DENSO MANUFACTURING: A FORMULA FOR SUCCESS

WHAT'S DRIVING OUR GLOBAL MOMENTUM?

Cars are now being designed to accommodate an ever-growing array of new functions and capabilities. This alone is supporting rising demand for automotive components. But this is an industry-wide trend, and it benefits our competitors, too. So how is DENSO consistently capturing a greater share of the global automotive component market? The answer lies in our technologies, our people, innovative problem-solving, and our unique approach to manufacturing. In this year's feature section, we put the spotlight on one of these key ingredients—manufacturing, or as we like to call it, *mono-zukuri**.

*The art of making (*zukuri*) things (*mono*)

MANUFACTURING AT DENSO: MORE THAN MEETS THE EYE

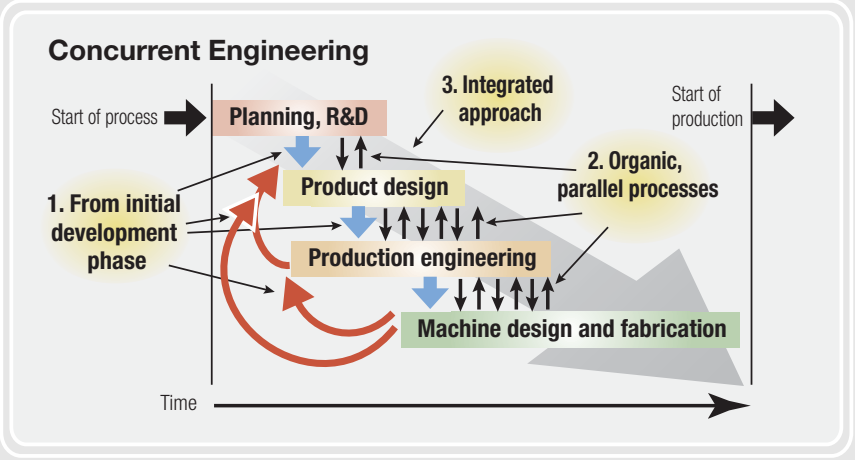
At DENSO, "manufacturing" means more than just making things—it represents innovative manufacturing technologies and processes that help us achieve dynamic and far-reaching improvements in quality, cost and delivery (QCD). On the following pages, we introduce just some of the approaches that make us an industry leader in manufacturing.

CONCURRENT ENGINEERING: WHAT IT IS AND HOW IT WORKS

Automotive suppliers face a number of challenges. Automotive systems are becoming more advanced, while delivery timeframes are increasingly shorter. At the same time, automakers are continually calling on suppliers to reduce costs.

To satisfy these contradictory requirements, DENSO was one of the first in the industry to adopt concurrent engineering.

Concurrent engineering works like this: people from a variety of departments, including product planning and production engineering, are brought together in multidisciplinary teams at the start of the product design process. This collaborative approach gives everyone involved equal access to the project's concept, blueprints and objectives. Design parameters are then fine-tuned based on in-depth discussions and parallel decision making within the team, so that remedial actions are taken well before the new product advances to the manufacturing phase. Cost estimates—including everything from personnel expenses to transportation costs—efficiency and quality can also be assessed more accurately to devise the optimum procurement and manufacturing processes. Cost and delivery times are both factored into the manufacturing process during the design phase, allowing us to achieve innovative cost reductions and significantly cut delivery time.



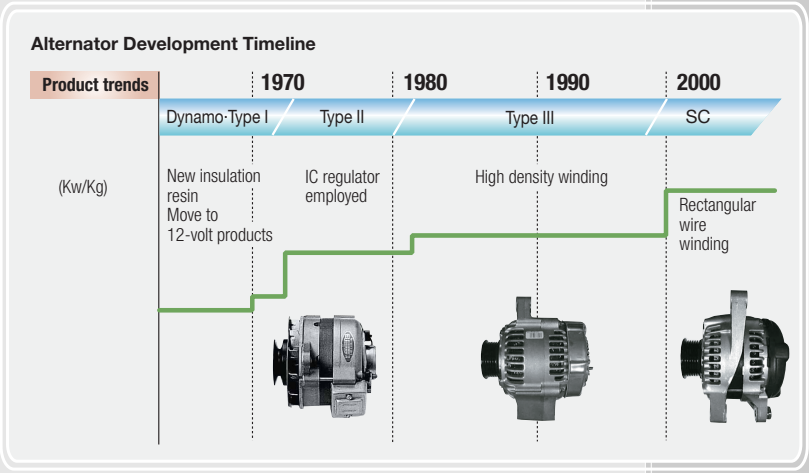
This differs from the conventional linear approach to manufacturing, where product planning departments create the initial concept, designers use the concept to construct blueprints, and the production engineering department designs a manufacturing process based on these plans. Each of these activities is done independently and without discussion.

The Fruits of Concurrent Engineering

In January 2001, we were asked to design a new type of alternator for the 2002 Toyota Celsior and Estima. The new alternator had two requirements—it had to be more compact, and it had to have a higher power output than its predecessor.

To increase output, our product design team proposed increasing the number of coils in the alternator. But that led to a number of issues:

- *The limited space available meant that engineers had to use finer wires to increase the number of coils.*
- *Due to the higher temperatures resulting from the required increase in power output, the coil wire had to be even more resistant to heat.*
- *Existing alternator production line equipment was incapable of manufacturing alternators with more coil windings.*



Taking on these challenges, DENSO's material engineers created a new type of high-performance wire that was finer and offered greater heat resistance, while the Machinery and Tools Department successfully developed proprietary manufacturing equipment capable of attaching coils inside components with smaller dimensions. At the same time, our production engineers used simulations to develop the best manufacturing equipment and processes for smaller alternators. These cooperative and concurrent efforts allowed us to meet the customer's requirements: alternator output was boosted to 85 amps from 55, while the diameter of the alternator core was reduced to 128mm from 135. Manufacturing costs were also cut by 30 percent.

THE BENEFITS: SYSTEMIZATION, MODULARIZATION AND STANDARDIZATION

Concurrent engineering processes do more than just streamline the design and development phases of new product creation; they also lead to smaller and lighter components, systemization and modularization, and standardized components, making us more competitive.

While compact automotive components help to reduce the size and weight of vehicles and increase cabin space (benefits for our customers and end-users), they help us in our own operations as well. We can cut the amount of materials used; reduce the size of manufacturing equipment; and scale back warehousing. Naturally, this results in a lower cost base.

Systemization and modularization also benefit both suppliers and automakers. Fewer parts in a component mean materials costs are lower, assembly costs are reduced, and production lines and logistic networks are smaller. In short, we can make products with the same functionality using smaller facilities and less investment. Standardizing components, which entails using common internal devices and systems without sacrificing outward individuality and appearance, allows us to respond to automaker model changes without losing time or resources.

ENHANCING QUALITY: ADVANCED MANUFACTURING EQUIPMENT AND SKILLS

Quality has to be built into production processes. That is why we trust our highly skilled associates and our highly reliable equipment to achieve the DENSO standard of quality. These are standards other companies find hard to match.

A DENSO associate takes on a challenge at the 2003 WorldSkills Competition.

How do we know? Our consistently strong showing at the WorldSkills Competition, formerly known as the Skill Olympics, is one way. In this competition, skilled technicians from around the world compete in a range of technical challenges that require micron-level accuracy. In the last WorldSkills Competition, DENSO associates participated in five categories, winning medals in all five competitions. In the instrument-making category, DENSO has won the gold medal six years in a row. Because most production lines are highly automated, this kind of expertise is vital in the construction of "mother machines," core manufacturing equipment employed in our production lines. Designed and manufactured in-house by the Machinery and Tools Department, these machines allow us to make components in unique and innovative ways.

LOWERING COSTS: AIMING TO ACHIEVE A GLOBAL MINIMUM COST

Since DENSO produced its first component in the 1950s, we have consistently worked to achieve a global minimum cost lower than that set by the customer. This process is even more difficult and demanding as automakers establish competitive global cost bases and automotive component makers face ever-tougher demands to reduce unit costs.

Concurrent engineering helps us accurately set a global minimum cost—and deliver on it.

The shared knowledge flowing from concurrent engineering allows each department to provide advice on how best to reduce the final cost of the component: by altering the initial design, adapting manufacturing processes or devising optimal materials, while keeping mid-process changes to an absolute minimum. Aware that most of the cost of a new product is incurred in the initial design phases, we target this stage of the process to deliver cost reductions to our customers.

REDUCING DELIVERY TIME: INITIATIVES BEGIN AT THE DESIGN STAGE

In the conventional linear approach to manufacturing, delays occurring in one part of the process have an unplanned effect on the rest of the cycle. These incremental delays build up, putting added strain on the production process and leaving less room for maneuver.

Our unique approach to manufacturing means we avoid this pitfall. At DENSO, “delivery” means more than getting products to customers on time. It is a concept that is factored into every part of the manufacturing process. Multidisciplinary teams cooperate at all phases of the process to devise innovative ways to cut delivery times. Every department plays a crucial role. Working hand-in-hand with automakers, DENSO enhances logistics and inventory control efficiency, and speeds up delivery by carefully reviewing and fine-tuning every part of the process. This way the burden is shared, reducing pressure on the end of the process and helping us to meet tight delivery targets.

QCD: AT THE HEART OF EFFORTS TO BOOST GLOBAL SHARE

By realizing world-leading levels of QCD performance, we are aiming to enhance customer satisfaction and ultimately increase DENSO’s share of the global automotive components market. Put simply, QCD is crucial to a key objective in our current medium-term management plan: capture the leading global share in 23 automotive product categories.

N-Time Technology: Driving Productivity Improvements

N-time technology is a phrase unique to DENSO. It was created to define technologies that drive dramatic improvements in productivity, not easily expressed with ratios. Instead, the word “times” is used. Heat exchange component production lines are a good example of how we have applied this technology to significantly boost manufacturing efficiency. Other benefits include a reduction in production line area and the creation of next-generation components that deliver real improvements in performance. Specifically, we introduced N-time technology soldering equipment that reaches its optimum operational temperature 4 times faster than earlier devices, speeding up the manufacturing process. Proprietary equipment using N-time technology was also installed at other stages of the production line, resulting in an overall increase in processing and assembly speeds of 2 to 3 times. The combined benefit of all our improvements in the heat exchange component production line was an increase in output of 1.5 times.

An evaporator, one of the products manufactured on the heat-exchange component production lines.

THE UNIVERSAL PRODUCTION SYSTEM: UNIFORM QCD PERFORMANCE

In building an optimum global manufacturing framework, we have to consider a range of local issues: the needs of automakers, workforce skills, procurement costs, and personnel expenses, to name just a few. Using this information, we rapidly adapt our universal production system to the local business environment and have it up and running with minimal investment. This tried and tested approach means we can quickly achieve uniform QCD performance wherever we operate.

THE VITAL INGREDIENT: INVESTING IN PEOPLE

No matter how advanced our facilities or materials, people are still the vital ingredient—it is DENSO associates who make the difference. They take to heart our approach to *mono-zukuri*, our commitment to Quality First, and help us create new manufacturing technologies.

In April 2001, we established the DENSO E&TS Training Center Corporation in Japan to evaluate skills and provide technical training. This company enhances the skills of two key groups of engineers: those involved in product development and those helping to fabricate the finished products on the factory floor. Building stronger ties between these two groups of engineers ensures that concurrent engineering remains an integral and widely accepted element of DENSO's corporate culture. The center also supports overseas facilities through training programs designed to foster the skills that our technicians need.

Devising Optimum Equipment and Workflow Processes

Concurrent techniques are not limited to product development processes. We also use them to develop manufacturing equipment.

On the factory floor, machinery and tools, production engineering and production control departments work closely with engineers, managers and other associates to devise optimum equipment and workflow processes.

Simulated production lines made of cardboard and wood.

Creating simulated production lines from cardboard is one technique we use. The approach was first employed in Thailand in 2002 to boost productivity and incorporate the expertise and work-related ideas of local personnel. Prior to installing new manufacturing equipment, we build life-size production lines made from cardboard and wood that incorporate mock-ups of the new equipment currently under development. This allows us to simulate and monitor actual workflow processes, helping us to reduce startup lead times. If we notice any potential flaws in the system, we can rapidly make adjustments to fix them. Moreover, we can achieve output targets almost as soon as a new production line comes on stream, helping to further reduce costs.