

Integrated Teaching and Research Platform - Flexible Assembly Line FUTURE DIGITALIZED FACTORY INDUSTRY 4.0



Systems Engineering

Flexible Assembly Line for

FUTURE DIGITALIZED FACTORIES

Integrated teaching and
research platform with
ABB IRB 120 robot

Industry 4.0 is a meaningful term that includes technologies and concepts of value chain organization. On its foundation lays the latest technological concepts such as Cyber - Physical Systems (CPS), Internet of Things (IoT) and Internet of Services (IoS) thus facilitating the vision of a Future Digitalized Factory.

Decentralized decision-capable Cyber-Physical Systems monitor the physical processes and create a virtual copy of the physical world that is analyzed in real-time to provide support for the decision - making process.

The real - time connection between various CPSs and humans is ensured over the Internet of Things. Internal and external services can be offered and used by participants of the value chain organizations over the Internet of Services.

Reasons for choosing

Flexible Assembly Line

Versatile platform for a broad range of manufacturing processes: pallet transport systems, warehouse stations, assembly stations, testing stations.

Modular control concept with Profinet, IO-Link and CANopen controllers, drive components such as frequency converters and brush-less/asynchronous/synchronous motors.

The platform comes with step-by-step training manual that introduces each subsystem and its interfaces.

RFID equipped workpieces and controllers. Great range of sensors and transducers. Latest SIEMENS PLCs and HMIs.

Open architecture equipment designed for laboratory use.

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Overview

Learning of automatic system integration has become already a very important part of the training in automatics.

Smart assembly is a concept that integrates production processes, equipment and information using both real and virtual methods to achieve improvements in productivity, lead time and flexibility.

The concept behind smart assembly is to develop and integrate smart tools, such as flexible conveyors, feeders, fixtures, workstations, robots, sensors, controls and intelligent fastening equipment, to address today's endless product variety demands and subsequent workstation-level complexity. A smart assembly system can adjust and adapt itself to respond to changes in the production environment, such as variability of incoming parts and components.

Smart Flexible Production Assembly Training System reflects the new developments in Industry 4.0 network production and offers a modular intelligent factory system for teaching and research purposes. The system illustrates the practical implementation of a networked factory and can be used to represent the entire value chain.

The Complete System

The main feature of the system is its modularity which enables great flexibility by combining modules in different configurations for training in a variety of applications and experiments. The flexibility of the training system is exceptional because of the modular design of its workstations, which is always identical: form and dimensions, conveyor structure, system cable.

Each station of the system is fitted on a workstation with modular supply panel. By connecting these workstations it can be formed an automatic production line. The stations have a modular structure, they are easy to set up, to disassembly and also can be freely combined.

As an automatic and smart system, the Flexible Assembly Line use sensor technology, electrical and electronic technology, control technology, pneumatic technology, servo drive technology and also industrial communications.

Flexible Assembly Line consist of training platform with pneumatic warehouse stations for 3D-printed workpieces, conveyor system with different types of electric drives, ABB six joint industrial robot assembly unit, visual detection device, finished product storehouse.

The work pieces contain information in the form of production parameters. The workpieces know what they are and can communicate with the facility through RFID technology. After approaching the correct station, they tell it which part they are, and request to be processed with the appropriate method.

Beside its modularity the assembly line can be an expandable factory model which can be used in many areas of teaching and research.



Assembly line area

The production and the assembly of the workpieces demand requirements on production in accordance with the industrial revolution *Industry 4.0*. To meet these requirements, the system includes:

- modularity
- RFID technology
- standard communication interfaces
- service - oriented program architecture
- mobility

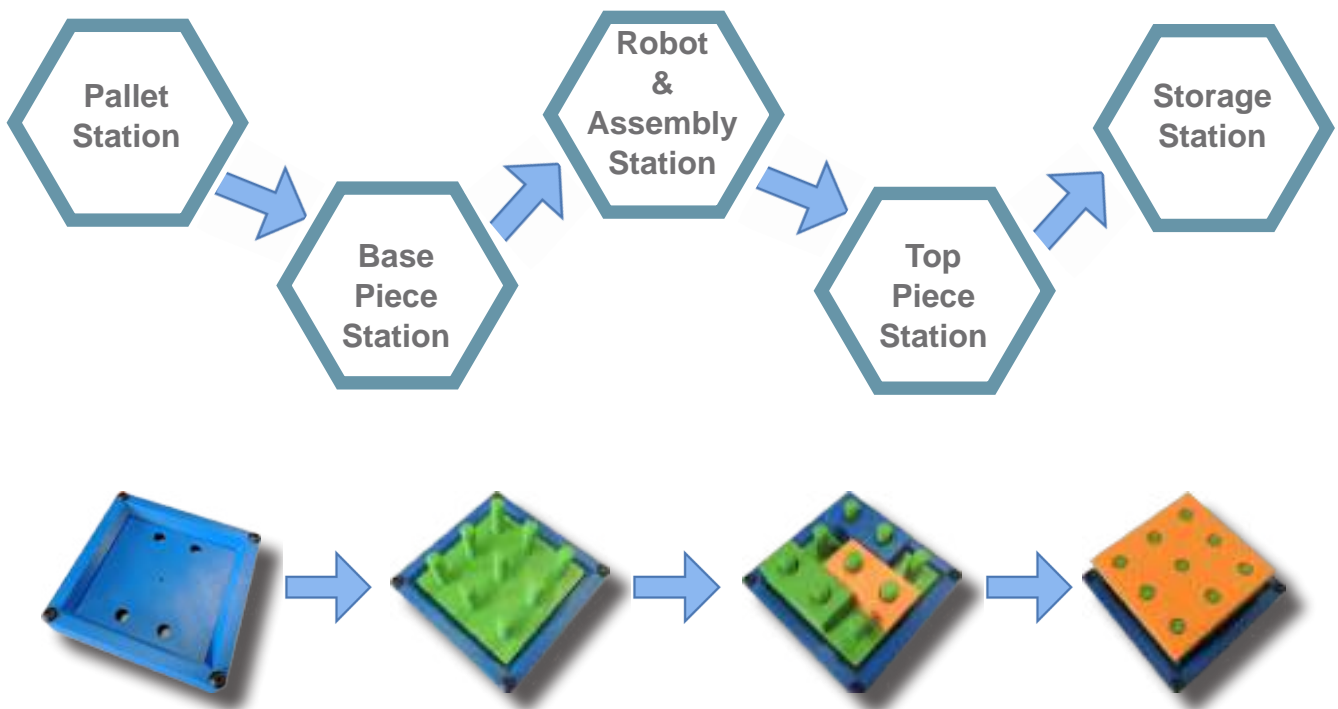


Transport area

An intelligent flow of the workpieces and networked processes are important facts for *Industry 4.0*. The training system offers a versatile training and research platform for a great range of logistical goals:

- RFID technology
- automatic warehouses
- service - oriented program architecture
- production stores
- pallet transfer system
- autonomous transport robot
- MES/ERP

Flexible Assembly Line features a manufacturing process that assembly specially designed 3D-printed workpieces. The complete process is described by the following diagram:



Concepts

Asti Automation has been committed to developing a flexible and comprehensive automation solution based on the latest Industry 4.0 concepts. The Flexible Assembly Line for Future Digitalized Factory has been designed to meet the highest standards imposed by the 4th industrial revolution:



Modularity: the Flexible Assembly Line can adapt to changing requirements by replacing or expanding individual modules or sensors.



Real-Time Capability: no compromise has been made regarding data processing power in the Flexible Assembly Line, thus enabling the system to collect, analyze and provide feedback on process data in real-time.



Decentralization: the platform has been designed to enable the cyber-physical systems within the Future Digitalized Factory concept to make decisions without the aid of centralized guidance and commands.



Virtualization: virtual plant models and simulation models of the Assembly Line can be linked to real sensor data in order to create a virtual copy.



Interoperability: the ability of assembly stations, warehouses and products (cyber-physical systems) to communicate and receive feedback from humans and Smart Factories Command Units via Internet of Things and Internet of Services.



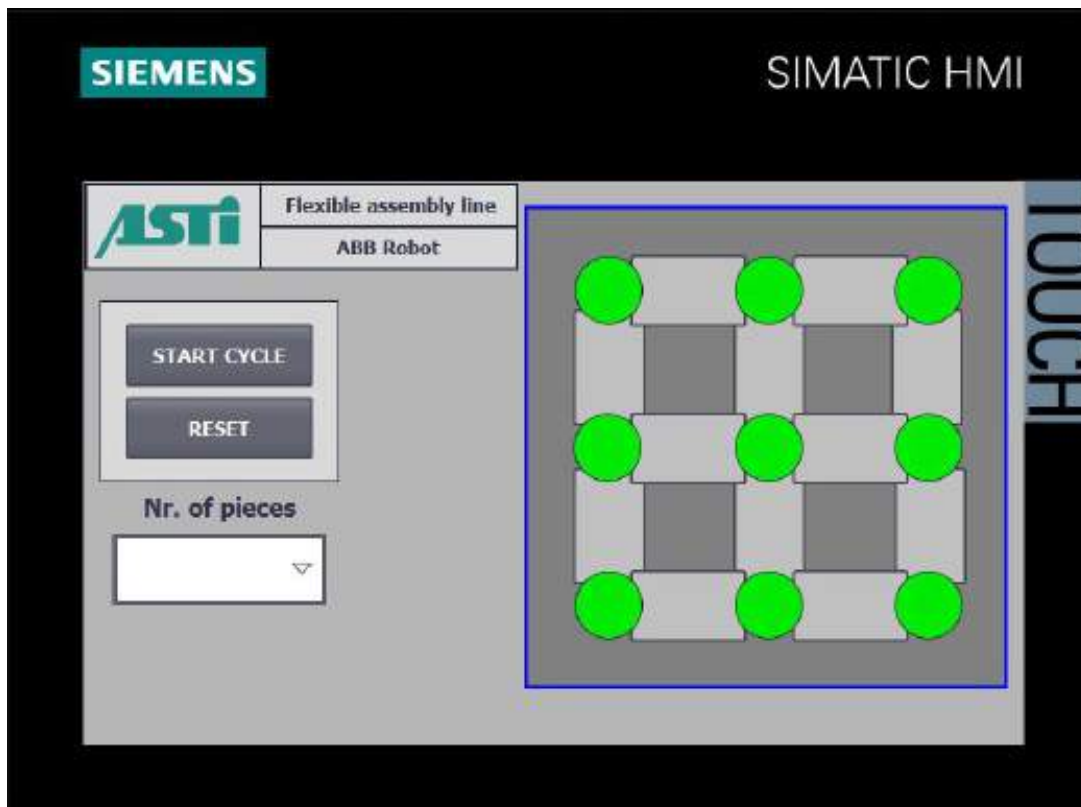
Service Orientation: Internet of Services compatibility through linking operators, cyber-physical systems and Smart Factories interfaces.

Dynamics

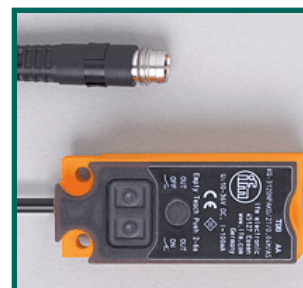
The FLEXIBLE ASSEMBLY LINE comprises of five conveyor belts linked together precisely at the same height to ensure a smooth path for the pallets that will flow through. A fully automated pneumatic warehouse station with a 12 workpiece capacity provides rigorous PLC controlled horizontal linear positioning of the workpieces with feedback ensured by two sensors (capacitive and inductive). Each of the conveyors are powered by different types of electric motors: AC or DC motors, synchronous or asynchronous motors, brush-less motor. For rigorous positioning, encoder disks with counters monitor the direction and speed of each conveyor providing valuable feedback to the PLC controller unit.

Versatility

The FLEXIBLE ASSEMBLY LINE can be configured in various setups designed for a wide variety of scenarios: linear assembly line, “U” shaped production facility. The various system layouts can be obtained by extending the basic setup with other similar functional modules, thus creating more individual group workstations for a more complex manufacturing processes. The extension functional modules can consist of conveyors, sorting units, sensors and even intelligent robotic arms for complete automation. Timing is everything in the automation industry and the Flexible Assembly Line is the perfect didactic tool for teaching and demonstrating the principles of manufacturing automation in future digitalized factories.



Sensors and Actuators



Secure industrial communication is mandatory in all future digitalized factories, thus we have fitted the Flexible Assembly Line with IoT modules on the SIEMENS S7-1500 PLCs that ensure the motorization of the platform.

Besides the control modules, RFID compatible equipment is used (RFID tags fitted on pallets, RFID receivers) to ensure the rigorous tracking and identification of each workpiece involved in the manufacturing process.



Inductive and capacitive sensors

The exact position of the workpieces is determined by a number of IFM Metal Face Industrial inductive sensors, with a 3mm flush sensing range and PNP output, placed strategically in key points alongside the conveyor belts. Both the monitoring system and the operator have to be aware when a workpiece is dropped onto the conveyor belt from the warehouse. For that matter, an IFM rectangular capacitive switch, with a 12mm sensing range, PNP output and Normally Closed/Opened programmable option, has been fitted exactly underneath the warehouse, at the delivery point of pallets on the conveyor belt.



RFID Readers and Tags

The pallets that are transported on the conveyor belt are fitted with an identification RFID Tag containing an unique identification code that can be both read and modified via the Siemens RF series RFID Readers. With a M12-8 pin connector and RS422 communication protocol, the information provided by the RFID Readers can easily be implemented into a HMI Panel where the operator can view and operate changes on the ID tags.



IoT Gateway

The smart IoT 2050 gateway is an easily and cost effective way of opening the doors to the digital dimension. It acquires, processes, harmonizes and saves machine data for analyzes. Due to the open architecture, the system is compatible with open-source solution, such as Node-Red for data acquisition, data processing and visualization on customizable dashboards. Further, it is used as smart edge device for third party platform.



Network Security

SCALANCE S615 LAN router is designed to protect devices/ networks in automation technology and protect industrial communication using VPN and firewall. Further functions of this router are address conversion (NAT/NAPT) and capability of connection to SINEMA RC. The router has 5 ports, 1 digital input, and 1 digital output.



Pneumatic Cylinders and Distributors

Compact cylinders function in the same manner as basic cylinders with both single acting and double acting, single or double rod, and non-rotating models. However, SMC compact cylinders minimize space requirements allowing for precise, direct mounting in the least amount of space possible. This allowed a robust pallet distribution action from the warehouse onto the conveyor belt.



Electric Motors

The Flexible Assembly Line platform is equipped with a wide range of electric motors. The Brushed DC Motor provides high speed stability, energy saving and space saving. Brushed DC motors also allow for stable speed control even with a fluctuating load and offer constant torque over a wide speed range. The AC/Asynchronous/Synchronous Motor is suitable for applications where the motor is operated at synchronous speed continuously in one direction regardless of load torque. Each product is equipped with an interface that connects to various master controllers featuring I/O or CanOpen. Networked products enable operating data and parameters for each motor to be set and sent to each driver.



PLC

The Flexible Assembly Line platform uses Advanced Controllers to automate assembly lines applications which demand the greatest performance, flexibility and networking capability. No performance compromise has been made with the Advanced Controller SIMATIC S7-1500, used in the entire automation industry in applications that are medium-sized to high-end machines with high demands on performance, communication, flexibility and technological features. The SIMATIC S7-1200 universal controller saves on installation space and features a modular design. For the Advanced Controllers fitted on the Flexible Assembly Line a wide range of modules can be used to expand the system centrally or to create decentralized structures according to the task at hand, and facilitates a cost-effective configuration.



Robot

The Flexible Assembly Line is equipped with ABB IRB 120 robot which demonstrates the versatility of the training platform. The flexible robot cell is equipped with a industrial pneumatic gripper.



Open architecture

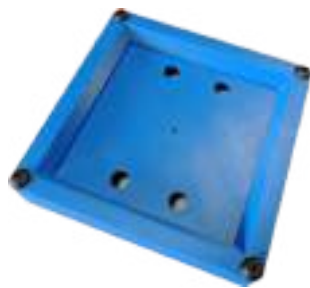
The Flexible Assembly Line has an open architecture. Signals from the sensors and actuators are available through 4mm connectors on the main panel. This allows an easy integration with laboratory equipment.



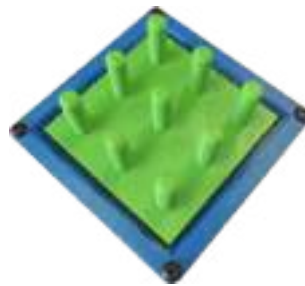
Turn-key Solution

We offer a tailored package for the Flexible Assembly Line consisting of SIEMENS PLCs and HMIs. The PLC performs monitoring and control functions whereas the HMI touchpanel offers convenient visualization and user input.

The Flexible Assembly Line features a manufacturing process that uses specially designed 3D-printed pieces.



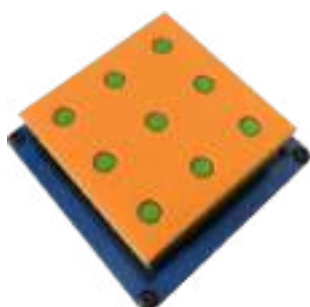
Pallet



Base piece



Small assembly pieces



Top piece

Robot Technology



As a result of the exponential evolution of robotics over the last decade, this technology has become essential in modern manufacturing processes, offering added safety, repeatability, precision and quality. Flexible Assembly Line provides an overview of robot-based technological processes through a systematic approach of the basic concepts of industrial robot programming within manufacturing structures. The current concepts related to robot programming is outlined and exemplified with a laboratory scaled industry application.

Features of the robot cell

The robot cell is the most complex and the most flexible handling device in an industrial environment. Therefore this learning arrangement, consisting of a ABB IRB 120 robot and different assembly stations, deals with an application of assembling 3D printed pieces using the robot. Different learning strategies can be applied in the range of teaching, simulating and also programming a robot as well as in combination with an assembly task to be fulfilled by a robotics application.

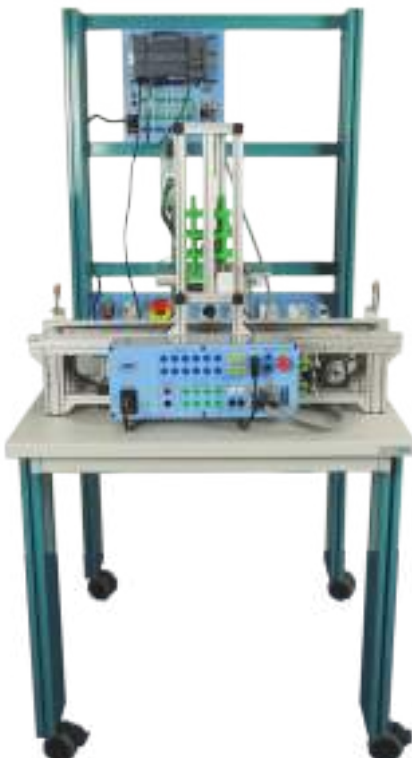
Station 1



- **AA200.000.02** - Workstation (800x800x750 mm.) with Modular Supply Panel
- **AA048.010.07** - PLC S7-1500 Training Panel (CPU 1513-1PN)
- **AA071.001.06** - TP1200 Comfort HMI Training Panel
- **AA094.101.04** - Conveyor Belt with Asynchronous AC Motor
- **AA042.000.02** - SINAMICS G120 - 1AC 230V Training Panel
- **AA095.000.01** - Compact Pneumatic Pallet Storage Unit
- RFID System SIMATIC
- **AA054.200.02** - Simatic IoT 2050
- **AA054.400.01** - Network Security

*The picture does not reflect the final product configuration!

Station 2



- **AA200.000.02** - Workstation (800x800x750 mm.) with Modular Supply Panel
- **AA044.000.07** - PLC S7-1200 Training Panel (CPU 1215C) with CMCanOpen Module
- **AA094.101.05** - Conveyor Belt with Brushed DC Motor and CANopen drive
- **AA095.000.02** - Compact Pneumatic Base Piece Storage Unit
- **AA059.000.09** - Air Compressor
- **AA059.000.06** - Air Supply Filter Regulator

*The picture does not reflect the final product configuration!

Station 3



- **AA200.001.02** - Workstation (800x800x750 mm.) with Modular Supply Panel for Training Robot
- ABB IRB120 Training Robot (Controller IRC5 Compact)
- **AA096.001.04** - Pneumatic Gripper
- **AA096.001.05** - Safety Cage for Training Robot
- **AA094.101.06** - Conveyor Belt with Servomotor SIEMENS
- **AA045.000.01** - SINAMICS V90 Training Panel
- **AA095.000.05** - Compact Pneumatic Index Unit
- **AA026.001.03** - HMI KTP700
- RFID System SIMATIC

*The picture does not reflect the final product configuration!

Station 4



- **AA200.000.02** - Workstation (800x800x750 mm.) with Modular Supply Panel
- **AA044.000.07** - PLC S7-1200 Training Panel (CPU 1215C)
- **AA094.101.06** - Conveyor Belt with Servomotor SIEMENS
- **AA045.000.01** - SINAMICS V90 Training Panel
- **AA095.000.03** - Compact Pneumatic Top Piece Storage Unit
- **AA095.000.04** - Compact Press Piece Unit
- **AA095.100.01** - 3D - printed Assembly Line Set
- **AA088.100.01** - Sentron PAC3220 Training Panel

*The picture does not reflect the final product configuration!



- **AA200.000.02** - Workstation (800x800x750 mm.) with Modular Supply Panel
- **AA094.101.06** - Conveyor Belt with Servomotor SIEMENS
- **AA045.000.01** - SINAMICS V90 Training Panel
- **AA089.001.02** - Energy Meter Training Panel
- **AA089.100.02** - Sockets Training Panel
- **AA095.000.06** - Compact Storage Unit

*The picture does not reflect the final product configuration!



The main training aims and competences of the robot platform:

- Learning the principles and rules of industrial robots technology and terminology
- Robot programming
- Implementing the industrial communication protocols that are used
- Interfacing the ABB IRB 120 robot with a Siemens PLCs and Siemens frequency inverters for controlling different conveyor belts
- Process and motion control via a vision intelligent industrial camera
- Performing motion sequences using the gripper mounted on the robotic arm and a set of 3D printed workpieces
- Implementing safety and security applications
- Commissioning of the entire sequence

Type of Applications



Motor Drives and Inverters

Target group: BSc students/ MSc students/ Engineers/ Researchers

- Familiarize with the operating principles of AC and DC motors, brush less motors, synchronous and asynchronous motors.
- Plot and interpret the characteristic for starting, acceleration and deceleration of various types of motors.
- Learn parameterization, diagnosis and predictive maintenance methods.



Industrial Communication Protocols

Target group: BSc students/ MSc students/ Engineers/ Researchers

- Familiarize with various industrial communication protocols such as PROFINET, IO-Link, CANopen.
- Learn to choose the right communication protocol to meet the communication needs thus obtaining an easy-to-use process control through hardware and software.



Instrumentation installation, parameterization and calibration

Target group: MSc students/ MSc students/ Engineers/ Researchers

- Familiarize with instrumentation setup techniques for different types of inductive, capacitive, color and optic sensors.



Sequential Control Systems and PLCs

Target group: BSc students/ MSc students/ Engineers/ Researchers

- Implement controllers in PLC for different scenarios and observe performance.
- Develop and optimize a mathematical model of the manufacturing process using traditional methods such as Petri Networks and State Machines.
- Design various sequential control structures with time-dependent individual steps that are processed in a predetermined order.



IoT & Network Security

Target group: BSc students/ MSc students/ Engineers/ Researchers

- Experiment with industrial communication between a Siemens S7-1500 fitted with a communication module and various RFID transceivers or other Siemens modules.
- Familiarize with the IoT (Internet of Things) concepts for industrial communication.



Fault detection and predictive programming

Target group: BSc students/ MSc students/ Engineers/ Researchers

- Monitoring the system, identifying when a fault has occurred and pinpointing the type of fault and its location.
- Familiarize with direct pattern recognition of sensor readings that indicate a fault and an analysis of the discrepancy between the sensor readings and expected values, derived from a process model.



Data acquisition, processing and monitoring

Target group: BSc students/ MSc students/ Engineers/ Researchers

- Exploit the processing power of the Siemens Simatic S7 PLC to increase productivity, create interfaces and analyze process data.
- Interact with various connectivity capabilities at an industry standard for obtaining a more powerful, flexible and cost-effective measurement solution.



Human Machine Interfaces (HMI)

Target group: BSc students/ MSc students/ Engineers/ Researchers

- Develop robust HMIs that include signaling and controlling the state of an industrial automation equipment.
- Learn to design user-friendly interfaces by applying concepts of ergonomics and psychology thus achieving the desired output through minimal input provided from the operator.



RFID

Target group: BSc students/ MSc students/ Engineers/ Researchers

- Track the progress of a workpiece through the assembly line manufacturing process.
- Develop a workpiece identification and sorting strategy using RFID tags and receivers.



SCADA

Target group: BSc students/ MSc students/ Engineers/ Researchers

- Familiarize with the common components and concepts of SCADA systems.
- Learn the differences between various SCADA architectures over multiple types of communication infrastructures and methods.
- Design and implement WinCC applications and interfaces for a remote supervisory and control station with an operational philosophy based on coded signals via industrial communication channels.

An investment for the younger generation

FLEXIBLE ASSEMBLY LINE

... An investment for the future!



ASTI Automation SRL, company founded in 2002, is one of the youngest members of the ASTI group. Since 1990, when the first ASTI company was established, ASTI has been a constant promoter of the most advanced automation systems in Romania. Currently, the company is acting in the industrial automation field, participating in projects from sectors such as oil and gas, automotive, food industry, chemical industry, urban utilities, etc.



Since 2007, the business of the company has been extended through active involvement in increasing the quality of technical education in college and university. The company develops didactic equipment related to approved programs of study, taking into account the current technological level encountered in main industry sectors. The portfolio includes didactic equipment for specific technical fields, integrated laboratories mainly for technical universities as well as for companies acting in the industry, training sessions for students or postgraduate courses for professionals in the industry.



Since 2011 ASTI Automation is Siemens SCE partner for training material and a full member of WORLDDIDAC, the global trade association for the education industry. ASTI Automation complies with the rules of quality management and is certified with ISO 9001: 2008.

ASTI Automation relies on strong partnerships with leading manufacturers of automation solutions:



Our valued customers:



*We bring industry to your school,
modern technology at your fingertips*





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