Industry 4.0 embodies the transformation at the forefront of modernizing manufacturing processes to keep competitive in this fast changing world. In order to match the rapid change of many industries due to the influx of new Industry 4.0 technologies, training programs and certifications for skilled labor needs to be renewed.

Employers need workers who are technically advanced, process savvy, and natural problem solvers to take a role in the ongoing design and improvement of manufacturing systems.

The SmartCIM4.0 solution is designed to introduce vocational and engineering classrooms to the industrial automation and industry applications needed in modern plants and to create skilled workers for next generation jobs. Taking a system-based approach, SmartCIM4.0 deals not only with individual components of industrial training, but also with networking and communications, systems integration and the essential employability skills students need in modern industry. Integration of cutting edge technology systems and collaboration is the core of Industry 4.0.

The solution is a modular and sustainable, and aligned to industry programs with curriculum options to match local industry needs & micro certifications for specific fields that align to advanced industry level certifications. The program includes all the hardware, software, curriculum, evaluation, train-the-trainer, and support required to develop a long term education program.

SmartCIM4.0 is a modular and flexible solution for educating and training students in the principles and technologies of Industry 4.0 computer integrated manufacturing.
Reshaping Manufacturing Training

As Industry 4.0 becomes more widely adopted new career options will be created in industry that do not currently exist.

Industry 3.0 vs. Industry 4.0 - the Gap

Industry 4.0 introduces technology and capabilities that at the highest level take automated, manufacturing to the next level. Information collection and data analysis enable predictive maintenance, flexible manufacturing and efficient optimized factories.

- As more complex systems are integrated both physically as well as in the cloud, system level understanding and system integration knowledge will be required. Strong skills in automation, integration, systems communications, networking and data analysis will be required.
- Industry 4.0 revolves around data collection and analysis from every part of the factory floor. Data will be the cornerstone of production planning, efficiency and predictive/preventative maintenance.
- Collaborative robots enable simplified assisted learning in a safer environment.

Intelitek’s SmartCIM4.0 is an integrated, end-to-end manufacturing process with real industrial equipment capable of producing real products. The cell has all the components typical to state-of-the-art industry 4.0 factories and is used to train students of all levels about manufacturing and Industry 4.0 concepts.

SmartCIM4.0

INDUSTRIAL HARDWARE
- Built with Intelitek and leading industry vendor hardware
- Full size, real industrial equipment from end-to-end
- Manufacturing line produces real products

MULTI STATION, FLEXIBLE DESIGN
- Industrial conveyor system links workstations with a variety of manufacturing capabilities
- Pick and choose, machining, welding, assembly, storage, additive, and 3rd party components
- Industry 4.0 sensors and communications link to central manager

INDUSTRY 4.0 ENABLED
- Sensors on all levels and all components report real-time cell status
- Multi-tiered IP and IIoT communications network all elements
- Central management, cloud connectivity and data analysis integrated

MULTI VENDOR INTEGRATION
- Partners and other vendor stations industrial equipment can easily be integrated
- Curriculum include industry leader certifications,
- Curriculum aligned with industry standard certifications...

Industry 4.0 Education Architecture

Intelitek manufacturing training is modelled around the ARM Industry 4.0 blueprint, that enables a stackable and modular approach in which certificates and micro-credentials can be awarded to students in different phases of their academic life or working career. The training addresses three levels of student training to differentiate between fundamental skills and high-end integration capabilities.

Working with industry, we have crafted a robust curriculum as well as this smart factory trainer that exercises technical, planning and problem-solving skills.

SmartCIM4.0 enables high schools, 2 and 4 year college programs, as well as industry training programs and apprenticeships, to offer valuable credentials to their students that lead to career advancement. The skill levels are tiered so students can pursue a fundamental technician tier, and build up towards a specialist or an integrator level.
SmartCIM4.0 Computer Integrated Manufacturing Industry 4.0 System

The SmartCIM4.0 Computer Integrated Manufacturing systems are complex interconnected manufacturing configurations that have several key components like automated production workstations, automated storage and retrieval systems (ASRS), assembly stations, quality control and additive manufacturing stations all linked by a continuous-loop conveyor, a central management control station, a TCP/IP communication network, and Intelitek’s OpenCIM software. Workstations can be added or removed for a variety of automated tasks as part of the production process including 3rd party machines and processes.

Stations Examples

1. AUTOMATED STORAGE & RETRIEVAL STATION
   The floor-mounted or a table top ASRS system includes a dedicated Cartesian robot that transfers parts between storage cells and conveyor pallets. The ASRS is controlled and monitored from the central management console. The ASRS can include RFID, QR code or other inventory and location tracking devices.

2. SUBTRACTIVE MANUFACTURING MACHINING STATIONS
   A multitude of semi-independent workcells where an articulated robot arm tends the machine and performs other part manipulation and/or assembly tasks. The robot loads and unloads parts to and from the CIM conveyor. The robot can be mounted on a linear slidebase for mobility and larger work area. Machining options include milling, turning, routing, laser engraving, etc. All machines and robots are Ethernet connected and include multiple monitoring sensors for health and status tracking.

3. ASSEMBLY & QUALITY CONTROL STATIONS
   The assembly and QC station is equipped with a range of assembly and quality control options including local storage jigs, and machine vision sensors. Typically these stations are used to collect, construct, measure and approve raw materials and finished goods.

4. ADDITIVE MANUFACTURING MACHINING STATIONS
   3D Printers
   Integrated into the process of parts production, the 3D printer can manufacture part of the finished goods or add customization to parts as they progress through production.

5. REAL PRODUCTION PROCESS
   The closed loop conveyor frame moves pallets carrying part templates (holders) that are loaded and unloaded at each station by robots and manipulators. The system can manufacture a variety of complex multi-part components in materials like aluminum, brass, plastic, wood, composite, and wax. Some examples of student projects include pen holders, games, chess pieces, etc.

6. PROGRAMMABLE LOGIC CONTROLLER AUTOMATION
   The PLC system controls and monitors the flow of pallets on the conveyor with the help of sensors and actuators that are built into the stations. PLCs also control safety devices, participate in intra device communications and control and report via Ethernet to the management station.

7. SENSORS AND IIOT
   A series of advanced sensors are used for monitoring, tracking, quality control and maintenance of the many devices and the products in the system. The sensors connect via a multi protocol IIoT configuration via wired (digital and analog), wireless, IoT protocols and Ethernet. The system provides a diverse learning environment for students.

8. MANAGEMENT STATION
   Integrating the system can be simple to extremely sophisticated. Using Intelitek OpenCIM software, 3rd party MES and ERP packages, Siemens PLM applications, Intelitek and other vendor design tools, cloud computing and remote monitoring applications, and many other options, the System Management is an advanced learning space for level 3 system integration students.
CERTIFICATION

Partnering with Industry

Partnering with leading industry vendors like Siemens, Cognex, Yaskawa, Miller, Allen Bradley and more to deliver training programs that lead to micro-certifications and align our curriculum to the ARM Industry 4.0 blueprint, as well as other well known credentials like NIMS. The Intelitek blended learning solutions with e-learning content, simulation and augmented reality, and industrial training equipment, allows students to gain the skills and credentials they need to advance in their careers.

Intelitek is part of the Advanced Robotics for Manufacturing Education & Workforce Advisory Committee. iCert4.0 certification is aligned with ARM Industry 4.0 blueprint for development of federal standards for Industry 4.0 certification.

Certification

Industry 4.0 CERTIFICATION
Curriculum included with the SmartCIM4.0 in collaboration with industry partners include:
- Yaskawa Certified Robot Operator
- Yaskawa Certified Robot Programmer
- Cognex Certified Vision Programmer
- Siemens Certified RobotExpert/Process Simulate Programmer

Industry 4.0 INTEGRATION
Automation and data sharing enable flexible production, automated processes, advanced analytics and predictive maintenance.
- PLC driven workcell and production cell automation
- Sensor network monitors equipment, raw inventory, WIP and finished products.
- Management station incorporating ERP, MES, design, planning and monitoring tools

Industry 4.0 COMMUNICATIONS
A core element of smart factories is the ability for all components and machines to be monitored and communicate with each other. SmartCIM4.0 includes:
- Ethernet network and Internet communications
- IoT including wired and wireless - OPC-UA, MQTT, Bluetooth, RFID, and more.
- Curriculum provides theory and cell includes hands on network setup and operation

Industry 4.0 SUSTAINABILITY
Education programs need constant maintenance and educators need ongoing support to ensure long-term viability of the program.
- Train-the-Trainer professional development on-site
- Curriculum and content maintenance to keep pace with ongoing industry change
- World-class support team to ensure day-to-day operation is smooth.

Industry 4.0 INDUSTRIAL COMPONENTS
Intelitek has integrated industry leaders into the cell to deliver solutions for CTE training and industry 4.0 that encompass real equipment. Some include:
- Yaskawa Robotics
- Cognex Vision Sensors
- Siemens PLM
- Allen Bradley PLC
- Miller Welding

Industry 4.0 CLOUD & CYBER-SECURITY
Internet access offers access, monitoring, analysis and visibility to you and external parties. At the same time, access is subject to intrusion or hacking and should be secured.
- Cloud connectivity for remote access and data backup
- Curriculum includes Cyber-Security awareness and tools for cyber monitoring.

SMARTCIM4.0 PG-6
Establishing Core Skills

With iCert 4.0 level 1, students develop a core understanding of manufacturing concepts and components. The program provides a broad interdisciplinary overview of the theory and parts of any manufacturing plant. The outcome is a core knowledge of systems for a machine operator or maintenance technician role with responsibility for competent operation and service of equipment.

STUDENT WILL LEARN TO:

- Understand safety procedures and operate independently in an industrial setting
- Identify the role of components in manufacturing processes
- Operate and maintain a system at maximum capacity including recognizing, troubleshooting and repairing malfunctions
- Fundamental knowledge of tools, documentation, electromechanical systems, fluid power systems, control systems, and robotics
- Effectively work in a collaborative environment, document clearly and communicate efficiently with co-workers
- Operate a robotic arm
- Understand the function of PLC automation and perform basic PLC maintenance
- Describe the function of system components and the interactivity between machines, control elements, and sensors
- Explain the concepts of Manufacturing in an Industry 4.0 Smart Factory
- Fully comprehend the role of smart sensors, and IIoT connectivity in a plant
- Understand fundamentals of data networks and be fully aware of Cybersecurity threats
- Have a fundamental understanding of the role operational data plays in a plant.

CAREER OPPORTUNITIES

- Industrial Maintenance Technician
- Electromechanical Maintenance Technician
- Machine Operator
- Production Technician

FOUNDATIONAL SKILLS

LEVEL 1: FUNDAMENTALS OF MANUFACTURING

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FOUNDATIONAL SKILLS
LEVEL 2: ADVANCED MANUFACTURING

Establishing Specialist Skills

With iCert4.0 level 2, students become specialists and learn to understand the entire system and the codependence of elements. The objective is for graduates to be skilled in implementing, operating, optimizing and analyzing the system as a whole. The outcome will be that they understand how components interact and have an in depth knowledge of the operation, programming and maintenance of the system.

ADVANCED MECHANICAL SYSTEMS & ELECTRICAL SYSTEMS
- Belt Drives, Chain Drives
- Couplings, Electric Brakes
- Industrial Power Electronics

ADVANCED ROBOTICS
- Advanced Robotics
- Collaborative Robots

ADVANCED FLUID POWER
- Electro Hydraulics & Electro Pneumatics

ADVANCED MANUFACTURING SKILLS
- Subtractive Manufacturing (CNC)
- Additive Manufacturing (3D Printing)
- Machine Vision
- Flexible Manufacturing Systems (FMS)
- Computer Integrated Manufacturing (CIM)

ADVANCED MANUFACTURING FOR INDUSTRY 4.0 LEVEL 2

ADVANCED INDUSTRY 4.0 CONCEPTS

ADVANCED IIOT & CONNECTIVITY FOR INDUSTRY 4.0

ADVANCED NETWORKING & CYBERSECURITY FOR INDUSTRY 4.0

INTRODUCTION TO INDUSTRY 4.0 SOFTWARE TECHNOLOGIES

STUDENT WILL LEARN TO:
- Understand, operate, troubleshoot and optimize production lines.
- Have an advanced understanding of electrical, mechanical, hydraulic and pneumatic systems.
- Troubleshoot and tune complex electrical and mechanical components of production lines.
- Operate and modify a PLC programs, operate and program HMI (Human Machine Interface).
- Operate additive and subtractive manufacturing machines including an in depth understanding of CNC programming, CAD and CAM software.
- Be fully familiar with machine vision systems and product identification techniques.
- Integrate smart sensors and inputs into automation-controlled systems.
- Explain communications in industrial settings and be able to configure, connect, troubleshoot devices on the network.
- Identify, avoid, and mitigate cyber threats.
- Become familiar with software tools like Virtual Reality, Simulations, Digital Twinning, Manufacturing Execution Systems (MES) and Artificial Intelligence.
- Gain a solid understanding of the advanced concepts and components of Industry 4.0 manufacturing.

CAREER OPPORTUNITIES
- Robotics programmer
- Mechatronics specialist
- Automation specialist
- Applications Engineer
- Systems Specialist

SMARCIM4.0 PG-10 WWW.INTELITEK.COM +1-603-413-2600 SMARCI4.0 PG-11
LEVEL 3: INTEGRATION FOR INDUSTRY 4.0

Industry 4.0 Integrator Proficiency

At iCert 4.0 level 3, students will learn to combine all their skills to develop integrated and complex Industry 4.0 systems. The objective is to learn systems knowledge, sound engineering practices, and the business side of industry process and process design. The outcome will be students able to be part of Industry 4.0 integration, design and planning teams.

STUDENT WILL LEARN TO:

- Utilize data collected and analyzed in real-time to implement advanced system operation and maintenance plans.
- Understand the benefits of Industry 4.0, and the opportunities and risks of the technologies.
- Utilize connectivity, IIoT and cloud applications for system operation and operational efficiency.
- Explain how system modeling and simulation can support design, optimization and predictive maintenance of production systems.
- Model and simulate a manufacturing cell / system.
- Design and implement manufacturing cell or system.

Career Opportunities

- Automation/Control Specialist
- Systems Integrator
- Manufacturing/Mechatronics Engineer
- Industry 4.0 Integrator
The Industry 4.0 Training Program outlined below is a combination of the SmartCIM4.0 Production Line, a series of standalone trainers and accompanying curriculum. The combined solution is a comprehensive program that will provide students with in-depth training on specific skills found in industry as well as the specific new skills related to Industry 4.0.

**Standalone Trainers**

The SmartCIM4.0 incorporates most of the elements of industry and much of the training is completed on the system itself, but some specific areas of expertise are served by standalone training stations. These include electrical, mechanical, hydraulics, pneumatics, PLCs, sensors, data analysis, IIoT, Virtual Reality/Augmented Reality and some of the integration packages used in the program.

**Curriculum**

The solution is accompanied by a series of learning programs designed for education. The curriculum are integrated with the equipment in the SmartCIM4.0 and the standalone trainers and are heavily focused on hands on and project based learning. The curriculum are developed in three levels to suit the needs of novice, specialist, and expert level as students progress through the program and become more familiar with the tools and technology of a manufacturing plant and Industry 4.0.

**Sustainability**

The hardware, software, applications, components and curriculum are supported by the Intelitek on-going maintenance and efforts to keep the solution updated and the educators trained. Annual train-the-trainer professional development ensures programs are maintained and educators are skilled in all aspects of the program and it’s content.

**SmartCIM4.0**

SmartCIM4.0 is the latest generation of 35 years of CIM systems delivered to educational institutions for advanced training. The system has been upgraded with many enhancements to ensure the components and the content is Industry 4.0 ready and student will learn to install, operate and use the new capabilities just as they may upgrade an existing production line.

**Quality Control with Vision**

Enhanced QC includes Machine Vision part inspection or laser measurements integrated to system reporting.

**IoT and Ethernet**

Diverse communication options offer realtime connectivity to components, and materials for analytics.

**Advanced Robotics**

Robotic arms augmented with collaborative robots and vision sensors for enhanced interactive operations.

**Smart Sensors**

Collect and detect operation and maintenance information for predictive maintenance and fault detection.

**Additive Processes**

3D Printing and Welding add flexibility and innovative manufacturing capabilities to the production line.

**Central Console**

Management and monitoring console for system management MES/ERP applications and training station for Design, AI, VR, Data Analytics, etc.

**Sustainability**

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Real Manufacturing Process

SmartCIM4.0 is not a demo system or made of simulated tools and components. The industrial equipment, conveyors, tools, materials and software in the system manufactures real products and every school using the CIM environment has developed their own unique outcome or variations of outcomes. The system can support multiple product development processes at the same time and this in fact will be a useful feature in educating around Industry 4.0 as processes can be integrated, optimized and machines shared and allocated to different processes as required. Some examples of product outcomes are below:

- Brass Cylinder Turned and Milled
- Plastic Ball Game Parts on Conveyor Pallet
- Laser Engraving on Acrylic Stock
- Engraved Brass Plate & Putter Head
- Robot Gluing the Ball Game Base before Placing Cover on Top
- Brass Pen Holder with Plastic Base
- Completed Ball Game
- Laser Engraving on Acrylic Stock
- Brass Chess Set
- Brass Cylinder Turned and Milled
- Milled Composite Box Bottom

Interoperability - 3rd Party Vendor Integration

SmartCIM4.0 is an open-architecture solution that integrates both Intelitek and many other vendor solutions. Intelitek partner with leading vendors in industry and when specific needs are defined for a solution, we have integrated multiple other vendor products and solutions into the production cycle.

Sustainability - Long Term Partnership

By collaborating with industrial vendors at the forefront of commercial production lines, SmartCIM4.0 is able to maintain an updated educational environment and constantly update and improve the solution technically. Hand in hand with the technical changes, the team working on the solution needs to be constantly retrained and expanded. Professional development and a capable support team are available to commission, train-the-trainer and help introduce new staff members to the system as the school’s program grows and matures.

Program Success Factors - KPIs

Over 35 years of installing and maintaining Computer Integrated Manufacturing in schools worldwide, we have identified Key Performance Indicators that can be measured to indicate success of the program. Student grades, graduation rate, employment into local industry, and success in certification tests are a few. As we address specifics of Industry 4.0 the program can be measured by:

- Student and trainers feedback
- Industry acknowledgement of student outcome levels.
- Students comprehension of Industry 4.0 concepts in evaluations.
- Industry evaluation of curriculum content
- Student completion of the project training up to the level they enroll for
- Percentage of students obtaining certification credentials.

Program Success Factors - KPIs

Industry 4.0 for Education
Capabilities of SmartCIM4.0

SmartCIM4.0 is an integrated system that is used as a full production line. However each individual component and station has its own functionality and can be used both as a production station and as a learning station for students to study and learn a particular topic. Some of the capabilities are listed below.

- Machining
- Materials Handling
- Flexible manufacturing
- Welding
- Pick & Place /Pick & Pack
- Painting
- Palletizing
- Assembly
- Storage & Inventory Management
- Asset Tracking
- Logistics

- Quality Control
- Machine Vision
- Electrical
- Control Systems
- Programmable Automation
- Human Machine Interface
- Sensors
- IoT and IIoT
- Networking/Ethernet
- Motors and Drives
- Belts, chains, gears

- Industrial Maintenance
- Pneumatics
- Hydraulics
- PLC Operation
- PLC Programming
- System Integration
- 3D Printing
- Robotic programming
- Collaborative robotics

Industry 4.0 for Education