Semiconductor Learning Factory

Bring the Fab Into Your Lab

Highlights

- Ready-to-use, practice-oriented curriculum
- Fully enclosed, smart cleanroom
- Electrostatic and environmental condition monitoring and control
- MES-integrated system
- Modular design for customization
- State-of-the-art equipment from Festo and key industry partners

Prepare students for one of the fastest-growing, most innovation-driven sectors in advanced manufacturing. Integrate a fab-like environment into your classroom to boost engagement and increase job readiness.

Our solution

The Semiconductor Learning Factory provides an immersive learning environment that mirrors key semiconductor industry processes and protocols.

Built on decades of expertise in factory automation education, this solution is specifically designed to develop real-world, specialized skills in cleanroom operations, FOUP handling, laser etching and dicing, ESD control, AI-driven quality control, and more.

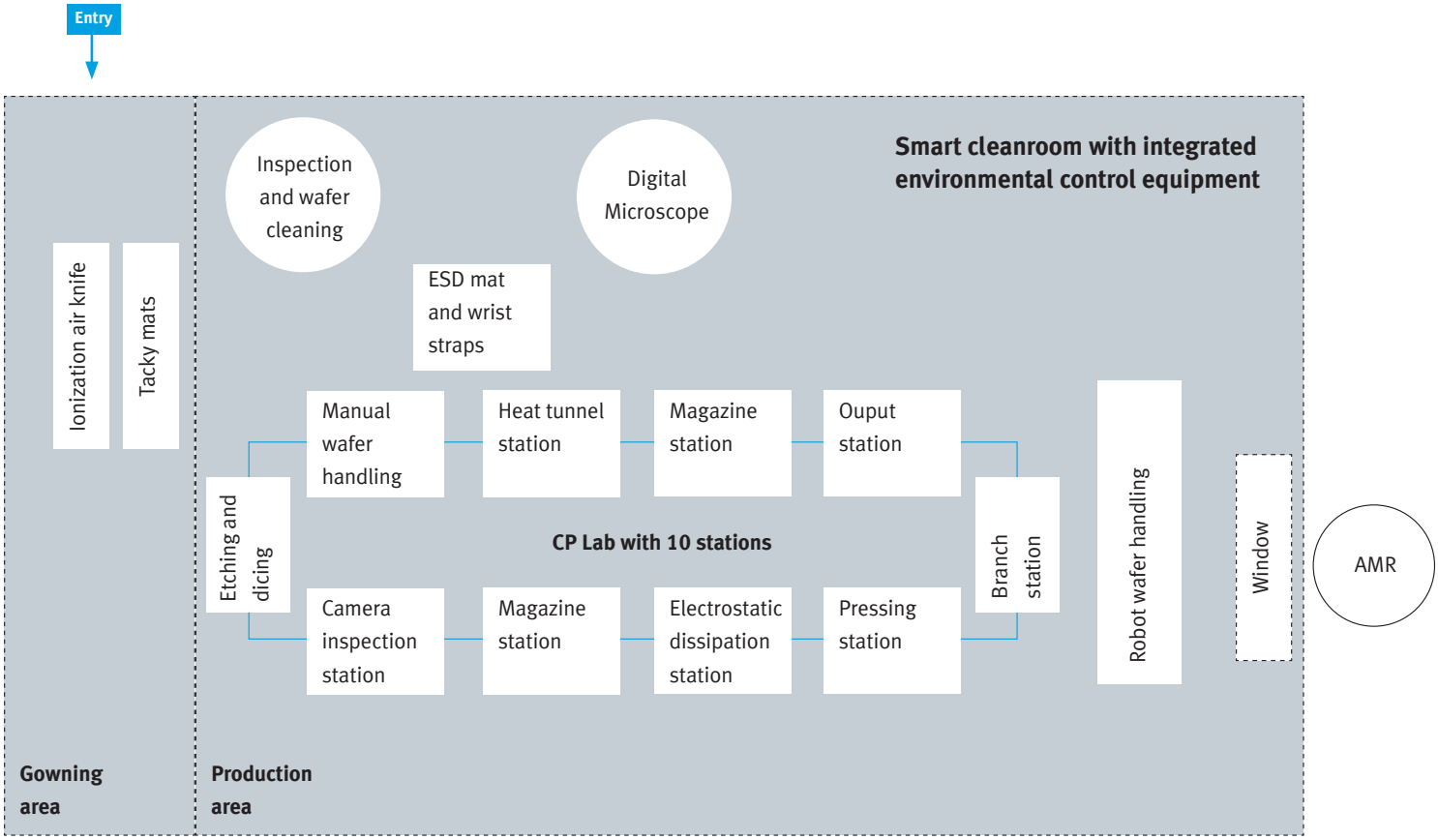
Your benefits

- Access hands-on, industry-specific learning and teaching resources.
- Equip students with employable skills that meet job market expectations.
- Update training programs and facilities with Industry 4.0 and IIoT technologies.
- Fit your budget and space requirements while keeping room for expansion.
- Position your institution as a leader in semiconductor manufacturing education.

The curriculum

The Semiconductor Learning Factory enables students to complete modules from the Capstone Semiconductor Curriculum, along with a wide range of additional courses from our extensive catalog. Most course materials are available on Festo LX, a digital portal that supports both eLearning and personalized learning experiences.

Experience the Silicon Wafer Journey—From Handling and Processing to Inspection and Distribution—in a Hands-On Learning Environment.



Key components of data-driven semiconductor manufacturing training

+ The core system
The Semiconductor Learning Factory is a CP Lab—an Industry 4.0 system enhanced with semiconductor-specific equipment. It also supports general automation training, making it a versatile investment.

+ Workpieces
Students work with two types of workpieces:

- 100 mm P-type silicon wafers
- 100 x 50 mm printed circuit boards (PCBs), in two parts (bottom and top).

+ Smart cleanroom
The portable ISO Class 8 cleanroom—measuring 8 by 16 feet and expandable to 24 feet—features a positive-pressure control and and a dedicated gowning area. It gives students hands-on experience working in a controlled environment while following industry-standard protocols. Inside, integrated sensors track key environmental parameters such as humidity, temperature, and air quality, all visualized in real time on dedicated monitors.

+ ESD control
An integrated electrostatic discharge (ESD) kit—including sensors, ionizers, and monitors—enables students to visualize, measure, and manage electrostatic charges to protect sensitive components from damage.

+ Robots
The universal robot ensures frictionless handling of wafers. An optional 7th axis enables it to tend multiple stations. For increased automation, an Autonomous Mobile Robot (AMR) with self-mapping capabilities can be added to transport FOUPs and workpieces.

+ Festo MES4
The Manufacturing Execution System (MES) is essential for training in data-driven manufacturing. It simulates a real-world production environment and provides hands-on learning in process planning, monitoring, and control. Through the HMI and monitoring stations, students gain skills in real-time data management, scheduling, and quality assurance.

+ FOUPs
Front Opening Unified Pods (FOUPs) with RFID tracking integrate seamlessly with the MES software, giving students real-time visibility into wafer handling and traceability across the production cycle.

Six Steps to Semiconductor Manufacturing Training

Start

Step 1 Environmental control
Students manage cleanroom conditions to ensure a safe, particle-free environment for wafer handling. Using sensors and ionization systems, they learn to control air quality, temperature, humidity, and static electricity.

Subject areas:
- Air particle count
- Humidity management
- HVAC HEPA filter rating

- Positive pressure monitoring
- Temperature
- Management
- Airflow visualization

Step 2 Cleanroom protocols
Students follow standard procedures to prevent contamination and maintain safety in the cleanroom. They learn about cleanroom classifications, best practices for contamination control, and proper gowning techniques.

Subject areas:
- PPE gowning
- Ionization air knife
- Anti-static sticky mat

- Cleanroom classification standards
- System optimization
- Security and access control

Step 3 Wafer initialization
Using the MES system, students create a work order and locate the correct wafer using a Pick-by-Light system with HMI guidance. The wafer is removed from the FOUP cassette and transferred to the laser etching station, where serial numbers, barcodes, or logos are etched for traceability. Circuit boards with fuses can also be processed and inspected.

Subject areas:
- Wafer cleaning
- Raw wafer inspection
- Vacuum wand / sterilized tweezers

- MES / data management
- Etching or dicing operation
- Grounding mats and straps

Step 4 Camera vision inspection
Students operate a vision inspection station where high-resolution cameras detect surface defects and verify wafer serial numbers with precision.

Subject areas:
- Object detection
- Defect identification
- Serial number verification

- Lighting and shrouding
- Lens calibration
- Machine Learning methods

Step 5 ESD inspection
Students monitor electrostatic levels through closed-loop sensors integrated into the MES4 and HMI. If energy levels exceed safe thresholds, the wafer is sent to an ionization blower to dissipate static and prevent damage.

Subject areas:
- Inline and handheld electrostatic sensors
- MES and HMI data visualization

- Ionization blower
- Generation of static electricity
- Static elimination
- Frictional charging

Step 6 Wafer packaging and distribution
Automated systems handle wafers through both FEOL and BEOL processes. After inspection, the robot removes the wafer from the pallet and loads it into a FOUP cassette. The robot delivers the sealed FOUP to the storage rack after the operator applies the lid.

Subject areas:
- Frictionless placement
- Wafer placement in/out of FOUPs and cassettes

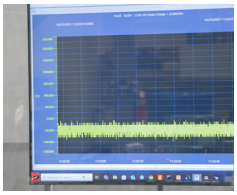
- FOUP robot material handling
- Back-End-of-Line (BEOL) and Front-End-of-Line (FEOL) processes

A Look Inside the Semiconductor Learning Factory

Exterior view of the gowning and production areas

Wafers on the conveyor belt

Inspection table for ESD monitoring



Visualization of the ESD monitoring

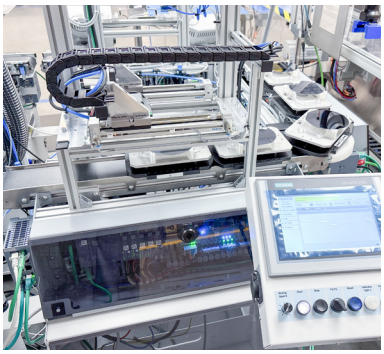
Environmental monitoring screen

Ionization air knife

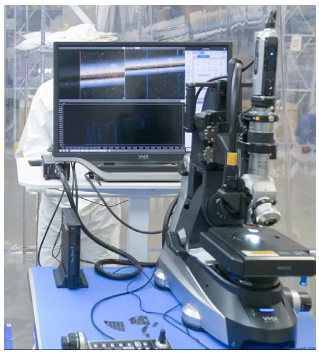
Manual wafer handling with a vacuum wand

Automated wafer handling

Mobile robot transporting the cassette out of the room



ESD inspection application module



2D and 3D inspection

Ready to learn more?

Contact Festo Didactic or an authorized dealer for product availability, technical specifications, and pricing.

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