Siemens's Main Locomotive-Building Factory Invests In New Technology

The ramping-up of Vectron production, based on a cyclical manufacturing procedure, a stronger orientation towards service-related business and digitalisation of locomotive fleet management keeps the competitive edge alive for Siemens. A recent visit to the München-Allach factory revealed the changes for the future which are being implemented throughout this historic complex.

In recent years the München-Allach factory has been following the Toyota production principles, which were introduced in Germany in the early 1980s by Univ.-Prof. Dr. Dr. h. c. mult. Horst Wildemann. At Passau University and TU München he attracted hundreds of participants to learn about his **„new production way"** message for the automotive industry. Over the years the „seeds from Japan" were sown all over the world. Industrial activities, including for instance Boeing's successful B737 airliner, are built nowadays on moving production lines. At the other end of the size scale there are domestic appliances, whose manufacturers would be unable to exist today had they not adopted state-of-the-art „lean manufacturing" production techniques.

At present the Vectron production at München-Allach is based on a **five-day cycle** - all items and modules of each locomotive move week by week from manufacturing to painting, pre-assembly, final assembly, testing and commissioning. In other words, each assembly station builds its components or assemblies in five days as an integrated part of the timescale for the whole locomotive.

Since the Vectron family has been developed as a modular system of components, the configuration of different AC, DC, MS or diesel types can be realised jointly in what is known as a **one-piece flow**. This enables production to take place as if it were for a batch of identical machines, but each locomotive can nevertheless be individually customised.

There are specified locations where suppliers' **components** are positioned, ready to be moved into their appropriate position. These components include converters and traction transformers (both supplied by the Siemens factory in Nürnberg), bogies (from Siemens's Graz Competence Centre), and components supplied by other manufacturers. Once these components have been mounted, the evolving locomotive is moved to its next assembly point for a further five days' work.

A view of the final assembly hall at München-Allach on 6 May 2016. This shows the standardised production procedure used for Vectron locomotives which have many components and sub-assemblies in common. Some of the machines in this row are ČD Cargo's future Class 383 Vectrons.

Let us now examine in more detail three flows which form part of what is known as the Siemens Production System (**SPS**). These flows focus on the bodyshell, the driver's cab modules, and the final assembly procedures. Steel bodyshell production is one of the core specialities at München-Allach works. Here robotic welding systems are also used in the steel production shop. It is worth mentioning that unlike other producers (such as Bombardier) Siemens was not and is not planning to move bodyshell construction from Germany to a different country. The cost savings are being sought by enhancing the work productivity instead of searching for lower labour costs in countries further east.

A separate production flow is dedicated to **bodyshell construction**. To shorten lead times between the receipt of orders and delivery, the complete bodyshell are built in advance and comes from the stockpile. Once an order from a client is received, the work starts not with construction of the bodyshell, but with the final assembly.

The front frame of each **cab** is entirely of a steel construction, and comprises a number of steel components which are welded together to create the final shape required. Once the cab module has been painted the windows are glued into position. Then all the electrical equipment, including the displays, is installed. These stages take place on the balcony floor of the assembly hall. Finally all the components within the cab module are tested to ensure that they function correctly, before the module is sent to the final assembly hall shop floor. Here the cab modules are stored until they are required for fit-

The main frame of another Vectron is born. This is the steel workshop, where welding and assembly of main frames take place.

Here the bodyshells are being welded in a different work station, before being moved to the bodyshell stockpile.

ting on each end of the bodyshells when the latter arrive at the appropriate work stations.

The **final assembly** hall is equipped with 13 work stations, each used for different purposes. Some bays form part of the ordinary five-day cyclical procedures, where each Vectron is assembled on a moving production line: one work station, for example, is used for laying wiring along the floor inside the locomotive, another is where the power converter is installed. At the end of this cyclical procedure the completed Vectron is moved to a test room where the power is switched on for the very first time. All the electrical equipment is activated, and its quality, when all systems are functioning together, is evaluated. Then follows commissioning.

Other bays in the final assembly hall are used for **static assembly**. These are necessary in the case of Vectrons which are not quite of the standardised design, a good example being VR's 1,524 mm gauge Vectrons. These have the Last Mile system (which is an optional extra and thus not a standard feature of electric Vectrons), a different roof configuration (with the ventilation system and louvres designed to prevent the ingress of snow during the severe winter conditions experienced in Finland), the SA3 couplings, additional handrails, side window mirrors, and suchlike. Such features would disrupt the five-day cycle if the locomotives were incorporated in the ordinary production line.

There are occasions when things do not run as smoothly as desired. Some locomotives, in spite of all efforts to avoid problems, are **trouble-makers**, and it often takes longer than five days to rectify the „bugs" in the system. The locomotive thus has to be moved to an out-of-sequence location for specialist attention. Once the problem has been rectified, the locomotive is returned to an empty slot in the production line.

This is VR's future 103 305 in the final assembly hall, but not participating in the five-day cycle moving production line on account of the large number of non-standard features incorporated in the Finnish Vectron design. Unlike 1,435 mm gauge Vectrons, the bogies of the Class Sr3 locomotives are fitted with wheelsets only at the Allach works. Following completion of final assembly the Sr3s are mounted on „loco buggies" (see R 2/15, p. 59) and moved by rail and sea to Finland.

Photo: Jürg D. Lüthard

A complete 1,524 mm gauge wheelset for a Finnish Vectron sitting on the 1,435 mm gauge auxiliary „bogie" used for transport purposes within the works (the wheels and axles have been manufactured by GHH-BONATRANS; majority of wheelsets for Vectrons are built from parts coming from its Czech plant located in Bohumín).

During the five-day cycle the cab modules are born in the steel welding shop and are finally moved to the assembly hall for mounting on the new Vectron bodyshells.

Here a traction converter is being installed in a Vectron in one of the moving work stations on the production line. The locomotives are not moved sideways through this hall on traversers. Instead they leave the hall through the doors in the background, change tracks outside, and return to the hall through the next door. This system ensures that the five-day cycle is achieved without interruptions.

This is PKP Cargo's EU46-512 undergoing its first electrical test, with power on to activate all on-board systems, as part of commissioning, which requires that all the systems have to be approved.

tion line and continues within the final assembly stage.

With the market demand rising, Siemens is now planning to **double annual Vectron output** over the next few years, according to Bodo Kalpen, head of corporate communication at München-Allach. Various strategies are being considered to achieve this:

- one involves doubling the amount of space available at München-Allach. This would mean massive investment, but it is not feasible, since there is insufficient space available for expansion of the factory complex.
- another possibility would be to double the number of shifts on duty. This would enable the completion of work at each work station to be completed in two and a half days instead of five.
- a third option is to halve the amount of time spent at each production and assembly station. This could be done through improved organisation, more streamlined handling of materials, or by increasing the amount of the „plug and play" assembly method, this involving a greater use of pre-assembled sub-components.

To date Siemens has not taken any decision on which strategy to adopt. However the growing market success of the Vectron family is going to place an ever greater demand on stepping up production rates.

Digitalisation is a major element in Siemens's business strategies, the target being to ensure 100 % rolling stock availability for clients' scheduled services. The company's **Data Services Centre** is situated at München-Allach, and has collected huge amounts of data from Siemens-built vehicle fleets worldwide. These will be assessed in the future, and are currently being handled by a team of around 30 data analysts, who use algorithms to identify patterns and trends and are thus able to anticipate potential malfunctions and damage before these even occur. This international team includes people with highly professional skills in data science, Big Data technology, platform architecture, mobility domain expertise and project implementation management.

The result is a new era of quality in predictive maintenance for clients. One of the latter is Renfe, involving the latter's fleet of 26 Class 103 Velaro E high speed trains, used mainly on Madrid - Barcelona and Madrid - Málaga high speed services. A Renfe/Siemens joint venture, **Nertus**, provides a high quality servicing programme for these trains, ensuring high fleet availability. Siemens managers reckon that a standard fleet availability of 85 % can be increased to a high grade one of roughly 95 % through the use of remote data analytics services.

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Photos, unless cited, by author, taken on 2 May 2016

Every locomotive or rail vehicle sends over 1 billion pieces of data per annum to Siemens's Data Services Centre in München. High operational availability is essential to ensure that trains run to schedule and to minimise the risk of cancellations. ***This representative photo of a Vectron driving console, showing the various displays, was taken on board BLS Cargo's Re 475 401 (see R 2/16, p. 14), recently delivered to the depot in Spiez*** (however, in the upper left-hand panel is the display of the Italian SCMT ATP).

Photo: Michael Raucheisen

The first ČD Cargo Vectron, 383.001, was moved from München to the Czech Republic on 27 May 2016, hauled by RailAdventure's 103 222.

Photo: Jiří Štembírek

The only Finnish Vectron fitted with 1,435 mm gauge bogies was 103 301, which was used for various tests in central Europe. Following tests at the VUZ test centre Velim (see R 1/16, p. 47) it was ***moved on 3 April 2016 from the Czech Republic to the RTA climatic test centre in Wien. This photo shows it en route to there at ČeskáTřebová, hauled by CZ LOKO's 709.401,*** which was used as far as Břeclav on the Czech/Austrian border. From Wien 103 301 was moved on 13 May 2016 back „home" to München-Allach (hauled by RailAdventure's 103 222). Its delivery to Finland was scheduled for mid-July 2016.

Siemen's **Rail Service Centre** opened to clients in October 2015 (see R 6/15, p. 18). The Rail Service Centre has a 2,000 m² under cover servicing hall with space where two locomotives can simultaneously be subjected to preventive and corrective maintenance. Subsequently an overhaul facility for bogies, wheels and axles will become available. This development is the first time that Siemens has combined locomotive production and maintenance at a single location.

The first „outside" locomotive to visit the München Rail Service Centre in München, apart from a number of Vectrons recently built at Allach, was MRCE's ES64F4-451. This machine dates from 2009 and since then has been hired to a number of Polish railfreight operators. Here we see it being subjected to its R1 examination.