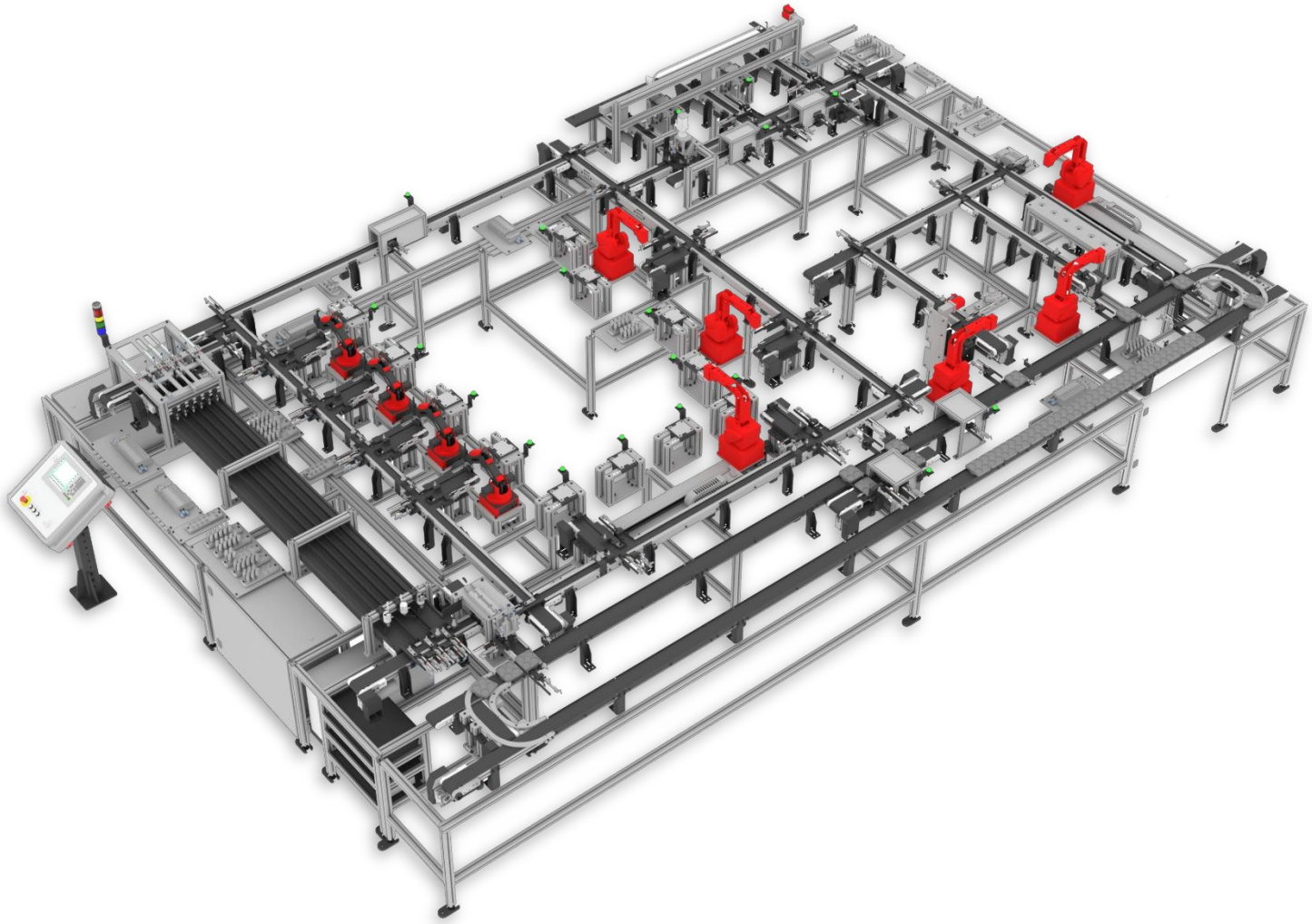
TEMEX

VŠB TECHNICKÁ UNIVERZITA OSTRAVA



SMARTLINE 4.0 - A COMPREHENSIVE PRODUCTION LINE MODEL FOR LEARNING LOGISTICS AND LEAN MANUFACTURING IN THE ERA OF INDUSTRY 4.0

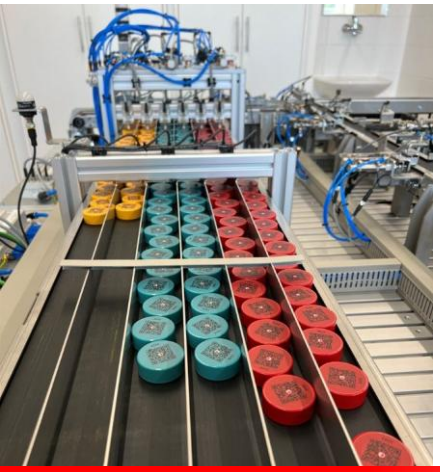
This **learning model of a production line** is an advanced tool that effectively supports the adoption of lean manufacturing and logistics principles in an Industry 4.0 environment. The model is based on a physical line that is connected to a virtual warehouse and an MES system for production planning and control. There is also an economic system to evaluate the selected technologies and production processes. The individual systems are connected via SQL server to form comprehensive production learning system. In addition to the physical line, students can work with a digital twin, which allows them to simulate real production processes and to analyse and optimise procedures. This will give them the deeper knowledge and skills needed to apply lean manufacturing principles and better understand the differences between real and virtual lines and their importance in production planning.

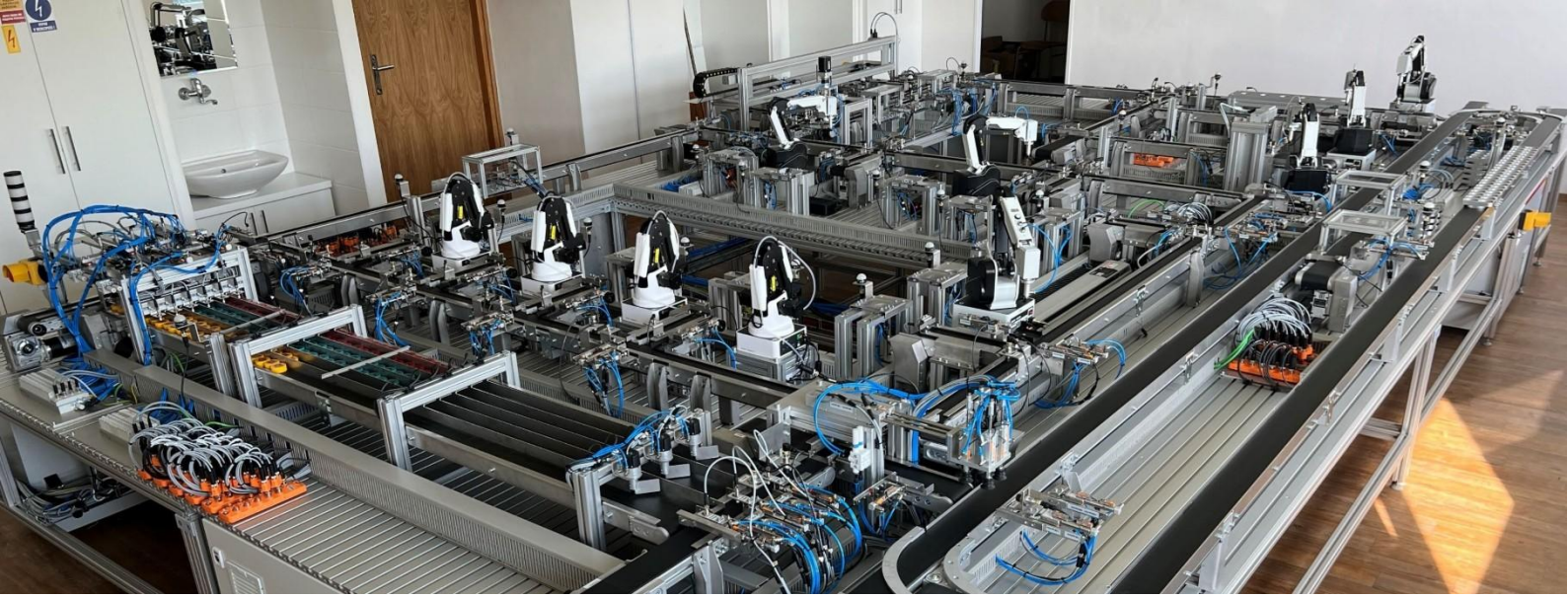
How the line works.

At the beginning, students are introduced to the market requirements, e. the quantity of products need to be delivered to the market at the required price. On the basis of this information, they choose the technological process and select the appropriate machines for each robotic workstation with to price. They also have options such as quality control systems, frequency of service or machine versatility. They have to carefully calculate everything in terms of technical possibilities, cycle time, cost and return on investment. After this analysis, students can purchase machines, plan production orders and start the actual production.

The entire line operates in accordance with Industry 4.0 principles and is capable of personalized production. On the basis of scheduled work orders, material is automatically fed into the production process in the form of coloured pucks , like the finished products, carry RFID chips. The pucks move along a conveyor belt where their codes are read by RFID readers before each production operation. A higher-level system, supported by an SQL database, then decides whether or not the material will be at a particular location based on the production process. All the information about the manufacturing processes performed is stored in the SQL database and students can verify it online at any time using QR codes on their phones. On the assembly line, pucks are assembled according to production orders into the final product, which then transported to the virtual warehouse. Students can freely adapt the layout of the virtual warehouse to their needs and try out different storage and logistics technologies (e.g. conveyor systems, shelf stackers or autonomous robots).

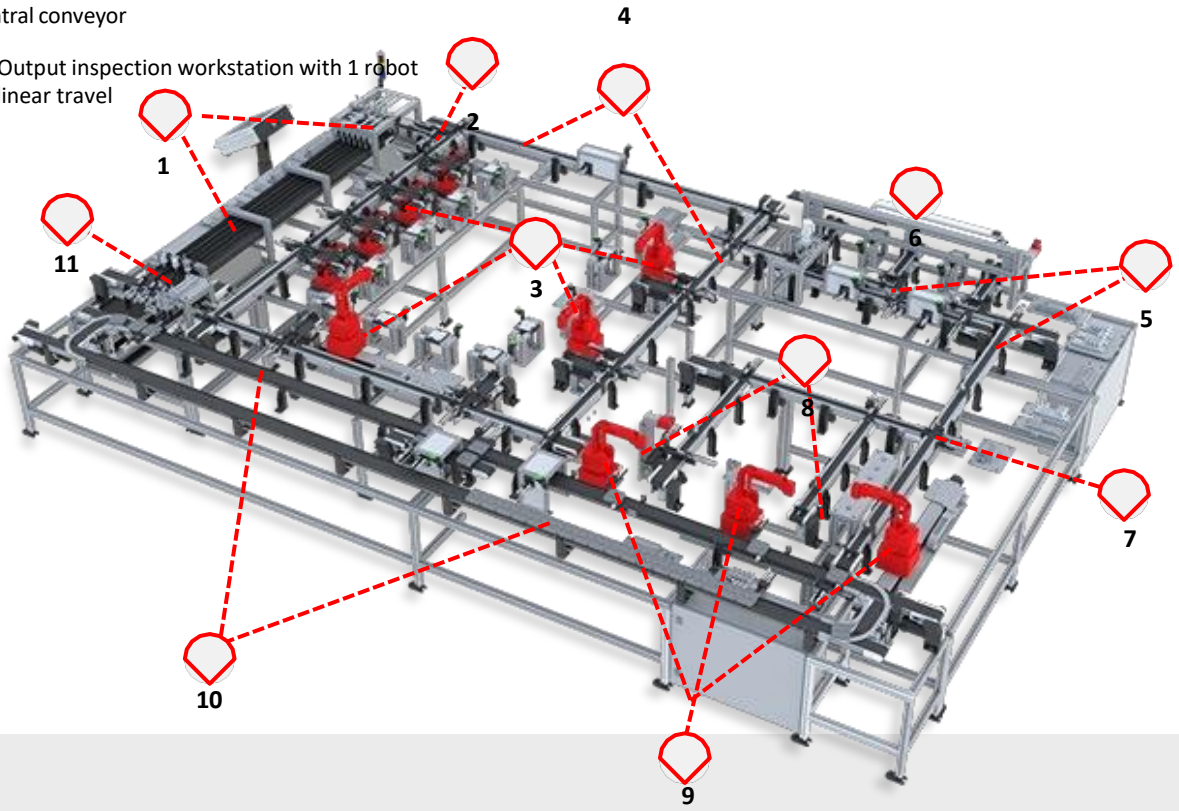
Once production is complete, students will receive an economic analysis to show the efficiency of their production and the return on investment.





The line consists of the following parts:

1. Conveyor warehouse of input material
2. Automated dispensing of input material
3. 3 x manufacturing centres, where students have 7 robots and 12 machines at their disposal
4. Production conveyor circuit connecting individual work operation centres
5. Central conveyor
6. 2 x Output inspection workstation with 1 robot on linear travel
7. Redistribution junction
8. 2 x LIFO trays and 1 x FIFO tray for production
9. 3 x robotic picking stations for palletising products
10. Circular conveyor for pallets
11. Depalletizing warehouse



Technical data:

The line has **dimensions of 6,220 x 3,922 mm** and consists of four conveyor circuits. The line is operated by **10 robots**. The line is controlled by **Siemens PLC**. The software for operating the teaching line consists of two parts: **client software and server software with SQL database**. The line itself can retrieve data and instructions directly from the server part of the system. Sufficient and reliable connectivity is ensured between the individual elements. The client software runs on an office computer in the form of a web application. The operation of the digital twin is handled by **Visual Components software**.