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Development of an Immersive, Digital Twin-Supported Smart Reconfigurable Educational Platform for Manufacturing Training: A Proof of Concept

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Abstract: The challenge of providing students with practical, hands-on experience in realistic industrial environments is increasingly prevalent in modern technical education. The concept of a Learning Factory addresses this issue by facilitating skill acquisition through immersive, practice-oriented training that integrates advanced digital technologies. An innovative educational platform has been developed, incorporating Internet of Things (IoT) devices, Cyber-Physical Systems (CPS), and Digital Twin (DT) technology to enhance manufacturing education. This platform combines modular hardware and software, enabling immersive visualisation and real-time monitoring through DT-supported systems. These features offer a comprehensive, interactive learning experience that closely simulates real-world manufacturing processes. The system's smart reconfigurability further enhances its educational potential by enabling customisable training scenarios tailored to specific learning outcomes. The proposed approach aligns with the principles of Industry 4.0 and serves as a catalyst for the improvement of both educational and professional training environments. By leveraging digitalisation, this platform not only supports adaptive learning but also enhances the efficiency of educational models. Through the simulation of dynamic manufacturing systems, students are exposed to a variety of industrial scenarios, fostering deeper understanding and skill development. The integration of IoT, CPS, and DT technologies is expected to provide a scalable framework for future educational environments, ultimately improving the adaptability and effectiveness of manufacturing training.

Keywords: Learning Factory; Digital Twin (DT); Internet of Things (IoT); Cyber-Physical Systems (CPS); Industry 4.0; Educational platforms; Smart reconfigurability; Manufacturing education

1 Introduction

Engineering education is deeply linked to global economic and social development [1, 2]. Industry trends include the integration of scientific concepts into real industrial environments. The learning-by-doing approach is much more effective than the traditional approach regarding skills learning and development [3, 4]. Enterprises need to constantly adopt the latest technologies and improve their systems and employees to adapt to the changing market environment and maintain their competitive advantage. Preparing for more complex tasks requiring higher levels of knowledge and skills takes up a lot of time and resources in a company, so outsourcing of training is becoming more and more common, towards training centers and universities with special knowledge and equipment [5]. In this context, using case studies and business games to apply theoretical knowledge in practical situations is becoming more common [6]. With the development of virtual reality and digital technology, the effectiveness of immersive systems has increased compared to the traditional approach [7]. Applying the Learning Factory concept is now gaining ground in education, training, research, and general competence development [8, 9]. This paper aims to evaluate the developed equipment according to the information basis, following the authors' previous research [10]. The other aim of the article is to explore the applicability of an entirely new concept in practical education through research development methods. The new concept is the application of minimal mechanical equipment from the hardware point of view, complemented by a high level of immersive visualization. Therefore, the authors of the current paper are looking for answers to the question of whether replacing mechanical processes with digital processes and using continuous techniques can increase the effectiveness of practice-oriented training.

2 Literature Review

The related work and background will be explored, presenting the work published and implemented by academia, case studies, and equipment available on the market by industry relevant to the Learning Factory concept. All this is grounded in digitization, and with the rise of digitalization and the growth of CPS, there is a growing emphasis on the role of the DT, first described in terminology by Grieves [11], Monek and Fischer [12]. According to Liu et al. [13], the uses of DT clearly support the operation of the physical system. Based on their research, they have classified them into concept, technology, paradigm and framework, and application themes, of which the amount of application-based ones exceeds the total of the other categories, thus creating a relevant link to DT for the Learning Factory concept.

2.1 Academic Overview

Zhang and Tang [14] have created a well-configurable learning and assessment system for teaching PLC (Programmable Logic Controller) to students to learn practical skills and engineering skills through interactive learning. This framework has received good methodological feedback from both students and trainers. Al-Geddawy [15] demonstrates the application and technologies of the Learning Factory in a real industrial environment. Many vendors deliver such solutions with some digital features, but they provide little flexibility to change the architecture or technology, limiting the maximum transfer of hands-on experience. To dissolve this, he has developed a low-budget, open-source system where he presents a digital system that accurately reflects the physical system layout and material flow, with a flexible structure that allows for future expansion. In their study, Ruppert et al. [16] propose an educational framework and laboratory based on the Learning Factory concept to help prepare students for developing Industry 5.0 technologies. The concept of smart space acts as an integrative framework, using real-time data in manufacturing processes. With a focus on education based on IoT devices, internal positioning systems, and targeted sensor development, the proposed framework focuses on the basics of digital manufacturing, enabling students to develop agile solutions. According to Schuh et al. [17], learning factories aim to provide practical training in production engineering while also providing opportunities for external participants through courses, seminars, and workshops. Using the Aachen Demonstration Factory as an example, it shows how it integrates educational and industrial functions in a hybrid manufacturing environment. Achievements include demonstrating educational cases along the manufacturing value chain and quickly adapting to manufacturing processes, allowing the development and introduction of innovations into production. According to Enke et al. [18], the primary objective of the subject area is to effectively develop the competencies of participants to manage complex situations. A systematic, competency-oriented design approach is important, integrating three levels: Macro level: general infrastructure design and competency definition. Meso level: configuration of learning modules and design of activities. Micro level: structuring concrete learning-teaching situations. This framework increases competence development and enables measurable effectiveness through observable activities and knowledge assessments. The approach aims to improve the design and impact of learning factories while ensuring they meet industry requirements. Matt et al. [6] at the Faculty of Science and Technology of the Free University of Bozen-Bolzano established a mini-factory for apprenticeship training, aiming to provide a more practice-oriented engineering education. The article presents the mini-factory concept, insights, and results of its implementation. It also highlights the cooperation between the university and enterprises, which allows small and medium-sized enterprises (SMEs) to train their staff within the mini-workshop infrastructure. According to Prinz et al. [19], Industry 4.0 is becoming more important, yet many companies are struggling to prepare their employees to make effective use of the available technologies. Learning factories are critical to bridging the gap by providing practical workplace training that allows participants to apply their skills directly. Various learning modules have been developed to facilitate an understanding of Industry 4.0, and plans include expanding workshops based on the organization's latest research. These workshops will cover different maturity levels of Industry 4.0, helping participants understand the topic holistically. Rasovska et al. [20] show how the University of Strasbourg has created the FleXtory Learning Factory to meet the challenge of developing new skills for enterprises related to Industry 4.0. FleXtory combines three main elements: real factory, virtual factory, and DT. This article presents the FleXtory architecture model, which is based on an interactive loop between the real and virtual worlds. The goal is to develop an intelligent tool that offers a customized, personalized, and updated learning pattern in the Learning Factory. The framework developed by Coskun et al. [21] effectively adapts engineering education to Industry 4.0 through a reworked curriculum, practice labs such as the Visual Production Lab and Lego-Lab, and practical projects. Using Kolb's learning theory, it emphasizes learning through experience, which increases student engagement and prepares them for real-world challenges. Preliminary results from the Turkish German University (Istanbul) show that this approach is feasible and beneficial for modern engineering education. Salah et al. [22] present a learning methodology designed to improve the engineering degree level in people's understanding of Industry 4.0. The study emphasizes that Industry 4.0 requires skilled human resources for the effective management and maintenance of smart factories, not only for automation. It acts as a case study for integrating Industry 4.0 concepts into engineering education and plans to collect industry feedback to further develop the curriculum. According to Barac et al. [23], educational mentoring and e-learning platforms are effective in facilitating personalized learning experiences and the development of practical skills by integrating Novel Educational Methodology (NEM) into an e-learning framework and providing an organized mentoring environment. In their article, Mabkhot et al. [24] explore trends in manufacturing, focusing on the concept of Industry 4.0 and smart factory systems. It identifies a gap in the literature and notes that while many works discuss the general vision of Industry 4.0, few focus specifically on smart factories and their required components. While control systems and communication are mentioned, there is a lack of practical applications and attention to the technical capabilities needed for smart factories. The paper concludes with key insights and suggestions for future research to overcome these gaps and facilitate the implementation of smart factory systems.

This clearly shows that the issue is relevant and that training the next generation of workers is a priority for the industry. However, there are still many challenges in digital skills and technology education, which academia does not always agree on.

2.2 State of the Art on the Learning Factory Equipment

In implementing the Learning Factory concept in practice, in addition to the options identified in the literature and case studies, there is equipment available on the market and for sale to increase the effectiveness of practical training. This equipment is typically supplied by market leaders in the automation segment (Festo, Siemens, Bosch Rexroth). Without being exhaustive, some of the equipment is presented and compared below.

1. Equipment: FESTO MPS 403-1. The learning system is designed to train basic skills and competencies in automation technology and mechatronics. As a miniaturized production line, it provides deep insights into the intelligent networking of machines in production environments and workflows. The system consists of three stations: Distribute Pro, Join, and Sort Inline. These stations are networked, equipped with multiple RFID (Radio Frequency IDentification) read/write heads and IO-Link-based smart sensors, and form an autonomous system [25].
2. Equipment: FESTO MPS 404-1. The system represents a small production line consisting of four stations: Distributing Pro, Joining, Measuring Pro, and Sorting Inline. The complete system is networked and extended with several RFID read/write heads [26].
3. Equipment: FESTO Compact Trainer I4.0. The MPS transfer system is the basis for the MPS TS Compact Trainer I4.0. A CPS is set up with the currently available automation components. A modern S7-1500 industrial controller is at the core of this autonomous and highly communicative unit. The PLC is programmed via the Totally Integrated Automation (TIA) portal. The KTP400 display and control unit is a user interface for intuitive operation and to guide the operator. Data is exchanged with the machine via an RFID reader/writer system that communicates with the controller via an IO-Link interface. The PLC has an integrated web server for fast process diagnostics using standard IT technologies [27].
4. Equipment: FESTO CP Lab Linear. The conveyor belt is the main component of the CP Lab and is used to transport the workpiece carriers to the next working position. Workpieces are identified by capacitive sensors at the front and end of the belt. Each carrier has an RFID tag on which the workpiece parameters are stored. The RFID read/write system exchanges data with the workpiece, communicating with the main controller via an IO-link interface [28].
5. Equipment: Bosch Rexroth mMS 4.0. The training system is a mechanical and electrical system with pneumatic and/or hydraulic systems. It can be used exclusively for the transfer of knowledge and expertise in the field of high-level programming language and control engineering education at a higher technical education level. Only the tools and toolkits for the mMS 4.0 training system are used to build complete assemblies. Operation is permitted only under the specified site conditions. The mMS 4.0 training system is intended for professional use only, not for private use [29].
6. Equipment: Siemens training case. It is not a commercial product but a tool for use in Siemens courses. Participants will develop their skills in commissioning, debugging, and maintaining an automation system with Human Machine Interface (HMI), PLC, drive, and communication network. Students will learn to navigate STEP7, use the built-in diagnostic tools, and perform basic program modifications. The course format is a combination of classroom instruction and practical training. A realistic conveyor model is used for demonstrations and participant training [30].

To compare the equipment, the relevant hardware features and functions have been defined, and the compliance with the criteria has been summarized and evaluated in Table 1.

Table 1. Comparison by hardware properties and functions

Properties /Equipment	FESTO MPS 403-1	FESTO MPS 404-1	FESTO Compact Trainer I4.0	FESTO CP Lab Linear	Bosch Rexroth mMS4.0	Siemens Training Case
Dimension	large	large	compact	compact	large	compact
Mobility	partly	partly	yes	yes	partly	yes
Infrastructure	pneumatic electricity	pneumatic electricity	pneumatic electricity	pneumatic electricity	pneumatic electricity	no
Flexible configuration	no	no	no	yes	no	yes
Educational suitability	partly	partly	yes	yes	partly	yes
Process monitoring	yes	yes	no	no	yes	no
Modular	yes	yes	no	yes	yes	no
Smart product	no	no	no	no	no	no

For implementing practice-oriented education and the Learning Factory concept, it is essential to compare the educational suitability (Table 2), which was done according to the educational topics relevant to the automation segment.

Table 2. Comparison by education subject areas

Topic /Equipment	FESTO MPS 403-1	FESTO MPS 404-1	FESTO Compact Trainer I4.0	FESTO CP Lab Linear	Bosch Rexroth mMS4.0	Siemens Training Case
PLC programming	yes	yes	yes	yes	yes	yes
HMI programming	yes	yes	yes	yes	yes	yes
Industrial communication	yes	yes	yes	yes	yes	yes
Wireless communication	no	no	no	no	no	no
Microcontroller programming	no	no	no	no	no	no
Robot programming	no	no	no	no	optional	no
RFID	yes	yes	yes	yes	yes	no
System diagnostic	yes	yes	no	no	yes	no

The state of the art in the field of automation education is that there is no equipment with full complexity in terms of both hardware and educational capability, based on the comparison criteria. The educational devices available for sale in the portfolios of the three major manufacturers can only provide a subset of the functionality, and full functionality is not available in any one device. A total of 5-10 square meters of floor space and a combination of several laboratory devices are required to achieve full functionality.

3 Development Objectives

The state of the art has generated the need to develop a smart manufacturing education platform that covers both existing and missing areas and can help to deliver practical education in a complex way. The main goal is to develop a tool that can transfer practical skills in a way that fits into the Learning Factory concept. The expected attributes that guide the development:

- A practical approach to education,
- Adaptation to the Learning Factory concept,
- Focus on the limitations of existing educational tools while retaining the strengths,
- Fulfilling the educational tool requirements of DT and virtual commissioning,
- Using immersive techniques.

Following these development trends is also in line with global industry trends, including integrating scientific concepts into real industrial environments. This can be fully achieved by developing a cyber-physics education and demonstration platform. The preliminary requirements for the platform, which provide a high level of complexity and modularity, but at the same time, a unique tool not available on the market:

- Using advanced industrial hardware components and software,
- Compact size, mobile equipment,
- Purely electrical, free of moving parts, safe,
- Modular physical processes,
- Collaborative robot application,
- Responsive device, smart product,
- Industrial communication (OPC UA, 5G),
- Real-time connection of components (PLC, HMI, RFID, Robot, PC, Smart Product),
- DT and Virtual Extension,
- Online workpiece tracking,
- Physical and Virtual Toolkit.

Currently, there is no existing smart educational equipment on the market with a compact size and a modular toolkit of components to meet these requirements. This platform will provide the opportunity to adopt an Industry 4.0 systems approach, including the transfer of practical knowledge on automation, robotization, industrial digitalization, and cyber-physical manufacturing systems.

4 Results and Discussion

Based on the objectives and requirements set, the development result is a mobile, portable, desktop-sized, purely electrical platform consisting of the latest industry standard hardware and software components. The platform is suitable for education, demonstration, and research. Within the section, the configuration of the platform, a use case, and the method and experience of their implementation are presented.

4.1 Smart Manufacturing Educational Platform

The platform desktop is designed in such a way that it has the control infrastructure (Figure 1) to provide the full functionality. This is how the PLC control, the HMI touchscreen control panel, the RFID identification system, the 5G router, and a monitor and PC with the necessary peripherals have been designed. The work area of the desk is where the modularized process from the hardware component kits has been set up, currently consisting of a workpiece dispenser, conveyors, and a UR3e collaborative robot.

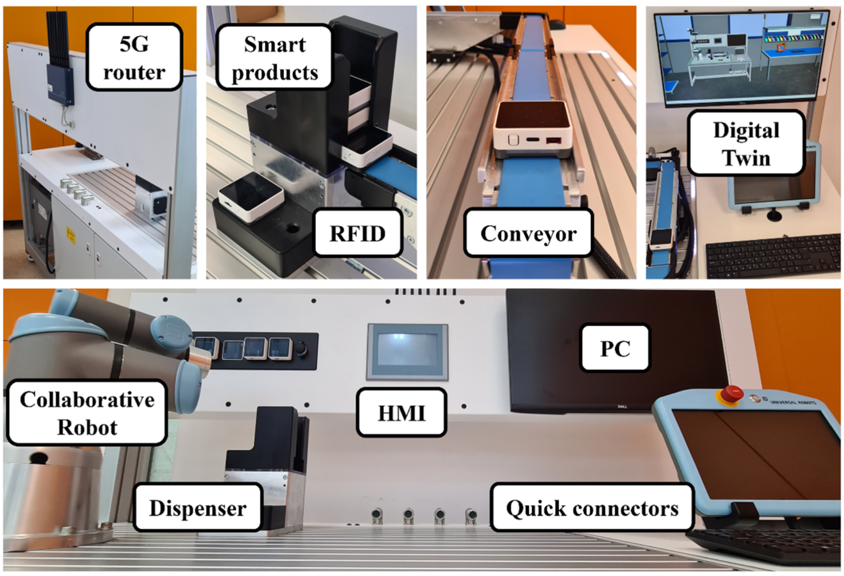

Figure 1. Main functional components

The product that moves on the hardware elements is an M5Stack Core2 microcontroller with a touchscreen display and gyroscope. All products have been retrofitted with RFID. The cabling and wiring of the hardware elements on the desktop are designed with a single universal connector mount for modularity and easy installation. The identification of the products is provided by the RFID reader built into the dispenser. The PC is connected in real-time to the PLC, and communication is provided by OPC UA, one of the most modern and popular industry standards in use today. The simulation software environment running on the PC has virtual models of the hardware elements, thus providing a virtual toolkit of elements, which allows easy creation of different process layouts and drag & drop type modeling. In addition to process representation, a virtual extension of a factory, plant, or production cell can also be implemented. During the operation of the platform, processes can be monitored and controlled on the computer in real-time DT mode, so there is bi-directional communication between the physical and virtual layers. The DT can help someone to have a lot of information about the processes, e.g., the exact position of the product is known, not only when it is physically in the sensor position.

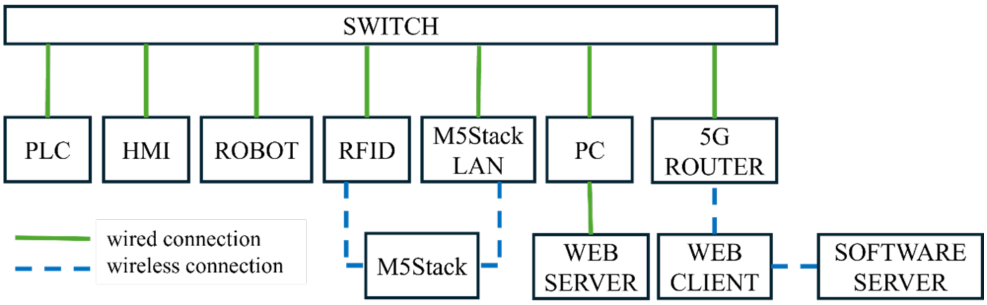

Figure 2. Internal network topology

The product is also equipped with a Wi-Fi module to send information to the display during the process. As it also uses wireless communication, 5G communication technology is also integrated (Figure 2), giving the device another unique feature. So, the platform has a control desktop, a collaborative robot, a set of hardware, and virtual toolkits with standard communication protocols.

The platform's main features are complexity, modularity, and representation of physical and digital processes. The physical and virtual toolkits and their communication give the equipment its special features, making it a complex solution for Industry 4.0. It has more functionality and educational capabilities than the equipment presented at the state of the art. It fulfills all the hardware criteria set out in Table 1:

• Dimension: Compact size, small area (1.5 square meters), fits through an average door.

• Mobility: Mounted on an industrial wheel, easy to move.

• Infrastructure: Low infrastructure needs. It uses pure low-voltage electrical devices; no pneumatic devices are installed, and wireless network access is provided via the industrial 5G router.

• Flexible configuration: The hardware kits (dispenser, conveyor belt, collaborative robot) can be reconfigured quickly (quick connector, only one cable per unit).

• Educational suitability: A fully competent, ergonomic, safe environment (Figure 3).

Figure 3. Smart manufacturing educational platform

• Process monitoring: HMI-based system monitoring (wired from hardware, wireless from smart product). Due to bi-directional communication between hardware and virtual tool kits, full process monitoring is possible in DT mode.

• Modular: It is not necessary to use all the tool kits together; training is possible from the basic to the expert level. At the same time, the environment can accommodate additional advanced add-ons.

• Smart product: The product is a microcontroller that has a touch display, an LED status indicator, speaker and gyroscope, with RFID retrofitting and its own wireless communication.

It can be applied to provide training in the educational subject areas listed in Table 2 and beyond. The platform is, therefore, suitable for training on the following topics: Industrial automation (PLC, HMI); Industrial communication (5G, OPC UA); Process simulation and DT; CPPS (Cyber-Physical Production System) design; ESP32 microcontroller programming; Robot programming; Collaborative workplace design.

The platform has already been integrated into the education of the Department of Automation and Mechatronics at the Széchenyi István University (Győr). Used by students of Mechanical, Electrical and Mechatronics Engineering B.Sc. in the context of practice-oriented project work. A representative survey has not been conducted, but personal feedback from students shows that they are very satisfied, highlighting the quick configurability, the immersive interface, and the fact that everyone can use the tool at the level of their qualifications.

The National Control Programming Competition is an important event in Hungarian technical higher education. This large-scale event is not only a competition but also a professional forum where companies interested in industrial automation, academics, researchers, and students can meet each other. At the 2023 event, the platform was one of the technologies where students could test their skills by solving a complex PLC programming problem [31].

The tool is also suitable for research purposes and validation of results, as demonstrated by the authors' research on real-time synchronization of physical and digital parts of manufacturing processes, which was validated on the platform [32, 33].

4.2 Immersive DT Use Case

One of the operating states of the platform is the virtually extended DT. This means that a real-time DT model of the processes in the real-life elements kit (product movement from the dispenser to the conveyor belts) is displayed on the screen, along with the mechanical processes that exist only digitally. The operating state is presented not in terms of implementation method and architecture but in terms of user perception, allowing immersion's role and effectiveness in education to be more easily understood.

In operational use, the process is a combination of physical and digital processes, where a vehicle is assembled and painted in a simplified way (Figure 4). During the physical process, the product stops in the middle of all four conveyors after leaving the dispenser; the process continues in all cases after the digital process is looped back (Table 3). So after the dispensing, there are a total of four operations that have a processing time.

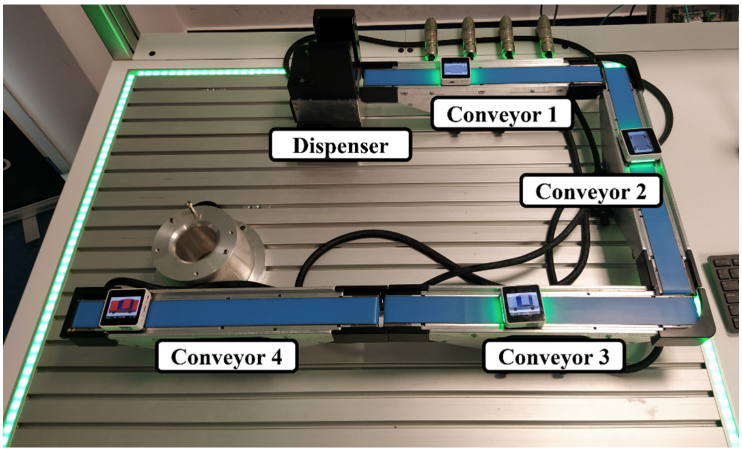

Figure 4. Car manufacturing on the platform

Table 3. Description of processes

	Dispenser	Conveyor 1	Conveyor 2	Conveyor 3	Conveyor 4
Physical layer	Product dispensing	Product stop	Product stop	Product stop	Product stop
Smart product	Display status change	Sound effect, Led light signal, Display status change	Sound effect, Led light signal, Display status change	Sound effect, Led light signal, Display status change	Sound effect, Led light signal, Display status change
Digital layer	Process tracking	Process tracking, Digital proc. I. Physical process start	Process tracking, Digital proc. II. Physical process start	Process tracking, Digital proc. III. Physical process start	Process tracking, Digital proc. IV. Physical process start

So, there is one operation per conveyor belt. The operations are represented in the physical system only by the product stop and start; the change of the product status at each operation location can be followed on the smart product display. The full process and visualization of operation locations and activities on the platform screen can be tracked in DT. The digital processes at each operation location are as follows (Figure 5):

1. Conveyor: Digital process I. Chassis mounting.
2. Conveyor: Digital process II. Wheels mounting.
3. Conveyor: Digital process III. Car body mounting.
4. Conveyor: Digital process IV. Paint spraying.

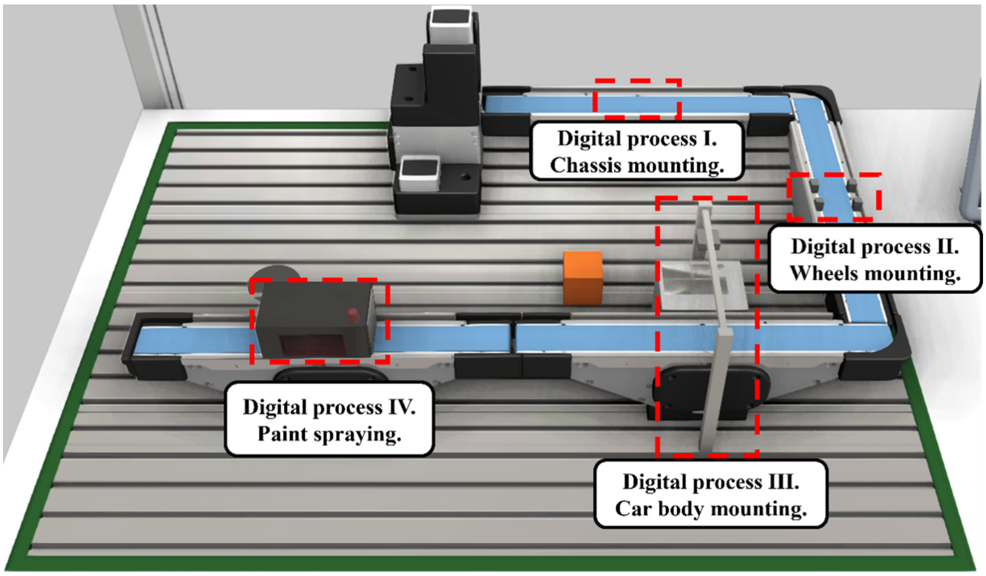

Figure 5. Car manufacturing in the DT

The DT starts the digital processes by monitoring the physical processes, which results in feedback to the PLC, and the physical processes continue. The physical process, the smart product, and the DT create an immersive environment in which, although the hardware technology is simple, it is possible to fully understand the system. Simplified but quickly configurable hardware technology also gives the ability to rapidly create new scenarios. The conveyors have 3 to 3 sensors (front, middle, back) under the belt, allowing a total of 12 physical workstations to be represented. For a new scenario, the physical representation of each operation is not necessary; these activities can be created in a digital environment so that the platform can represent processes in different industries, not only classical assembly activities. In the case of the equipment analyzed earlier, this option is completely missing; at most, the layout can be implemented from existing elements, but only at a high investment of time and resources. Moreover, the smart product display means that it is not a classic plastic or metal workpiece but a 3D image capable of representing the specific scenario and its numerous state changes. The advantage is, therefore, the possibility of reconfiguration and the speed at which it can be possible since these activities only have to be done digitally. Several DT modes (scenarios) have been developed for the platform, and our experience confirms both our hypothesis and our statements that any process can be demonstrated in a short lead time with this level of modularity.

The developed use case can also be evaluated according to the information basis defined by the author's previous research [10]. The basis of the rating is the availability of a DT; a system can be called DT if it has a physical and a virtual part, and there is bidirectional communication between the two layers with the possibility of intervention. These conditions are fulfilled, so the classification by DT information basis can be done both from a spatial and a temporal point of view:

- Spatial
  - Possibility of virtual augmentation: yes
  - Number of source devices: 1
  - Number of locations for intervention: 2-5
- Temporal
  - Period of state changes on the source device [s]: 1-60
  - Period of physical-to-digital updates [s]: 0-1

Given that the information transfer rate is higher than the rate of physical state change, DT can be considered as a real-time updated DT, where real-time only describes the temporal communication between components.

5 Conclusion

The developed platform demonstrates the efficacy of combining physical and digital processes to enhance manufacturing education, aligning with the Learning Factory framework and advancing practice-oriented training. This platform offers an advanced method for developing technical competencies in industrial automation and mechatronics by integrating immersive visualization and digital simulations. Key features, such as modularity, compact design, and the use of DT and IoT technologies, facilitate a realistic, interactive experience that prepares students to engage with the latest industrial standards.

Results from student feedback indicate high satisfaction with the platform's configurability, intuitive interface, and capacity to adapt to various skill levels. The platform enables a hands-on learning environment where students can control and monitor processes through bidirectional communication between physical components and their digital counterparts. Furthermore, the platform has been successfully incorporated into project-based learning within the Department of Automation and Mechatronics at the Széchenyi István University (Győr), offering Mechanical, Electrical, and Mechatronics Engineering students' practical exposure to industry-relevant technologies.

The platform has also been validated in professional settings, as demonstrated by its inclusion in the 2023 National Control Programming Competition in Hungary, where it was used to challenge students to solve complex PLC programming tasks. Beyond educational uses, the platform has shown potential for research applications, such as real-time synchronization of physical and digital manufacturing processes, reinforcing its value in experimental and validation studies.

The DT functionality also enhances monitoring and control precision by providing real-time feedback and enabling immersive simulations that extend beyond physical limitations. The platform's versatility allows it to support various industrial scenarios, from automated assembly processes to collaborative robotic operations, making it an adaptable tool for exploring Industry 4.0 applications in manufacturing education.

The platform not only meets current educational demands but also establishes a scalable model for future learning environments that prioritize flexibility, immersion, and real-world applicability. Its multifunctionality positions it as a robust instrument for advancing industrial education and training, equipping students and professionals alike with the skills needed for the ever-evolving landscape of smart manufacturing.

Author Contributions

Conceptualization, N.S. and G.D.M.; methodology, N.S. and G.D.M.; software, N.S. and G.D.M; validation, N.S., G.D.M and S.F.; formal analysis, S.F.; writing—original draft preparation, N.S.; writing—review and editing, S.F.; visualization, N.S.; funding acquisition, N.S. All authors have read and agreed to the published version of the manuscript.

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Data Availability

Not applicable.

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Conflicts of Interest

The authors declare no conflict of interest.

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Nomenclature

$CPPS$	Cyber-Physical Production Systems
CPS	Cyber-Physical System
DT	Digital Twin
HMI	Human Machine Interface
IoT	Internet of Things
NEM	Novel Educational Methodology
$OPCUA$	Open Platform Communications Unified Architecture
PLC	Programmable Logic Control
$RFID$	Radio Frequency Identification
SME	Small and Medium-sized Enterprises