected to be nearly flat, growing by one percent per year, assuming that the price of oil stabilizes (but not necessarily at a low level). Japanese, European, and American companies will stage a dog fight for the high end of this market (sports/luxury models which, along with pickup trucks, gained market share in the past decade).

By 2001, electric vehicles will be made commercially, but not for large segments of the market, and solar cars will be about where gasoline-powered ones were a century earlier. Despite the environmental pressure, the internal combustion engine will probably have several more reprieves before disappearing. The potential for more efficient conversion of fuel energy to motion is still considerable, and so is the potential for alternative fuels such as liquid propane gas (LPG). Clean exhaust and vehicular fuel efficiency will remain high on the list of customer demands.

The degree of success of Japanese transplant manufacturing is critical to manufacturing changes in Japan itself. Japanese manufacturers expect to level out production in North America at 2.5-3.0 million vehicles per year in the early 1990s. The plan has long been to add supply plants and link with American suppliers until local content tops 80 percent. That is necessary to both decrease trade deficits and hedge against currency fluctuations. Export volume to North America will drop into the vicinity of 500,000 vehicles per year, a decrease of two million units below the 1986 level. Rather than competing on price, most of these exports will feature high performance, luxury, or unique design.

If the yen exchange rate stays above ¥120 to the dollar, exports to the United States will decrease slowly. If it sinks below ¥100, exports will drop rapidly.

Combining both homeland-built and transplant-built vehicles, the total number of Japanese nameplate cars sold in the United States will remain a nearly constant percent of the market. The new threat to both Americans and Japanese in the North American market could well be imports from NICs, which could rise to between one and two million units by 2001, depending on the trade policies of the U.S. government.

NIC nameplates will take some of the "entry level" market share from both Japanese and Big Three companies. More likely is that a percentage of Japanese transplant production will be sold as American nameplates, and that both Japanese companies and the Big Three will sell NIC entry-level imports under their own labels. One or more Japanese car companies could move their headquarters to the United States. (Honda is the most-rumored possibility.)

Transplants in North America will continue to mass produce mid-scale vehicles. Production strategy will be to implement factory automation along with productivity and quality improvements so that the quality of cars is equal to those built in Japan at a competitive price. The most "advanced" processes will not start in the transplants.

The total European auto market will grow slightly faster — 1.5 percent per year. Japanese transplant production will be limited to one million units per year with development of suppliers to meet local content requirements. Production strategy will be similar to that in North America except that when producing smaller standard cars, cost reduction is more important. Protectionist regulations will limit Japanese imports to 200,000 or fewer units per year, mostly car types not made in Europe.

While the auto markets stagnate in the established industrial economies (how many more cars can we use?), they could boom in some of the developing countries. However, for some time rapid growth will be confined to pockets of the People's Republic of China, the former Soviet Union, and Eastern Europe. Most of this developing world market will be for mass-produced econoboxes, but affluent "third-worlders" will be a significant market for upscale cars.

Sometime in the 1990s, South Korea will probably replace Japan as the major exporter (in units) to North America. Taiwan, Malaysia, and other NICs moving into automotive production may also try to establish marketing beachheads in North America. Japanese companies have joint relations with a number of NIC auto companies. These joint ventures will mass produce a limited number of inexpensive basic models exportable to a world-wide market, including Japan. Procurement strategy will again aim for high local content, focusing on the quality of parts.

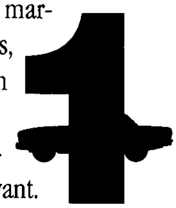
The Japanese domestic car market will continue to expand by 1.5 percent per year — but might top out due to traffic congestion. If current forces continue, imports from established countries will capture five to ten percent of this market, about one percent from the United States and the rest from Europe. Most of these will be "upscale" cars unique to Japan. The major shift will be in small cars imported from the NICs.

About half of the Japanese domestic market will fragment into many small niches. The other half will be supplied from domestic production of basic transportation nameplates selling 20,000 to 100,000 units per year, much as now. The fragmented half will consist of numerous different models produced in quantities of less than 20,000 per year. A small, but significant, number of customers will desire cars to be tailored to their individual requirements — extensive customization.

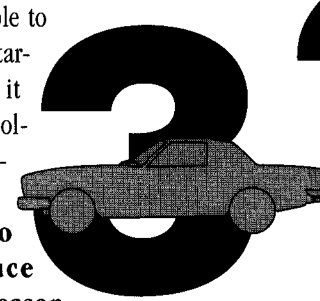
The Japanese auto industry must learn to deal with offshore competition, especially from the NICs. Serving the niche and custom markets is the most difficult challenge. If niche markets can be dominated and a "fair" share of the basic car market retained, the Japanese domestic auto industry will remain healthy.

Flexibility: A First Step for the 90s

An intermediate strategy is vital because we cannot instantly transform to the wild world of the future. Today, not a decade from now, **Challenge No. 1 is to break dependence on economy of scale in production** — big lots and long runs. Production is more likely for a specific market.



Internationally, "economy of scale" is in marketing, common processes, and common systems, and the nature of these functions will begin changing significantly from the way we know them today. World-wide name recognition promotes marketing, but people want what they want. Properly used, a common information system for product and process development in every production base in the world should stop engineers in both product and process development from "reinventing the wheel." Any production base should be able to quickly modify any design for its target customers and start building it — if its personnel, equipment, tooling and processes have been developed for flexibility. [3]

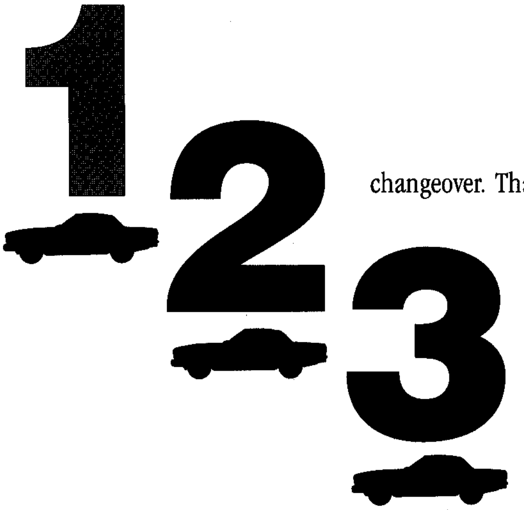


Challenge No. 2 is to create a system to produce vehicles in low volumes at reasonable cost. Manufacturing excellence practices are a great start enabling this, but to take advantage of it, the time and cost of new model development and start up must be drastically cut. This is now the number one priority of the Japanese auto industry. Product and process design must occur in parallel. Tooling and equipment conversion time and expense must be reduced by about an order of magnitude.

In order for this intermediate system to be financially sound, many new models must make a profit on 10-20,000 cars in their lifetime. Development cost can be held down by reusing old ideas and modifying them to new needs. Certification of power plants and tooling for body parts are the most expensive development costs.

Intelligent Body Systems

The Nissan Intelligent Body System, already in use, is an opening move to reduce new body costs. The basic idea is to design flexible body handling and metal fabrication equipment, so that equipment within a given size range needs no modification for new body shapes, and only tooling remains as the major new model expense. In fact, the objective in a stamping shop is die changes in five minutes or less (on monster dies) for small lot sizes. Then flexible equipment in a body shop should weld any sequence of body styles without any time for



changeover. That is possible if equipment can accommodate any configuration within its working space.

Other car companies are known to be working on their own version of the Intelligent Body System. Implementation is made easier by the convergence of body shapes. The need for a low coefficient of wind drag restricts the envelope in which all body shapes can be differentiated.

In addition, assembly lines are designed and manned by highly-skilled, adaptable workers who can trade off work among themselves within team-operated line stations. A large number of detailed practices, including ability to re-position equipment and materials, either manually or automatically, allow workers to assemble multiple models intermingled in sequence at varying rates. At the same time, with less focus on rock bottom cost, the Japanese companies are investing in equipment (and kaizen time) to make the work and the working environment physically easier on the worker. More variety equates to high mental alertness, but less physical stress. But this is 1990s intermediate strategy, not a three-day car for the 21st century.

The three-day car will be exclusively made to order — no dealer inventory.

The Manufacturing 21 "Three-Day Car"

If one wants to offer truly customized cars to a segment of the market, unit body construction has limitations no matter how intelligent the system to design and build it. To break through this, the Japanese Manufacturing 21 team considered many different concepts to achieve several challenging objectives:

Challenge No. 3: Deliver a car with custom features very quickly — within three days after ordering. Today, delivery takes about three days if the order is expedited through the system. (Ten days or so is a more normal Japanese domestic customer leadtime.)

Challenge No. 4: Further downsize the scale of the production operations. Build clusters of small plants, with suppliers feeding a mini-assembly plant, all near the customers to cut the transport traffic, expense, and time.

Challenge No. 5: Allow the same components to be configured many different ways.

Challenge No. 6: Create work stimulating to the people doing it.

All of these challenges can be met by a modularly designed car. Fabricate and assemble each module in a small space compared with today's plants. Final assembly would also require little space. This cannot be done with unit body designs because large parts must be fabricated on big machines, welded together in a large body shop, painted as a unit, and then have hundreds or thousands of parts attached to a big unit. The space necessary to do this can only be compressed so far.

Cars designed in structural modules could be subassembled in different locations, then brought together for final assembly and attachment of the body panels. The external shape of the completed body is thereby partly independent of the form of the structural framework. (This design concept is one step beyond that of the Saturn and the Pontiac Fiero, in which body panels fasten to an underbody framework. The extra step is building the underbody in modules so a big plant is not required, and is similar to a 28-module production concept once proposed by Chrysler.) A design truly ingenious in dimensional stability and modular interconnects could even be assembled in a dealer shop.

Smart designs that enable compensation in assembly for dimensional variation in parts might allow them to still be made of sheet metal. However, if parts are to be reused or re-manufactured many times, some parts may need to be made of more durable materials. These problems may require high-tech materials, but within down-to-earth budgets.

Whatever the final result of technical changes to designs and production processes, the key factors are the development of suppliers and the acceptance of customers. If large subassemblies are fabricated and assembled prior to final assembly, the supply network must change. The modules are either made by the car company itself or by very capable suppliers working very closely with the car company. The high-tech demands of the process and the degree of coordination required suggest that the suppliers need to be "high-tech" partners of each other as well as of the customer company.

This concept also presumes that many features of a car are electronically achieved. For example, on a few models the ride of a suspension can now be adjusted by the driver.

Ordering a Three-Day Car

This car would not be ordered off a dealer lot. Instead of taking a spin around the block, the customer might view displays or demonstrators, then enter a simulator. Inside this "flight trainer" he can position controls in different locations and replicate different rides and responses — a form of virtual reality. The set of preferences checked would be stored and converted to design requirements for the order.

From the simulator, sit down at a design work station, probably with help from an advisor (future speak for a salesperson). The work station would be a CAD-type program linked to the production and design system. Using the station, the customer can check the physical appearance of the car inside and out. With a 3-D screen, the visualization may be close to reality. The system will allow the prosumer to select feasible or safe designs and option combinations.

The three-day car will be exclusively made to order — no dealer inventory. By today's system, American Big-3 dealer stocks "normally" range from 60-90 days' of sales, which cover the normal leadtime for a factory order of 6-7 weeks, plus order cycle time. In Japan today, similar leadtimes to receive a factory-ordered car range from 3-21 days, so the average domestic dealer stocks 20-30 days of cars, which covers his leadtime for replenishment (about a week for the sales order cycle plus about 10-20 days from order-to-receipt using a pessimistic forecast).

Cars built in modules would probably require more expensive materials. Initially this concept might appeal only to affluent car buffs, but eventually would be a system for everyone. Customers must learn to trust their own judgment on styling and features. The total design-to-delivery time must be short, though from the customer's viewpoint how short is debatable. However, if custom-built cars need no dealer stock, those savings alone would help offset the higher cost, and for customers of modest means, payments for a long-life vehicle could be spread over a longer period.

Challenge No. 7, crucial to success, is cultivating the automotive "prosumer." A prosumer is a customer that participates in his own service or order fulfillment, especially if done with computer assistance — a high-tech version of a "do-it-yourselfer." In this case, the prosumers participate in the design of their own vehicles.[4]

The car company's prosumer-friendly design software will first be used to select a combination of body structure, drive train components, and suspension components that have been tested for safety and performance. A number of creature-comfort features can be custom-designed, depending on how much the customer wants to pay. The seat contour can be custom-profiled, the car's lighting system designed as the customer likes, the instrument panel layout modified to suit personal preferences (easily done if it just consists of repositioning images on screens). Within limits, prosumers might even modify the shape of body panels (want your monogram stamped in the door?), design their own trim, and "imagineer" sound systems to their own tastes. Of course, features that are electronically controlled can be modified by a different PC board or different software, possibly without visiting the dealer.

Challenge No. 8 is creating an ordering system that will instantly check the combination of requests by the customer for engineering safety and feasibility. As soon as an order is generated and checked, it will be transmitted to the cluster of factories that will build it. Leadtime to delivery: three days. That is where the three-day car got its name.

This story in various forms has circulated in Detroit for some time. A popular version of it has a three-day car achieved if the line-up of vehicles in an assembly plant's schedule is no more than a three-day sequence. That's far short of the idea. Many Japanese assembly plants today have fewer cars than that in the vehicle build sequence.

Japanese refer to both the software and "humanware" aspects of this as a "holonic" system.

Engineering, Production, and Delivery

Data requirements are huge. Suppose a custom designed vehicle is damaged. Securing its CAD/CAM record (or escort memory) and transmitting it to the proper plants would be necessary to make the replacement parts.

Challenge No. 9 is managing large masses of data and controlling their flow. It is made easier by the transmission of "macro" commands to the locations where detailed data is kept. For example, your suppliers will maintain on their site the part of your bill of materials representing the parts they make.

Learning the human discipline to operate such a system seems as daunting as generating the data and software. Central control would create a choke point, less likely if distributed control is coordinated throughout the network. (Japanese refer to both the software and "humanware" aspects of this as a "holonic" system.)

After an order is entered, it is transmitted from the dealership to the cluster of plants (car company plus supplier plants) selected to build the order based on distance and backlog. Orders would flow to the plants individually, not in groups as in 1992. One can imagine that some order requests would not automatically process on the design software, or translate into CAM instructions at the plants and kick out for immediate engineering attention. Some questions would have to be referred to the locations where work is done, and one can anticipate that the connoisseurs among auto prosumers would relish that form of "car talk." (Most customers will probably prefer to order something suitable using a minimum of their time to evaluate complex alternatives.)

The synchronization of a distributed system — assembly, feeders, suppliers, dealers, planning centers, maintenance, service centers, etc. — carries JIT concepts to a new level.

As soon as the assembly plant has sequenced an incoming order, the sequence and relevant data, including CAM instructions if necessary, is transmitted to all supply plants. (Imagine an elegant database organization for this.) Each plant keeps very little parts inventory that is not designated for an actual order, but fabricating plants might need to have the correct raw material on hand to start an order. All this planning needs to sequence jobs through two or more tiers of suppliers (easier if everyone can work in lot sizes of one in any sequence). With no backlog, fabrication work could begin almost immediately after an order's processing is validated.

Each cluster of plants operates its quick-change, adaptive equipment nearly round the clock. Some equipment self-repairs its own minor faults, so no long daily downtime periods are required. System maintenance downtime takes a few hours once a week, similar to the periods required for large computers. Once activated, many cells can operate "in the dark" for prolonged periods without attention.

An order begun in fabrication passes to module assembly and then to final assembly in Vehicle Identification Number (VIN) sequence. Sequence control moves material where needed when needed. Processes in any plant can check the sequence and status of orders in assembly plants or in other fabrication plants as necessary. From any point in the system news of a "really serious glitch" can be quickly transmitted throughout the system so that orders can be resequenced, if necessary, but that is rarely done. Challenge No. 9 means production control by computer synchronization of the whole system so that material, tools, tests, and data march in unison through the network of supply areas into final assembly. Though similar to the "broadcast" system now used by auto companies to bring such items as seats to assembly in proper sequence, the system is neither MRP nor a pull system. It cannot work by itself, but only if all the items to be marched are "designed for marching."

Though some parts for repair and retrofitting may be made by "off-line" facilities, a portion of the main system's production time is regularly set aside to make parts. Many customers of modularly designed cars will surely want to change its features or add "new releases" (like software) to existing cars. They might install the easy ones themselves. Service agreements must contain clauses on retrofitting.

By day three, the order should be ready to ship. Since the order is usually built by a cluster of plants close to the customer, the car should arrive at the dealership within a day. Some customers may come to the plants to pick up the cars themselves, and even to watch it being assembled.

The production and engineering concepts for the three-day car simply assume that Total Quality and the failsafing of operations are at maturity. The system will choke unless defect rates on complex cars and processes are infinitesimal. (Japanese refer to this as "Zero Defects," — easily confused with an earlier phase of our development in North America.)

The synchronization of a distributed system — assembly, feeders, suppliers, dealers, planning centers, maintenance, service centers, etc. — carries JIT concepts to a new level. Everything — CAD/CAM systems, product specifications, vehicle performance data, customer credit information — must be able to link. Nothing like it exists today, although databases and data communications could grow into this state.

The Agile Manufacturing Version

In the summer of 1991, the Agile Manufacturing Enterprise Forum at the Iacocca Institute, Lehigh University received a grant from the Department of Defense to create an American vision of 21st century manufacturing. They adapted the Japanese scenario of the three-day car to the United States. One modification illustrated the Department of Defense as an institutional prosumer of military vehicles. An enhancement emphasized the modularity and interchangeability of many parts and subassemblies in the basic design. A customer's "pet" features, such as a custom-contoured seat, could simply be retained while much of a vehicle was reconfigured to a different purpose for its owner, as might be desired when going through a life change such as a growing family, retirement, etc.

Another addition considered prosumer maintenance of a complex vehicle. Using one or more special service compartments, they could perform normal oil changes and other fluid additions while "dressed in a suit." Each vehicle's full history would be recorded and updated by an on-board "smart chip." The system would tell the owner when service was needed. Unless a malfunction were disastrous, the "limp in" design should prevent unfortunates from being stranded in some God-forsaken locale.

The agile scenario also projected the future of "roadside service" to include electronic diagnosis. Any apparent malfunction not self-diagnosed by the vehicle itself could be recorded during vehicle operation for later play on a service center's diagnostic computer. Better yet, if digital data can be easily transmitted via UltraComm, a remote car can be diagnosed by the manufacturer's computers while on the road.

The Agile Forum scenario also began to bring out environmental implications. A totally-instrumented car should be much less prone to drift out of "environmentally safe" operating condition.

Finally, while the American version concentrated on technical requirements, it noted that a major challenge of bringing such a world to pass was human development: flat organizations, tight links between small operating units, and enterprise integration of relationships between people as well as those between computers. Although the present trends toward team organization will strengthen, the Americans viewed future organizations more as a linking of entrepreneurial operating units.

The Plot Thickens

Both the American and the Japanese versions of the three-day car were devised by people with manufacturing experience. They subjected their dreams to reality checks. While no one can foretell any long-term scenario with precision, the concepts are not crackpot. The conclusion: The technology is at hand. The human will to change is more doubtful.

Reflection by the author on the implications leads to other possibilities. Any system resembling the three-day car changes the basic nature of the auto industry.

Challenge No. 10 is recognition by everyone involved that the basic mission of an auto company is to provide transportation service to its customers. Manufacturing, as we have known it, is only part of the means to provide transportation. Since almost everyone who has brainstormed this scenario in depth is committed to strengthening manufacturing, few like to admit that the scenarios do not revitalize rust belt industry according to a conventional economic growth scenario. The 21st century will not be like the 20th, with factories absorbing millions of additional workers.

In fact, the big old mass production companies will probably not live in anything like their present form. For example, sharply reduced tooling costs will drastically change the production economics of General Motors, Toyota, and other behemoths and reduce barriers to entering business. Smaller operating companies hooked to partners may "enter the auto enterprise system." To see why, add a few more twists to the scenario.

The design of the three-day car envisions a mechanical frame that is really a platform for the electronics, software, and cosmetics (more like ships, aircraft, and computer frames). The cars may be equipped for "smart highways" — traffic advisories allowing drivers to avoid jams, and computer-controlled vehicles that allow dense packing in high-traffic flows. In addition, a current planning trend is to improve the connections between cars and other forms of transport — planes, ships, and trains. That will surely become part of the intelligence network available to drivers of 21st century "smartwagons."

Thus equipped, a car can be easily tracked. A car bristling with electronic sensors and transmitters will also deter thieves seeking to practice rapid disassembly on modular equipment. However, one can easily imagine civil libertarians revolting at the thought that police can constantly check their vehicle's whereabouts. Privacy issues will surely arise. (Will parking in lover's lane become a quaint 20th century custom?)

To continue lightening the mechanical platform, components should be made of more durable materials. For instance, precise, long-life bearings might be smaller than today's, but still more reliable. Interchangeable,

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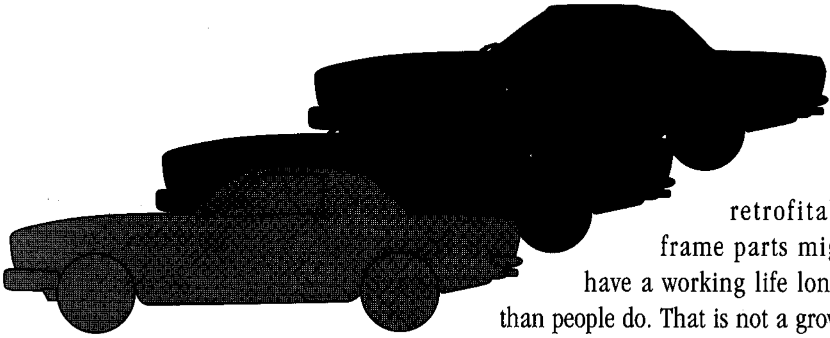

retrofitable frame parts might have a working life longer than people do. That is not a growth scenario in the historic sense, though the replacement of the current stock of vehicles should provide a steady business. The 160 million cars now licensed for American roads will not pass from existence quickly.

In the long-run, we may really have a case for remanufacturing, rather than manufacturing as we have known it. Remanufacturing upgrades a product into a better-than-new condition. Then cars would not be so much bought and sold, as periodically taken to service centers for refurbishment and upgrade.

Challenge No. 11 is learning remanufacturing. Ecology could become as big a driver of the scenario as the desire for ultimate transportation service. A car which can be remanufactured is "greener" than one which requires recycling of its base materials. If the electronic content changes the quickest, the ability to remanufacture or recycle PC boards will become a rising issue.

At the outset, a three-day car might be only for the affluent, but if the scenario becomes ecology-driven, it will evolve into a system for the average driver. If the car or its parts must be disposed of by its manufacturer (or service company), then owning a car begins to be less interesting. Long-term car leasing, already a trend, could avoid complications. On the other hand, long-term ownership combined with service contracts might be a way to make a superior vehicle affordable to the average person. (How about a 20-year mortgage on your car?)

So What?

The advent of a new millennium leads to anticipation of more change than may actually occur, but the shape of changes now beginning casts the shadow of those to come. An assumption of the "three-day car" is that Total Quality, Just-in-Time, Employee Involvement, and other acronyms we now call excellence are but the foundation for a different kind of manufacturing system, and perhaps a modified economic system.

The acronyms themselves should fade as their content becomes mainstream, but they will never be totally natural. Therefore inculcation of the attitudes for them must begin early in life.

Challenge No. 12, and the biggest of all, is a redirection of ourselves and our human institutions. It begins with our approach to education (much belabored by industry leaders). We need a more rigorous approach to career education, and more intense development of people by the enterprises within which they work. We cannot yet recognize that in an information age, the key to the use of all technology and all capital is ourselves — the human element. If that can be accepted, then some of the requirements to bring the vision of a three-day car to reality are:

- **"Visionary" guidance**: The value of a common vision is direction, not precision. It enables diverse people to stumble in roughly the same direction by different paths. For instance, the ideal of designing both products and processes must be "agility," which assumes an understanding of all the underpinnings of that phrase.
- **"Open System" Information**: Of course, computer systems must universally talk to each other. However, despite enthusiasm for enterprise integration, we still have islands of automation, CAD/CAM systems that cannot communicate, and EDI linkages that are really used as fax machines.

The problem is far deeper than computer systems compatibility. Intellectual capital derives its name from the assumption that if we know something unique, the world must come to us to buy it, and we protect that opportunity through non-disclosure. That assumption turns on us when we find that what we do adds value only if it will fit into a universal system. In the19th century, railroads discovered that none of them added value unless each used the same width track. In this century, we simply expect any telephone to connect to all other telephones. In the 21st century virtually any system must interact with other systems, and that is first a problem of human perception.

- **Decentralized Interactive Organization**: This shift has begun today with emphasis on flat organizations and teams of every kind: functional, cross-functional, and cross-company. If team members are remote and computer connected, they may be termed "virtual companies." We are headed for a radically different form of business. The organization of even an auto business — a big-scale enterprise by any standard — will likely consist of much smaller operating units with tight linkages between entities operationally focused on separate processes from raw material to customer service — and back again. An auto company as we think of it today may become a transportation service network consisting of comparatively small operating units.

- **Common Interactive Human Processes**: The need for this is more subtle. Computer interaction is insufficient. Whether the new human organization is called a network, a holonic system, virtual companies, or buckyballs,[5] it cannot function unless work habits and customs have a common framework, but one that allows individuals to exercise freedom and creativity. Otherwise the "culture clash" will wreck the three-day car.

Human systems include everything from expectations of normal work times to common drawing conventions. They are "the way we learn to get things done." No one unlearns a lifetime of experience quickly. Such basic changes force us to put at risk whatever small career status we may have acquired, learning by doing and discovering anew "what really works."

We have barely begun to use information technology in all its possible forms as an interactive tool. Today we still often work with programmers as an armless carpenter telling someone else exactly how and where to drive each nail. We must learn different concepts by which things get done. (Imagine a three-day house.)

Those interacting in the same network must have common visions and strategies, and at least three practices in common:

1. A method to diagnose and solve problems — bedrock TQM;
2. A common concept of good operating performance. ISO 9000 is an early form of common standard, but much tighter, more comprehensive, codes of performance will become necessary;
3. A shared sense of common systems. (For example, common conventions to describe products and more precise concepts for how operations should mesh. We now think of meeting shipping dates instead of how our total sequence of work meshes with those of everyone else that we must merge into.)

Today in the systems business it is commonly said that hardware has outrun software. Beyond that, software is years ahead of the "humanware." The kind of world which is upon us is not beyond imagination, but any version of the three-day car leads to the conclusion that achieving prosperity and quality of life in the future depends on us improving ourselves and not hoping for more fortunate circumstances. We'll continue these challenges in later issues of *Target*.

1 Iwata, Makashima, Otani, et al. *Manufacturing 21 Report*, Research Report of the Association for Manufacturing Excellence, AME, 380 West Palatine Road, Wheeling, IL, 1990.

2 Iacocca Institute. *21st Century Manufacturing Enterprise Strategy*, Lehigh University, Mohler Laboratory #200, Bethlehem, PA, 1991. In two volumes. The scenarios are in Vol. 1. (Also available from AME.)

3 Hall, R.W. and Nakane, J. *Flexibility, Manufacturing Battlefield of the 90s*, Research Report of the Association for Manufacturing Excellence, 380 West Palatine Road, Wheeling, IL, 1990.

4 The term "prosumer" was coined by Alvin Toffler in *The Third Wave*, William Morrow and Co., New York, 1980.

5 Buckyball, the newly-discovered sixty-carbon spherical molecule.

Robert W. Hall is Director of New Programs for the Association for Manufacturing Excellence and is also Editor-in-Chief of Target. *He is a founding member of the Association. Bob was an examiner for the Malcolm Baldrige National Quality Award from 1988-1990 and is on leave from Indiana University. His new book,* The Soul of Enterprise, *will be published by Harper Collins this year.*