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Operatives take a front soat in With many operatives working to as little as a

Operatives take a front seat in MSD risk reduction on Toyota's production lines

Words: NICK WARBURTON

oyota Motor Europe's specialist in health, safety and ergonomics, Stuart Bassford, recognises the pressure car assembly line workers are under if components do not fit smoothly into place.

All the company's plants follow the Toyota Production System, which uses lean manufacturing principles. Fundamental to this system is having a workforce of flexible, skilled and healthy operatives. With many operatives working to as little as a 66-second "takt time" – the time between starting to build one unit and the next – the slightest delay can have repercussions along the line.

"If something doesn't fit properly and it takes you an additional three seconds to fit it, suddenly you are at 69 seconds and behind on the build process," Bassford says.

Where a delay is caused by an ergonomic issue, such as a hard to fit part, there is also a risk that it can lead to employee fatigue.

That's what Bassford, who has worked for the Japanese car maker for 25 years, observed in 2004 when he was a shopfloor safety group leader at the Burnaston plant near Derby.

Then, an increase in reported fatigue cases prompted management to reassess the assembly line



operations, with the aim of minimising the risk of musculoskeletal disorders (MSDs).

After determining that the effort expended in fitting some parts together was an ergonomic problem, Bassford worked with Toyota's engineers and designers to ensure only components that met the company's ergonomic force standards could be accepted.

The potential for MSDs is an ever-present in a fastpaced environment that combines the three points of the "ergonomics triangle": force, frequency (and/or prolonged static posture) and awkward postures.

Senior management recognised that MSD risk could be best mitigated with operative buy-in on workstation adaptation.

Bassford says: "This is where our early symptom investigation comes in because we want the

employees to have faith and confidence to say to their supervisors, 'This really doesn't feel right. I've got a problem with this process or part'."

On Andon

Toyota Motor Europe, which has nine plants in seven countries, operates an Andon (alarm) system, a cord that workers can pull if they see safety, quality or production problems. There is also a process known as "invisible Andon", in which operatives are encouraged to speak up if they have ergonomic or other health concerns.

"When they pull that physical cord, if the vehicle gets to the end of the pitch – the section where their job ends – and if the problem isn't fixed, the production line stops," says Stefan Adamski, who works with Bassford as manager for production engineering in the safety department.

Though Bassford has worked for Toyota's European operation for the past nine years, he is still based at the Midlands plant, which employs around 2,000 operatives on the production lines, with about 40 processes on each line. Having worked his way up from the shopfloor he can empathise with the challenges operatives face.

"They are the experts within their processes and they'll know exactly why something is not going in or fitting correctly or is not to the right force standard," he says. "Without their involvement, we can't collect the data we need and, if we can't collect that, we can't drive change through design," he says.

It is rare now for anyone to stop the line due to a concern about parts fitting easily. But there is a pressure on the supervisor to act if they do.

"If you do not act, the operatives won't tell you again. You've got to provide feedback," he says. "We give constant feedback. We'll explain to them each step, such as 'We can't fix it right now, but we've got the quality/ ergo[nomics] team checking against the standard'. We will also involve the suppliers and they'll work with us to retrofit or tweak the parts to make them good."

Many of the employee-led interventions that are changing the way operatives work across Europe were road-tested at Burnaston and the engine plant in Deeside, north Wales.

Japanese handle

Toyota's ergonomic risk management process is underpinned by the Japanese philosophy of kaizen, which promotes continuous incremental improvements. The Joshi-ten (JT) and Shisei Juryo-ten (SJT) system is an ergonomic burden analysis tool that works with the early symptom investigation procedure.

Introduced into Toyota's European car plants in 1997, JT focuses on upper body postures and how they interact with the production process. The tool covers critical points, such elbow-above-shoulder-height movements, the shape and weight of hand tools, (2.5 kg is the limit for manual tools, which is the trigger for engineered replacements), wrist postures, force of push with thumb and finger, and neck deviation. SJT covers the lower body and movements such as back bend, weight lifted, body twist, and body twist and bend.

The JT/SJT system comprises four scoring elements: arm raise; arm raise and hand postures; back bend and weight; and back bend postures. Each scored element is represented in a green, amber and red traffic light format.

With the employee's consent, line managers and supervisors or "ergo" teams video the task and time the posture movements. Although the system cannot tell the manager whether an operative will develop MSDs, it does enable the manufacturer to identify counter measures and plan work to mitigate ergonomic risk.

"Does putting this bracket on to this vehicle cause this operative to have some back bend?" asks Bassford. "Yes or no and, if yes, for how long? If it's red [based on a table of coefficients], we need to take some immediate action. If it's amber, it's a lower risk and if it's green it is good to go but it's still worth looking at. The main priority for us is to reduce our number of red processes across Europe and that is part of our [long-term] strategy."

One job flagged up as red was fitting assist grips – the handles above a driver's head to help them in and out of the vehicle. Bassford says it is a complex part to insert because it is anchored in the car's roof and has to be pushed into place between a curtain side airbag and the roof liner. Stuart Bassford, plant engineering and senior safety specialist, Toyota Motor Europe



If you do not act, the operatives won't tell you again. You've got to provide feedback



"We've got four of those on each vehicle so, if we have an employee fitting all four, that could give us concern because they've got four repetitions of a force," says Bassford. "What we've done is split them up, so each is fitted by different employees on different processes. That's an example of containment."

Bassford says the ergonomics team would then push for design changes to these parts. Another solution is to introduce counter-measures, redesigning a workstation activity, often with the task operative's input. One example of this is in Toyota's plant in Turkey where workers were instrumental in solving an ergonomic issue in the weld shop (see box on p 48).

Bassford oversees implementation of the company's ergonomics strategy in the nine plants; a key priority is to reduce the processes coded red by the JT/SJT system.

When he took up post in 2009, his first job was to audit each site, taking into account the different production line layouts and processes. The visits led to the formation of a European ergonomics working group, which consists of a designated person from each plant responsible for ergonomics. Along with Bassford, they headline the case for continuous improvement. The group holds monthly videoconferences to share best practice and highlight common issues.

The working group draws on a regional ergonomic database, which collates examples of containment and countermeasures introduced across Europe. When a new vehicle model is developed, the group refers to the database to note any problems that cropped up in the production of similar models.

On the line

Toyota Motor Europe operates six vehicle assembly plants and three unit factories, where engines and transmissions are manufactured and supplied to the

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Counter measures

An example of Toyota's encouragement of its production line operatives to come up with answers to ergonomic problems was in the fender-fit process in the weld shop at its vehicle production plant in Sakarya, Turkey, which builds the C-HR and Corolla models. Production team members had flagged that operatives had to squat uncomfortably 300 mm above floor level to fit a bolt on the fender panel inside the vehicle's wheel arch (see photo above).

Operatives reviewed the process and identified three possible solutions:

- Move the task to a different position on the production line. The difficulty was
 that the task would still involve another operative squatting, so there was no
 benefit in doing this.
- Install a fixed-position, low-level seat. Although this would be low cost, it did
 introduce the potential for extra ergonomic risk factors operatives would
 have to raise and lower themselves from and to the seat.
- Install a powered lift/lower seat. Although this would add costs to build and maintain, Toyota's JT/SJT assessment score showed that the automated lift seat would reduce possible MSD risks.

Toyota's engineering (kaizen) team reviewed the request, developed drawings and consulted with the production team before building the powered seat in house (see photo below). Toyota Motor Europe plans to design out and eliminate the bolt-fitting task on all its production lines for future models.



assembly lines where most of the manual work takes place. The plants have near-identical set-ups, with slight variations according to the models they build. Inside each plant there are also subsidiary activities: press, welds, paint, plastics and assembly shops as well as a logistics area.

As Bassford explains, the vehicle plants follow the same production sequence: trim line, engine line and chassis line(s). Every vehicle model must be built in the same order.

His audit showed that, though some plants had fully embraced the JT/SJT system, others were relying on local initiatives to manage MSD risk. Toyota Motor Europe wanted the burden analysis tool to be adopted as the standard to ensure consistency in the scoring and to provide comparable data.

In 2011, Bassford ran week-long training courses for plants that were unfamiliar with the JT/SJT system. He analysed the workstation data with the local ergo teams and explained the scoring.

"Then I'd ask them to video a process, come back and score it. I'd then assess it separately. We'd run through that until I was comfortable with the skill set and was satisfied they understood it in detail."

Bassford still audits the European plants yearly to check they are using the tool correctly. In the UK, a bespoke training course was developed and aimed at supervisors, who would then cascade the key learning points to the production floor.

The UK management team felt it was important that the training had external verification so approached the HSE's Health and Safety Laboratory to develop a one-day course, first delivered in 2012. The course continues to run and around 500 supervisors have attended. The learning points have also been transmitted to their European counterparts.

Motion capture

The JT/SJT tool is most effective at rating posture changes for repetitive, short-cycle work but not so useful for activities that last more than five minutes. The logistics area is a case in point.

Adamski says: "You'd have an employee driving a tow-train. He's got a vehicle he stands on and he's towing carts behind him with boxes on. He'll stop at the production line, deliver them and move on.

"In order to assess that, traditionally you've got to have someone following him around the shop floor with a camera filming the process. Then, for each box, you've got to know what height he is lifting from and what the distance is away from the body. You also need to know how heavy it is and the height and distance he's going to."

In 2013, Toyota worked with wearable technology firm dorsaVi to assess the logistics process using sensors to measure employee muscle movements. The technology helped to highlight points of concern and to support those coaching operatives in the correct manual handling techniques.

More recently, motion capture sensor technology developed by Netherlands-based XSENS has been integrated with JT/SJT scores to improve the accuracy of Toyota's ergonomic assessment.

"XSENS uses motion capture sensors to digitise and analyse human movements. What their sensors create as you put in the person's body measurements is an avatar," Adamski says.



"Because we were looking at movement in our JT/ SJT system, the two items married together.

"We've built a software to link them. That gives us an accurate understanding of an employee's posture within the process. It's critical for us to get that accuracy. The system will tell you 'This employee is bending past 30 degrees,', whereas when we video the process with the JT/SJT system sometimes it can be difficult to make that judgment because of the way the vehicle is positioned and what the posture is."

The technology has been trialled in the UK and Turkey. The data it provided has allowed Bassford to work with Toyota's designers to make further production line tweaks.

Another advance has been the application of Zero G technology, commonly used in film-making and the sports industry. Football fans may have noticed the cameraman running down the side of the pitch filming with a spring balanced arm strapped to them. The arm supports the camera and reduces camera weight and vibration.

"We use a similar technology, but it's fixed to part of the production line and just takes the weight of the tool the operatives are using," says Adamski.

"One thing we can't avoid without significant investment is working under the vehicles. You will see other vehicle manufacturers who will turn the vehicle on its side, so the operatives are working next to it but, even then, you will have quite a big range of work areas from the bottom to the top."

By deploying the Zero G tool arms, Toyota has reduced the burden of underside work.

So why doesn't Toyota use more robots to minimise MSD risk? Bassford says access to the car interiors is tricky. "It would take a robot a long time to do it and increasing automation also makes it more complicated to manage the change."

But Toyota has introduced some collaborative robots to help operatives carry out tasks such as applying adhesives to components.

Morning stretch

Production operatives warm up and stretch before their shifts to minimise the risk of fatigue. A physiotherapist will assess each line to ensure the operatives are performing the correct exercises for their activity.

"The line starts at 7.30am prompt each morning and the operatives need to be warmed-up and ready to go, just as a professional athlete would be before competing," says Bassford.

In many of Toyota's plants, the company provides small baths of hot, melted wax to aid preparation. "The workers put in their hands and it warms all the tiny muscles," he says.

To support the lean manufacturing system, all operatives are trained to rotate through several processes – up to five – each shift. When planning the day's rotation pattern, each supervisor not only takes into account absences, but also employees with injuries caused outside work. Occupational health staff tailor advice.

"If someone has a shoulder injury, they may say, 'No work above shoulder height' and we can move [the worker] to another process," Bassford says.

"We don't have one employee, one process, so if we have an employee who can't do a process for some reason others will pick it up, temporarily reducing their rotation and keeping the line running."

The Burnaston plant has the oldest average age in the European plants' workforce. It's a stable population; many operatives in their 40s or 50s have worked for Toyota from their late teens. However, Bassford says that, even with an ageing workforce, production times cannot be adapted. Everyone must achieve the same takt time on a process regardless of age, reinforcing the importance of good ergonomics.

"We have discussed this with other motor industries and we all recognise that this work actually keeps people fit," he says. "It's a physical job, not overdemanding, and employees are burning a lot of calories every day."

As an integral part of Toyota's long-term strategy across Europe, ergonomic activities have now become an everyday part of the business, he says.

"The resources we invest in new technology are primarily to improve our operatives' long-term health and wellbeing. They are our number-one asset, they contribute great ideas, and are invaluable in helping us to further improve the business, with the benefit to all being improved health, wellbeing and productivity."

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