A French journalist serving as a bridge linking Japan and France, Dora Tauzin reports on her firsthand experience with kaizen (continuous improvement) that continually transforms Toyota Boshoku’s manufacturing sites.

There are two words of interest that are commonly used throughout Japanese industry. One of these is monozukuri, which means manufacturing. Even in pursuing high productivity and creating high-quality products, large companies, which are not workshops or small factories, use the word monozukuri, a term that embodies a certain warmth.

The second word of interest is kaizen, which is used by Toyota Group companies. One fundamental mission of persons working at production sites is to continually pursue kaizen in the manufacture of reasonably priced, high-quality products. This does not mean only improving production technologies but also encompasses methods of working and ways of thinking. So what exactly are monozukuri and kaizen? I asked myself this as I stepped inside to have a look around the Toyota Boshoku Sanage Plant (No. 5 plant).

The plant visit took place on May 14, 2010.
Seat assembly model line a treasure trove of ideas

I was shown around the plant by Mr. Imaeda, Mr. Ohyama and Mr. Noguchi. First, they explained to me the features of the seat assembly line and emphasised three main points. Specifically, the plant can make timely responses to model changes and changes in volume, aims to be global No.1 in terms of quality and ceaselessly implements kaizen. In the more than 10 years since efforts began to realise the optimal production line, the plant has made one improvement after another. It has also adopted simple processes, achieved a compact line and streamlined peripheral areas by stocking only the needed parts and inventories. In 2003, the plant was highly lauded internally as having the best line, and its concepts have been deployed at plants in Japan and overseas.

The first thing that captured my attention at the plant was the assembly line, where an assortment of parts gradually becomes seats. The people working in front of the line moved very smoothly and appeared to be completely at ease.

As I gazed at the line, Mr. Imaeda explained, “In the past, workers had to take parts from the shelves behind them and then turn back around to attach the parts. We improved this process to the current configuration. This enabled us to do away with the cumbersome task of having to constantly turn around as well as to eliminate mistakes when workers had to take similar-looking parts from the shelf”. In place of the original parts shelf, one box containing all the requisite parts for each seat moves along on the conveyor belt. In the same manner that food is packed with precision into a Japanese lunch box, these handmade parts boxes were created using a wealth of ingenuity to accommodate all the parts needed for seat assembly.

The next sight that caught my eye was hog ring pliers, a giant stapler that fastens seat covers. The original hog ring pliers moved in an up-and-down manner, while next-generation models could be moved both vertically and laterally. Subsequently, the currently used hog ring pliers were improved through kaizen and can be moved freely 360 degrees.

What was especially interesting was a machine that uses air pressure to send only the needed clips to the assembly line through a hose. I was totally amazed by the dancing-like movements of parts flying through the hose and fascinated by the concept of transporting parts through an air hose. People who still possess the playful minds and spirits of children probably created this machine.

Kaizen definitely brings enjoyment and satisfaction

Mr. Noguchi then introduced me to a truly convincing type of kaizen in the form of a protruding jig. Specifically, this is a type of platform that enables work to be performed on the backside of the chair portion of seats that move along a conveyor belt. Despite being just one seat, these are actually quite heavy and difficult to move, even for males. However, thanks to this protruding jig, moving a seat does not require any significant strength.

A company member familiar with the situation before and after kaizen said, “No matter how busy I am, the physical burden has been completely alleviated”. I learned that being able to work gracefully and fluidly in this manner means that no excessive force is required to handle products. This in turn helps to prevent quality-related flaws such as smearing and scuffing and thereby contributes to improvements in quality and productivity.

There are actually numerous other examples similar to this. So who comes up with ideas for kaizen and who gives these ideas shape? The ideas are not the brainchild of an advanced industrial robot, but originate with a unique process that gives company members a great deal of satisfaction.

Mr. Ohyama explains, “Everybody working here thinks about kaizen on a daily basis. What’s more, we have a workplace culture that fosters a fervent
A worker-friendly line raises competitiveness

I think people are the most crucial element of any workplace and that harnessing their abilities and power is also important. Here at the plant, I felt there is a high awareness that manufacturing seats is so important for the passengers who ride in cars. I also sensed a warm and at-home feeling amid an atmosphere where efforts are being made to create a good environment for company members. I think this is truly the essence of bien-être (happiness and satisfaction). Also, the plant itself naturally serves as the perfect place for cultivating new ideas.

Kaizen raises productivity and generates profits. Of course, I also sensed that kaizen continues to be implemented to ensure workers derive true fulfilment and meaning from their jobs. A worker-friendly environment not only enhances safety but also raises product quality. Even in mass production, workers devote their feelings to the production of every single product and everyone continually strives for improvement. Seeing this, I could firmly understand the feeling of why manufacturing is expressed by the term monozukuri.

I was told that kaizen best practices at this plant are also being deployed globally. The cultures and national traits of each country and region differ, so I don’t know if these best practices are being deployed in the exact manner as in Japan. However, valuing and nurturing workers to foster a corporate culture emphasising kaizen and raising the level of manufacturing makes a lot of sense and I can certainly relate to this concept.

I think that in the future as well, the plant will take on the challenge of meeting even higher targets. Upon wrapping up my visit, my departing thought was that I would like to see the shape of the Sanage Plant in one year’s time.

Welcoming Dora Tauzin

We welcomed Dora Tauzin, who is active in both France and Japan, and showed her around a representative production line of the Toyota Boshoku group. We were pleased that Ms. Tauzin took such a deep interest in monozukuri and kaizen, which are terms that we use on a routine basis. We think that Ms. Tauzin understood that kaizen also leads to the development of people.

Production line manufacturing cannot be undertaken by a production plant alone, but is carried out working together with the development division. Although we were able to show Ms. Tauzin our production site, in the future we would like to introduce large-scale kaizen that is carried out across our entire production system.
Toyota Boshoku’s environmental technologies aim to create interior parts completely from plant-derived materials

The Toyota Boshoku group undertakes manufacturing aimed at realising a low-carbon society from five perspectives: lightweight solutions, compactness, preservation of resources, plant-derived materials, and energy-saving production processes. Here we introduce Toyota Boshoku’s initiatives regarding plant-derived materials.

Contributing to the use of Ecological Plastic for approximately 60% of an automobile interior surface area

With a view toward preserving resources and attaining carbon neutrality*, in the latter part of the 1990s Toyota Boshoku commenced research on the use of plant-derived materials for automobile components.

First of all, Toyota Boshoku set its sights on kenaf, an annual grass that grows quickly and has high CO2 absorption capabilities. In 2000, we succeeded in commercialising a kenaf base material consisting of kenaf and petroleum-derived polypropylene (PP) resin for use as door trim. Our integrated operations for this kenaf base material, which we carry out in Indonesia, range from development to cultivation and the production of boards. We substituted the PP used in this kenaf base material with a plant-derived polylactic acid (PLA) resin to develop a plant-derived, bioplastic base material that is more environmentally friendly. This new base material was then applied in the commercialisation of spare tire covers and door trims. Additionally, we also use castor oil taken from the seeds of a castor oil plant as a raw material for seat cushion pads.

Ecological Plastic** utilising plant-derived materials and co-developed by Toyota Boshoku has been widely adopted in the Toyota SAI hybrid sedan launched by Toyota Motor Corporation in December 2009. This plastic accounts for approximately 60% of the vehicle’s entire interior surface area.

Toyota Boshoku is promoting the development of technologies as it aims to create automobile interiors completely from plant-derived materials.

<table>
<thead>
<tr>
<th>Raw Material</th>
<th>Development/Part in which used</th>
<th>Area used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecological Plastic covering material***</td>
<td>Plant-derived polyester, Polyethylene terephthalate (PET)</td>
<td>H: Headliners, I: Sun visors, J: Pillar covers (front, centre, rear)</td>
</tr>
<tr>
<td>Ecological Plastic base material****</td>
<td>Kenaf fibre, polylactic acid (PLA)</td>
<td>K: Door trim ornamentation (front, rear)</td>
</tr>
<tr>
<td>Ecological Plastic injection material***</td>
<td>PLA, Polylactic acid (PLA)</td>
<td>A: Cowl side trim, B: Door scuff plate, C: Finish plate, G: Toolbox</td>
</tr>
<tr>
<td>Ecological Plastic covering material (nonwoven) **</td>
<td>PLA, Polylactic acid (PLA)</td>
<td>D: Trunk mat, E: Trunk trim (front, side), F: Trunk door trim</td>
</tr>
<tr>
<td>Ecological Plastic foam material***</td>
<td>Polyl derived from castor oil, Polyol, isocyanate (cross-linking agent)</td>
<td>L: Driver’s seat cushion pad</td>
</tr>
</tbody>
</table>

*1. Net zero CO2 emissions during the life cycle of a product or process. Carbon neutrality is based on the concept of not increasing CO2 emissions into the atmosphere during a product’s life cycle, even when incinerating plastics made from plant materials, since plants originally absorb CO2 and grow through photosynthesis.
*2. This is a collective name for automobile-use plastics developed by Toyota Motor Corporation (TMC) that contain plant-derived elements that improve heat- and shock-resistance compared with ordinary bioplastics.

*3. Jointly developed with TMC and Toray Industries, Inc.
*4. Jointly developed with TMC and Toray Industries
*5. Developed by TMC and Sumitomo Chemical Co., Ltd.
*6. Developed by TMC and Toray Industries
*7. Jointly developed with TMC and Mitsui Chemicals, Inc.
We achieved the level of quality required for interior components by using a specially structured fibre composed of plant-derived polyester and traditional petroleum-derived polyethylene terephthalate (PET), as well as by establishing an optimal structural design and processing technologies. By doing so, Toyota Boshoku became the first company in the world to use an Ecological Plastic covering material utilising plant-derived polyester for its interior components for mass-produced vehicles. For cabin headliners, high quality is essential in terms of heat resistance, sunlight resistance and abrasion resistance. To attain this level of quality, we established proper temperature conditions during the manufacturing process to ensure that the properties of materials are not lost. We also provided our partners in joint development with proposals concerning weaving and production methods for coverings while developing an optimal weaving structure. These efforts also enabled us to attain our quality targets.

In the run-up to commercial mass production, we performed various types of evaluations with prototypes and made repeated considerations to ensure the required quality was incorporated at the stage for formulating blueprints for the shape of the product. Even after deciding on the shape of the product, in reality there were many problematic points. These issues became apparent only when actual production began, and we focused our efforts on elucidating every cause. Although it took much time to undertake the process of verifying quality, which included evaluating and testing under high temperature and humidity conditions, we were able to be involved in manufacturing quality products that satisfy customers.

Utilising a base material that mixes PLA and kenaf fibre, which has high CO2 absorption capabilities, we developed a 100% plant-derived door trim ornamentation base material. By establishing a unique technology that optimises the raw material mixture and the conditions of the injection moulding process, we achieved the high level of heat resistance and shock resistance required for automobile parts.

PLA has a heat-resistance temperature of only around 70°C and was thus unable to maintain the heat resistance needed for automobile interior materials. Nonetheless, PLA has a property that allows its heat-resistance temperature to be raised by performing “crystallization” to systematically arrange its molecular structure. During the crystallization process, however, the base material must be kept inside the die for a long period of time when undertaking shape processing, which results in a sharp decline in productivity. To address this issue, we developed a high-speed crystallization technology that reduces the time needed for crystallization. We were thus able to create an Ecological Plastic base material with high heat-resistance capabilities while maintaining the same productivity as for previous products.
Toyota Boshoku’s environmental technologies aim to create interior parts completely from plant-derived materials

**Ecological Plastic injection material and covering material (nonwoven)**

**Injection material**
We have developed such interior components as scuff plates using an injection material that substitutes PLA for a portion of its PP content. We have attained the same performance capabilities and quality as for previous products by utilising our unique technologies, including those related to die designing, product forming and conditions of the injection moulding process, in addition to establishing necessary conditions.

**Covering material (nonwoven)**
We used an injection material that substitutes PLA for a portion of the PET content to develop luggage trim. By ensuring that the established moulding technical method, shape of the product and condition of the injection process were optimally suited to Ecological Plastic, we attained the same performance capabilities, quality and texture as with previous products.

Conventional covering materials are press shaped after the base material and covering materials are bonded together and heat treated. However, we found that it was difficult to form an Ecological Plastic covering material using this method because of the low fusing point of fibres. Accordingly, we newly developed the post-spreading method in which the covering material is bonded after the base material is heat treated. This enabled the same performance capabilities and texture as conventional materials.

Moreover, because an Ecological Plastic injection agent has low fluidity, we carried out new development starting from the actual structure of the die.

**Ecological Plastic foam material**

We substituted and mixed an element of non-edible castor oil for a portion of the petroleum-based polyol used as a primary material in polyurethane for cushions. We used a technology that denatures castor oil at the molecular level to realise a structure close to that of polyol and achieved the impact resilience and durability required by automobile seats.

We substituted and mixed an element of non-edible castor oil for a portion of the petroleum-based polyol used as a primary material in polyurethane for cushions. We used a technology that denatures castor oil at the molecular level to realise a structure close to that of polyol and achieved the impact resilience and durability required by automobile seats.

**Raising the proportional content of biopolyol results in a decline in elasticity. Accordingly, we performed repeated testing to seek the optimal content ratio for biopolyol for maintaining elasticity and durability required in conventional seat cushions. In mass production, we developed a method that allows production under conditions that are the same as previous conditions, including urethane injection machinery and die forming temperatures. This allowed us to maintain productivity and attain high quality.**

Kenichi Takahashi
Group Manager
Material Engineering Development Division

Yoshiyuki Murata
Project Manager
Interior Parts Production Engineering Division 3

Tsuguyoshi Sakai
Interior Parts Production Engineering Division 3

Castor oil plant seeds

*Ricinus communis (castor oil plant) is in the euphorbiaceae family of plants and its castor seed provides castor oil. This plant is widely cultivated as an oil-plant in tropical and temperate regions around the world.*