The Future of Work: Integrating Emerging and Cross-Cutting Technologies: Edge Computing

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Project Goals

1. Empower community colleges to prepare technicians for the work of the future.
2. Promote regional collaboration between community colleges and industry to determine the technical demands of work of the future.
3. Support ATE Regional Networks focused on technician education for the work of the future.
4. Foster implementation of the cross-disciplinary STEM core to maximize impact on technician education.

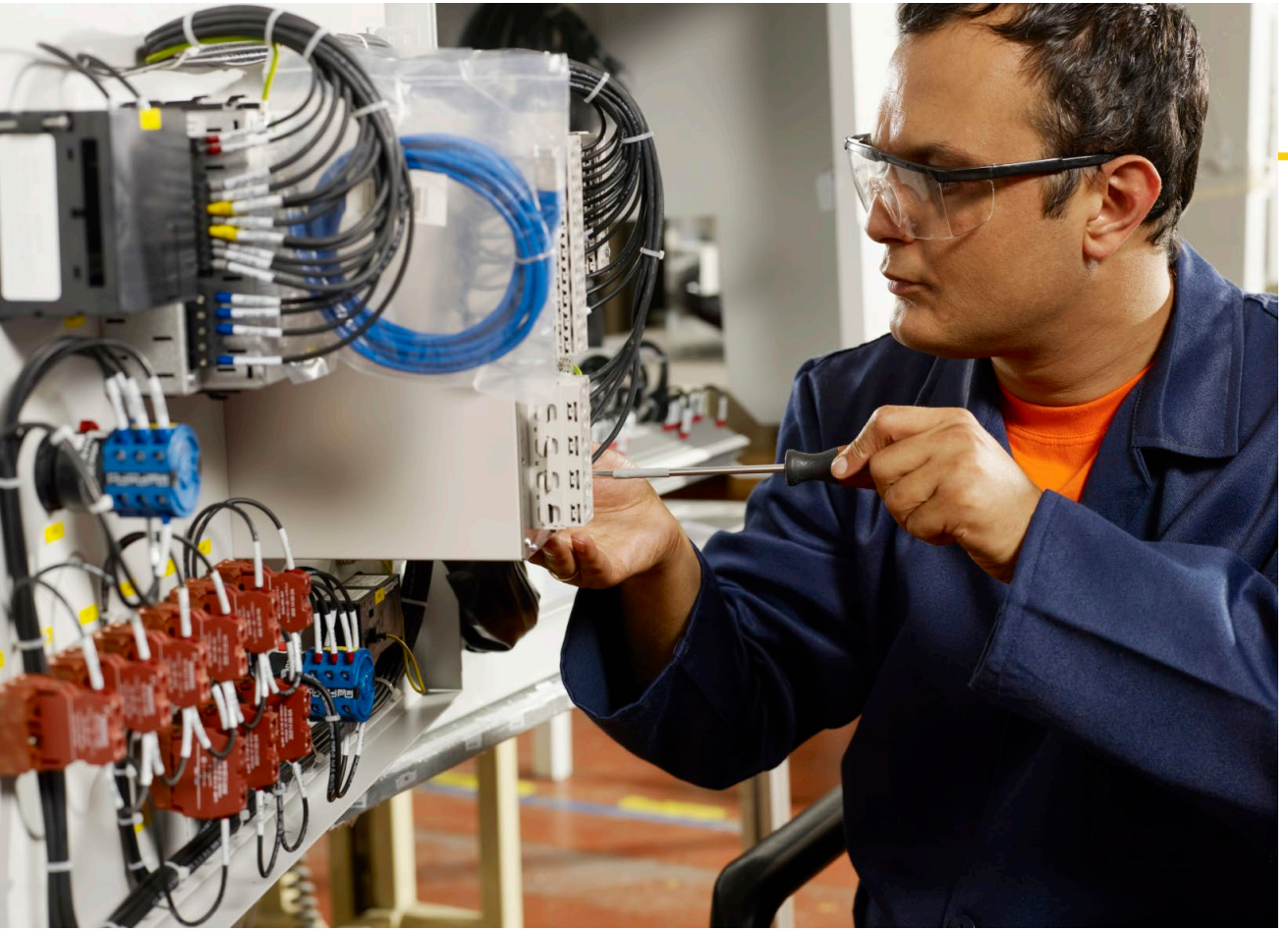
What's Happening?

- Nature of work changing at unprecedented speeds
- Technology advancements in machine learning, AI, IoT, and robotics eliminating some jobs, creating others
- Technicians sit at the center of much of this disruption
- Education must keep up
- Our students' career paths will evolve

Preparing Technicians for the FUTURE OF WORK

preparingtechnicians.org

Future-proofing STEM Technicians



The Cross-Disciplinary STEM Core:

Skill Area 1: Data Knowledge and Analysis

Skill Area 2: Advanced Digital Literacy

Skill Area 3: Business Knowledge and Processes

By Integrating the Cross-Disciplinary STEM Core into Technical Programs

Marilyn Barger
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Preparing Technicians for the FUTURE OF WORK

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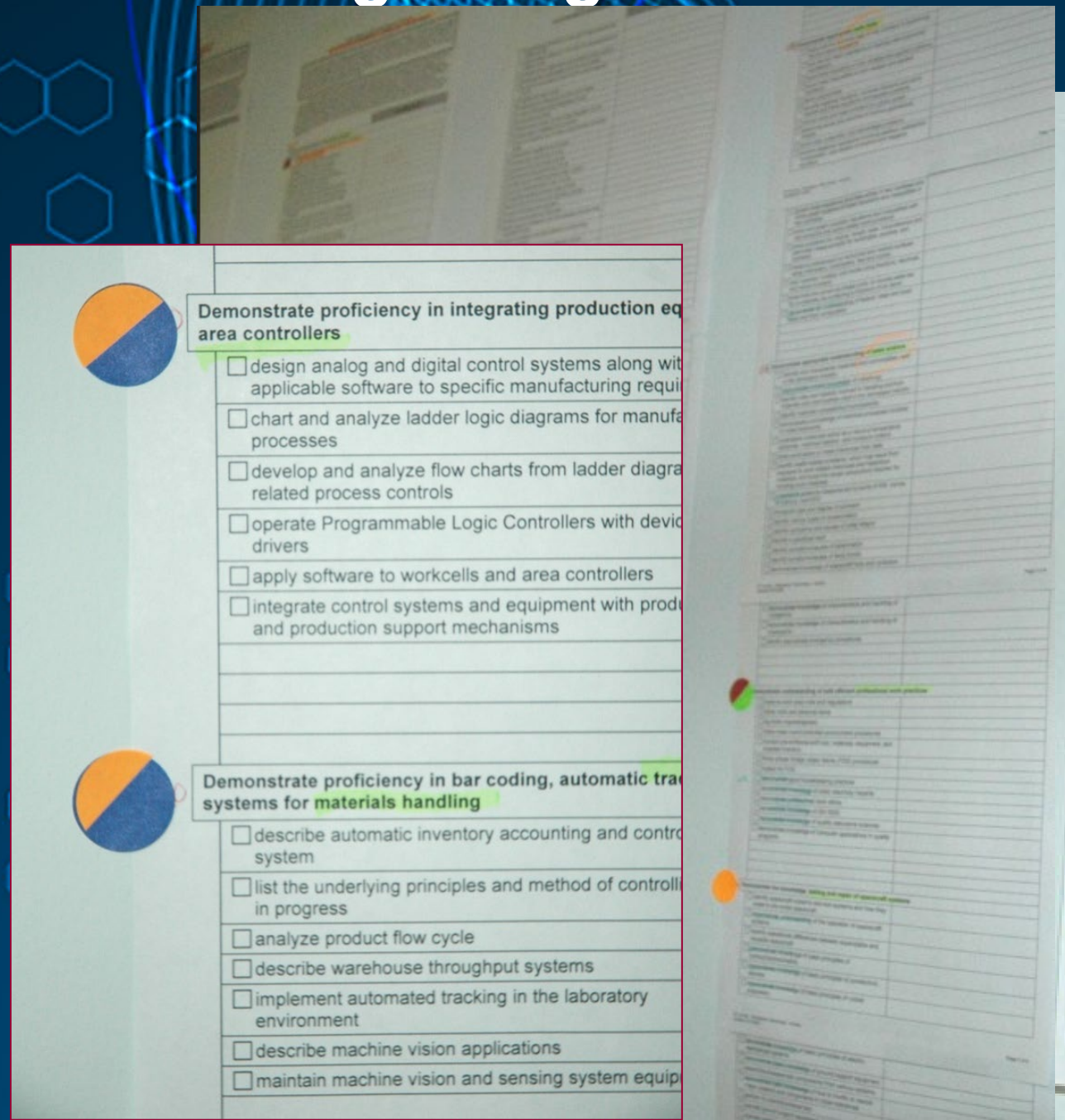
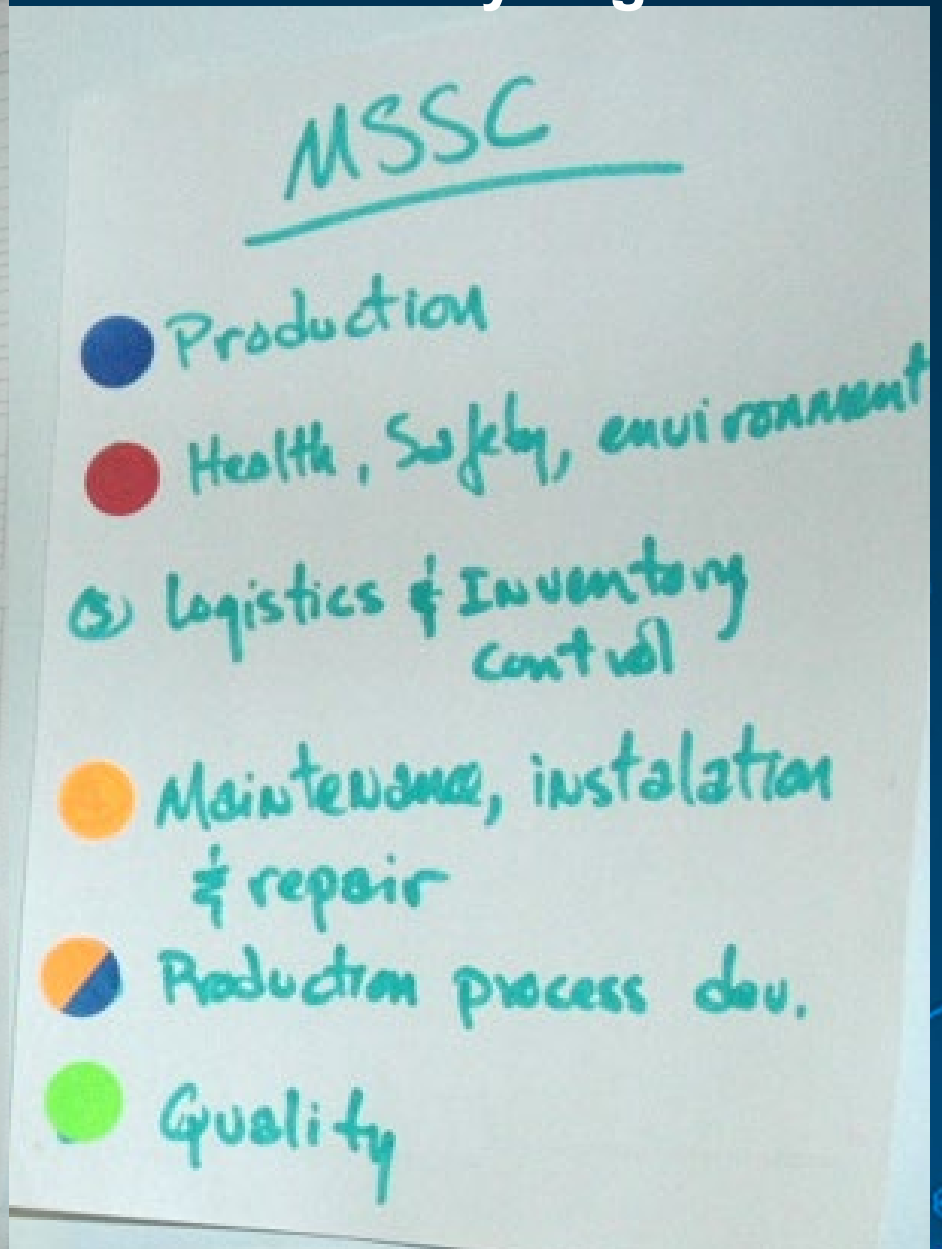
CORD
Leading Change in Education

At Our Beginnings

42 Industry Partners
22 Academic Partners
9 Community Organizations





FLATE
CENTER for MANUFACTURING EDUCATION

AS Engineering Technology Degree

ET Degree Components

I. General Education: 15 -18 hours

English Humanities Math Science Social Science

II. ET Technical Core: 18 credit hours

Computer Aided Design
Manufacturing Processes & Materials
Mechanics & Instrumentation
Electronics
Quality
Safety

III. 11 Specialization Tracts: 24 – 27 credit hours

Advanced Manufacturing
Alternative Energy
Advanced Technology
Biomedical Systems
Digital Design & Modeling
Digital Manufacturing
Electronics
Mechanical Design & Fabrication
Quality
Relay Substation
Supply Chain Automation
Advanced Industrial Automation

ET Degree GOALS:

- **Increase enrollment.**
- **Provide multiple entry and exit options.**
- **Meet industries' workforce. needs for skilled technicians.**
- **Remove course duplications.**
- **Integrate Industry-approved credentials.**

Florida Technician 21st Century Skills Needs

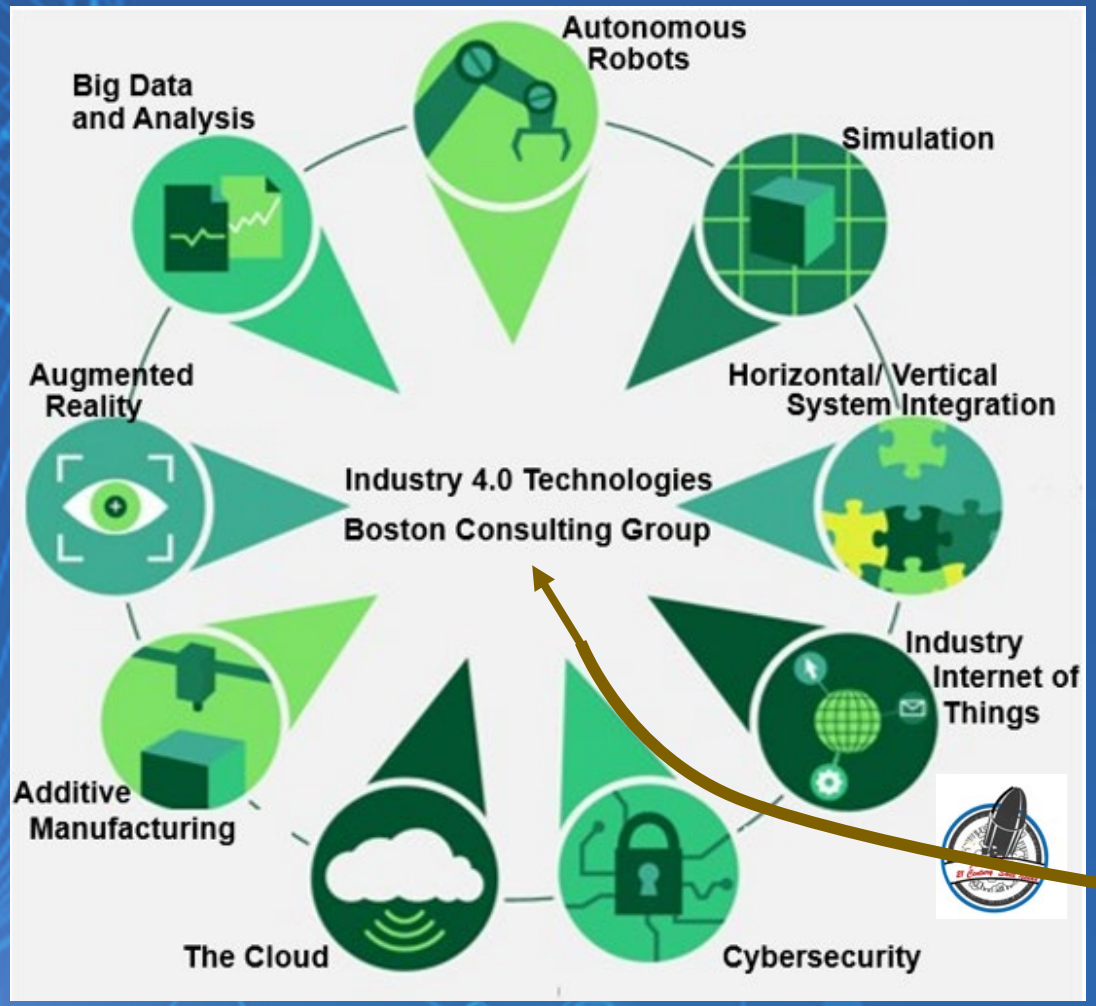
NSF ATE # 21248138: Future of Work ISSUES FOR Florida Two-Year Engineering Technology Program

Industry Educator

Questionnaires

Research I 4.0 Technologies

Define I 4.0 Technician Skills



Publish Results

Interpret Data

Define Skills Gap

Virtual Caucus 2

37 ET Skills

Virtual Caucus 1

NSF #1939173:
Technician Future of Work Issues Caucus for Florida Community Colleges and Manufacturers

Updating Florida's ET Pathways

Florida Manufacturers' Choice of Vocabulary

1 Ask 5 Whys
2 Brainstorming
3 Cloud
4 Critical Thinking
5 Data Integrity
6 Programming
7 Prototyping
8 Quality Testing
9 Test & Executing
10 Three D Printing
11 Write SOP

12 Data Interpretation
13 Destructive Testing
14 Fishbones
15 Integrating Systems, PLC
16 Interdisciplinary Skills
17 Material Knowledge
18 Material Testing
19 Provide Design Data
20 Reverse Engineering
21 Support Mockup/Test
22 Troubleshooting
23 Use Root Cause Analysis

24 Awareness of the Security Requirements
25 Basic Understanding of Databases & Networks
26 Building/ Assembling Prototypes
27 CAD Layout for Production Processes
28 Diagnose & Understand Full Process
29 Ensure Measurement has Uncertainty Stated
30 Human Factors and Interactions
31 Identify Opportunities for Improved Products
32 Integration Eng. Tech. / Adv. Mfg. / Computing
33 Knowledge of Product Standards and Regulations
34 Math, Communication, Teamwork, Solve Problem
35 Spreadsheet Creation & Manipulation
36 Use Technical Tools to Identify Root Causes
37 Write Technical Reports including Data

Skills are not prioritized, but are arranged for easy visual review

Skill matched to the Florida Department of Education Standards and Benchmarks

1 Ask 5 Whys
2 Brainstorming
3 Cloud
4 Critical Thinking
5 Data Integrity
6 Programming
7 Prototyping
8 Quality Testing
9 Test & Executing
10 Three D Printing
11 Write SOP

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37 Write Technical Reports including Data

Thirty-three of these Skills are covered.

Current Status

Identified I4.0 Skill Sets Absent from Standards		
	Core	Adv. Manufacturing Specialization
Cloud Skills	none	none
Data Base Skills	none	none
Data Integrity	none	none
Integrating Systems (using PLCs)	none	12.0, 14.0, 15.0, 16.0, and 17.0
Data Interpretation	Vague Connection	
Interdisciplinary	Vague Connection	
Security Requirements	Vague Connection	

Manufacturers indicated that Cloud Information Technology skill expectations for manufacturing technicians depend on their overall experience with Operational Technology..

The project team is interacting with Daytona State College to use an Advanced Technical Certificate to meet both knowledge and "standards" needs.

Identified I4.0 Skill Sets Absent from Standards

Skills are found in one of the 3 skill areas of the CROS-DISCIPLINARY STEM Core.

- ***Data Base Skills***
- ***Data Integrity***
- ***Integrating Systems (using PLCs)***
- ***Data Interpretation***
- ***Interdisciplinary***
- ***Security Requirements***

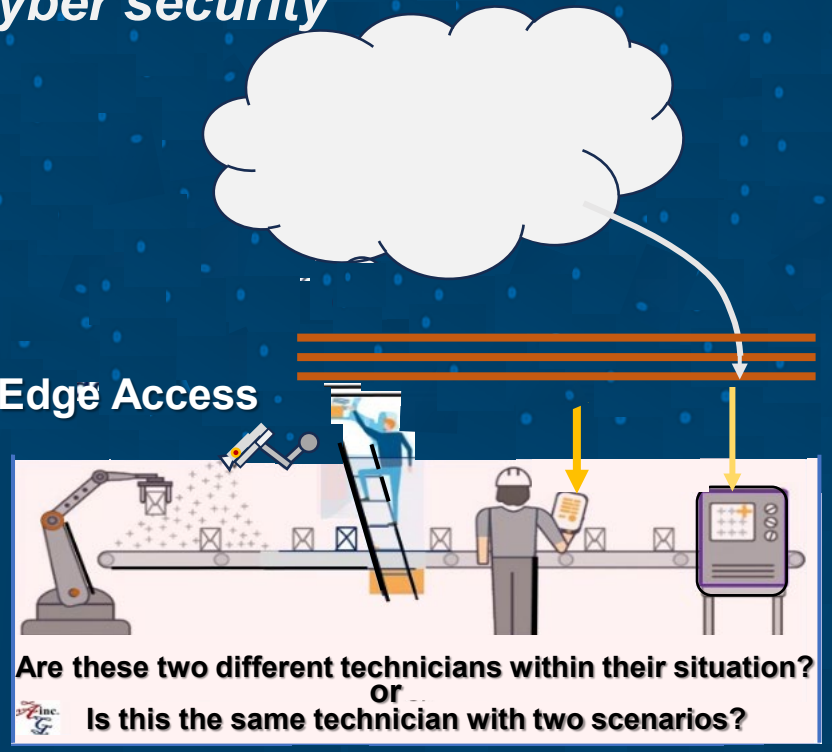
EDGE COMPUTING

Responding to Industry 4.0 Driven Required Skills with Edge Devices

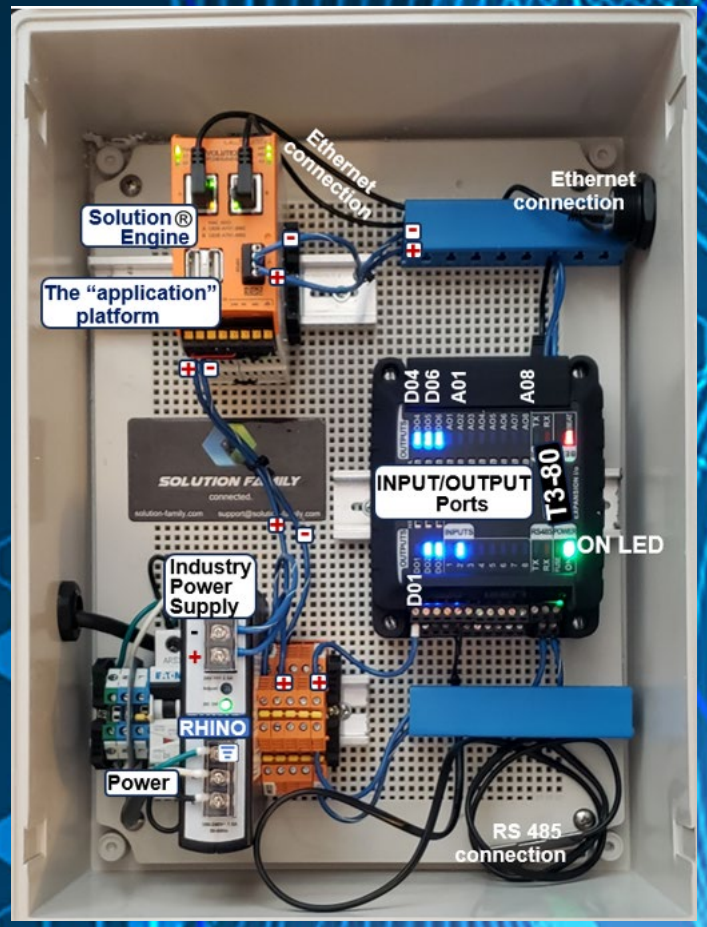
Technicians working with I4.0 Operation Technology need a subset of Internet Technology

To support manufacturing processes that require edge computer interactions.

To avoid cyber security mistakes.

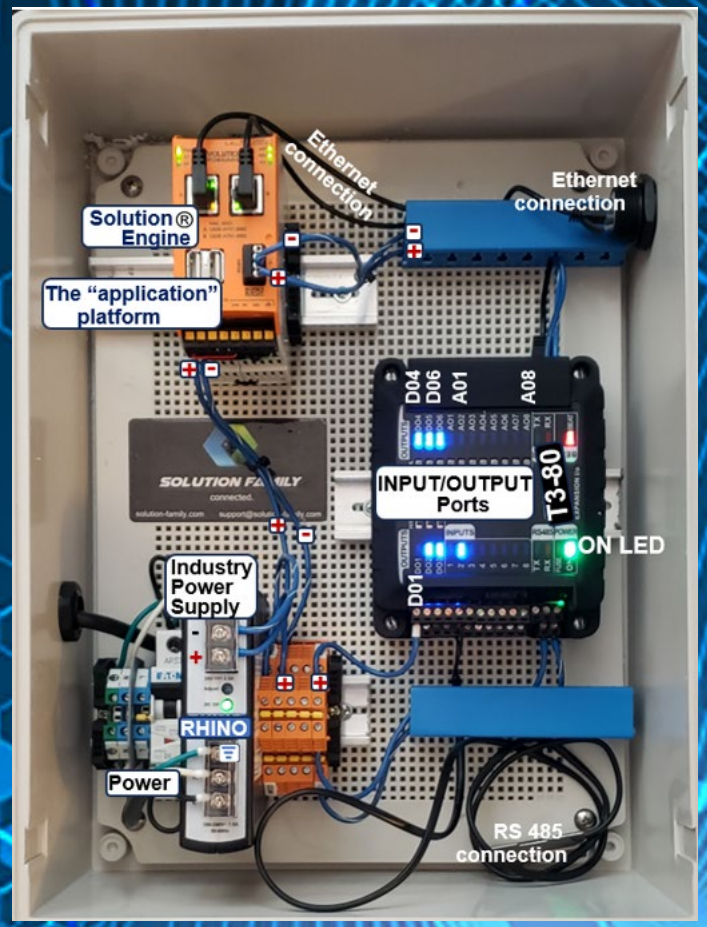


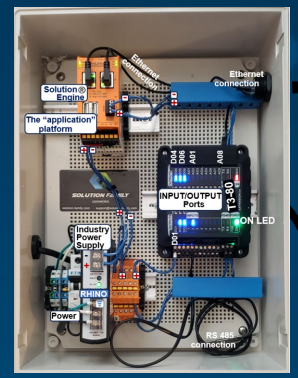
Skills are found in one of the 3 skill areas of the CROSS-DISCIPLINARY STEM Core.

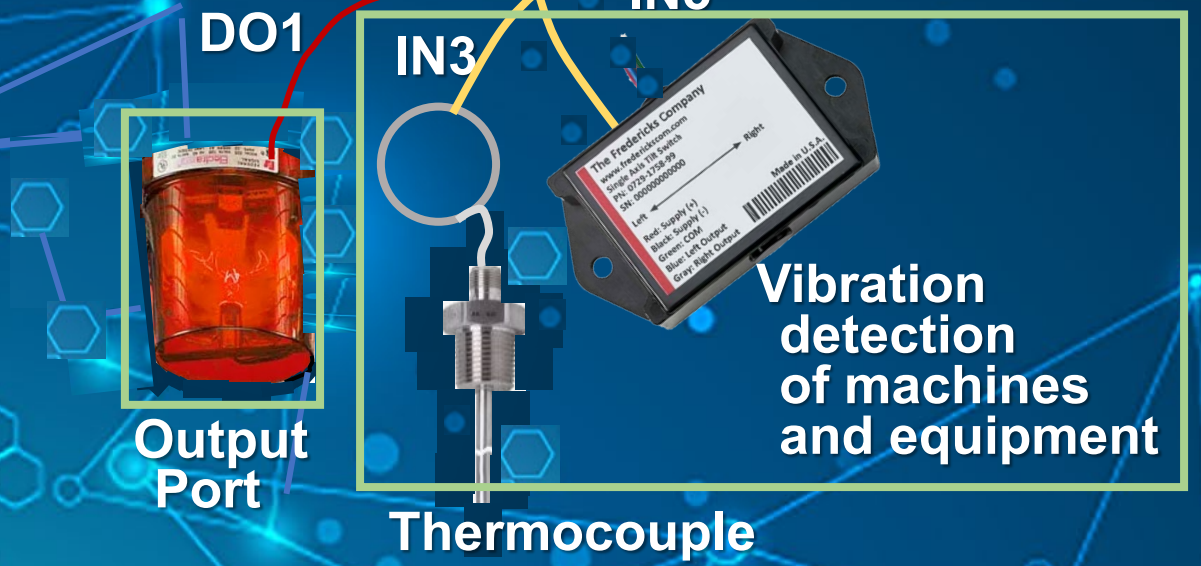


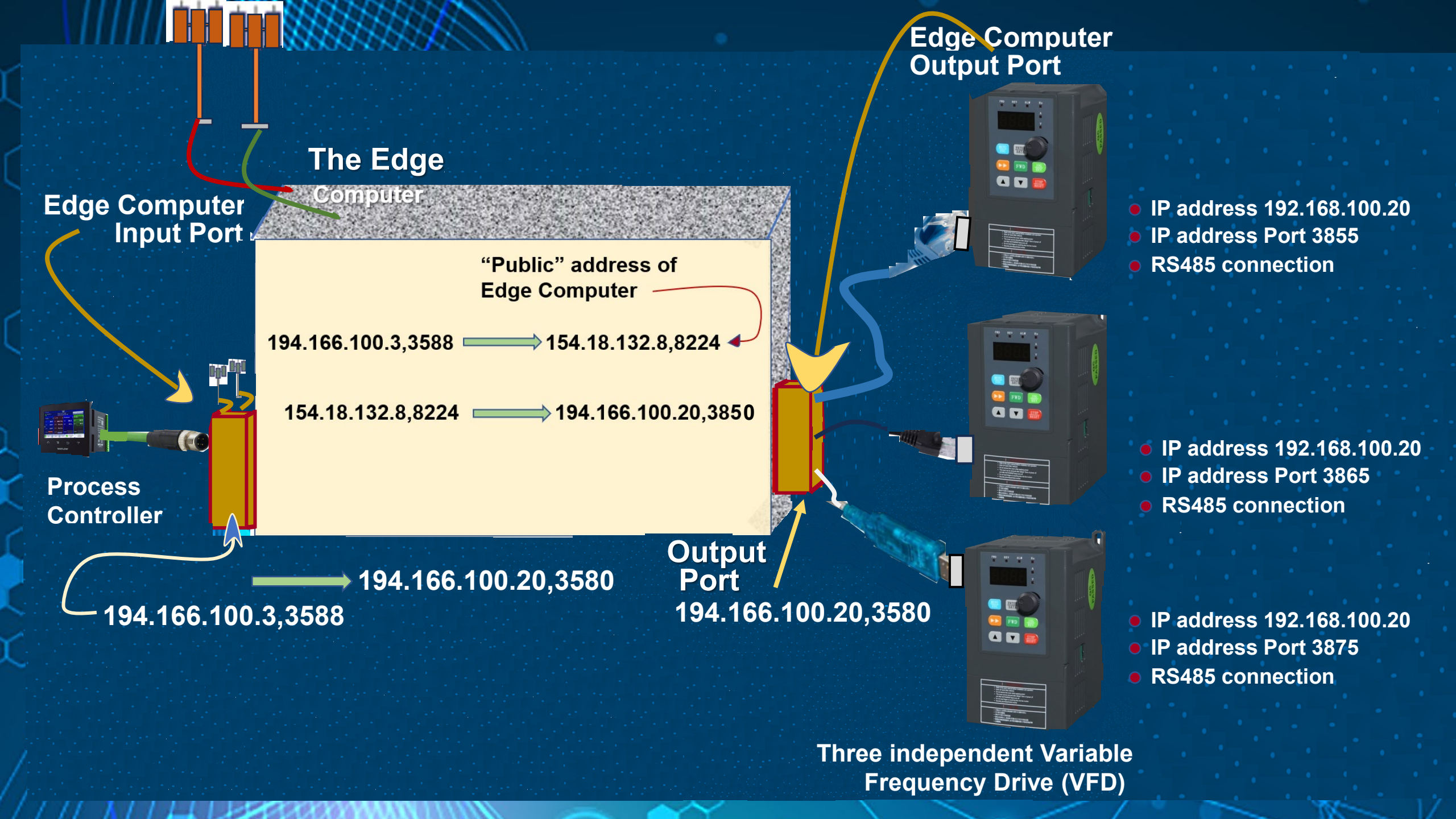
https://www.sme.org/technologies/articles/2021/september/lims-edge-device-expedites-entry-into-industry-4.0-production-competitiveness/

Skills are found in one of the 3 skill areas of the CROSS-DISCIPLINARY STEM Core.








Edge Computer
Output Port
The Edge
Computer
Edge Computer
Input Port
"Public" address of
Edge Computer
194.166.100.3,3588
154.18.132.8,8224
154.18.132.8,8224
194.166.100.20,3850
Process
Controller
194.166.100.20,3580
194.166.100.3,3588
Output
Port
194.166.100.20,3580
IP address 192.168.100.20
IP address Port 3855
RS485 connection
IP address 192.168.100.20
IP address Port 3865
RS485 connection
IP address 192.168.100.20
IP address Port 3875
RS485 connection
Three independent Variable
Frequency Drive (VFD)

Responding to Industry 4.0 Driven Required Skills with Edge Devices

Responding to Industry 4.0 Driven Required Skills with Edge Devices

Attention
for your
Thanks

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gilbert@usf.edu

Data Knowledge and Analysis

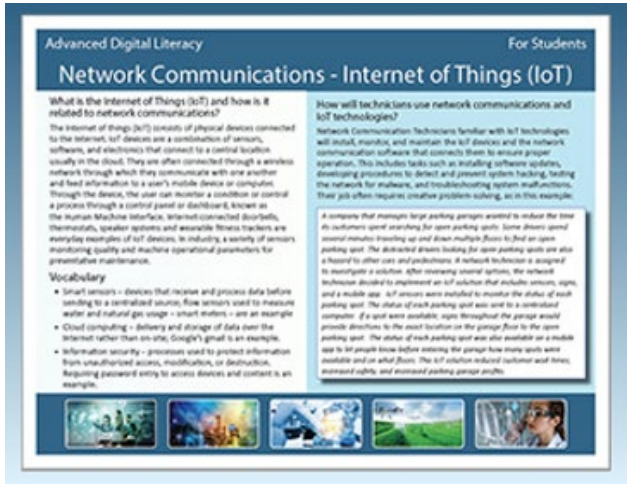
Manipulate and interpreting data to resolve issues and using Excel and other common software proficiency to accomplish tasks

Instructional Activity Cards

- Analytical Tools
- Data Visualization
- Data Literacy/Fluency
- Data Visualization

Advanced Digital Literacy

Understanding digital communications and networking, cybersecurity, machine learning, sensors, programming, and robotics at a higher than introductory level



Instructional Activity Cards

- Automation/Robotics/HMI
- Basic Programing-Python
- Digital Twins
- Network Analysis

Business Knowledge and Processes

Understanding the value chain and business practices of an enterprise and applying principles of ethical adoption of new technology

Instructional Activity Cards

- Communication
- Entrepreneurship
- Lean Processes
- Supply and Demand

Cross-Disciplinary Instructional Cards

Data Knowledge and Analysis

Manipulating and interpreting data to resolve issues and using Excel and other common software proficiently to accomplish tasks

DATA KNOWLEDGE AND ANALYSIS — For Students

Data Visualization

What Is Data Visualization?

Data visualization represents information in the form of a chart, diagram, picture, or infographic so that the data can be quickly and easily understood. Technicians use data visualization software to create graphics that communicate complex and relational information to a variety of audiences.

Vocabulary

- Dataset – a collection of data, often organized in a spreadsheet or database
- Chart – a graphic representations of data; examples are charts, pie charts, histograms, line graphs for example
- Scale – marks on a visualization that indicate the range of data values presented. A scale on a graph reflects the magnitude of the data presented.

Common Types of Data Visualization

- A pie chart uses "pie slices" to show relative sizes of data.
- A histogram uses bars of different heights to group data into range.
- A scatter plot uses points plotted on an XY axis to show the relationship between two sets of data.

How will a technician use data visualization?

Evan Garcia is a technician for Green Mountain Power Company. He is responsible for tracking increased system outages over time across a metropolitan network, collects outage statistics, including system logs, environmental information, and helpdesk ticket details from network nodes and service centers in order to determine the cause. Evan stores the data in an Excel workbook, then imports data into SAS, Tableau, or MS Power BI visualization tools and creates a dashboard to present to management. The data dashboard provides an interactive geographical heat map showing outage details and other graphical representations of his data analysis of the event. The heat map allows management to make real time decisions and troubleshoot problems.

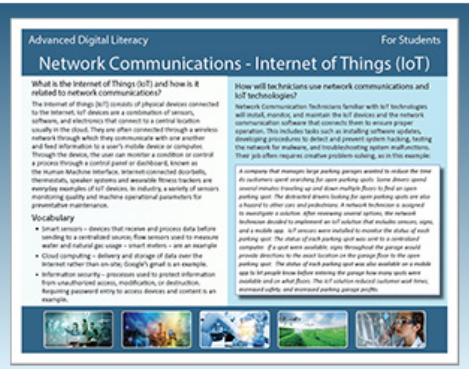
A heat map uses a warm-to-cool color spectrum to represent data values by color.

Instructional Activity Cards:

- Data Visualization
- Data Literacy/Fluency
- Spreadsheets
- Analytics Tools

Advanced Digital Literacy

Understanding digital communications and networking, cybersecurity, machine learning, sensors, programming, and robotics at a higher than introductory level


Advanced Digital Literacy — For Students

Network Communications - Internet of Things (IoT)

What is the Internet of Things (IoT) and how is it related to network communications?

The Internet of things (IoT) consists of physical devices connected to the Internet. IoT devices are a combination of sensors, software, and electronics that connect to a central location usually in the cloud. They are often connected through a wireless network through which they communicate with one another and feed information to a user's mobile device or computer. Through the device, the user can monitor a condition or control a process through a control panel or dashboard, known as the Human Machine Interface. Internet-connected doorbells, thermostats, speaker systems and wearable fitness trackers are everyday examples of IoT devices. In industry, a variety of sensors monitoring quality and machine operational parameters for preventative maintenance.

Vocabulary

- Smart sensors – devices that receive and process data before sending to a centralized source; flow sensors used to measure water and natural gas usage – smart meters – are an example
- Cloud computing – delivery and storage of data over the Internet rather than on-site; Google's gmail is an example.
- Information security – processes used to protect information from unauthorized access, modification, or destruction. Requiring password entry to access devices and content is an example.

How will technicians use network communications and IoT technologies?

Network Communication Technicians familiar with IoT technologies will install, monitor, and maintain the IoT devices and the network communication software that connects them to ensure proper operation. This includes tasks such as installing software updates, developing procedures to detect and prevent system hacking, testing the network for malware, and troubleshooting system malfunctions. Their job often requires creative problem-solving, as in this example:

A company that manages large parking garages wanted to reduce the time its customers spent searching for open parking spots. Some drivers spend several minutes traveling up and down multiple floors to find an open parking spot. The distracted drivers looking for open parking spots are also a hazard to other cars and pedestrians. A network technician is assigned to investigate a solution. After reviewing several options, the network technician decided to implement an IoT solution that includes sensors, signs, and a mobile app. IoT sensors were installed to monitor the status of each parking spot. The status of each parking spot was sent to a centralized computer. If a spot were available, signs throughout the garage would provide directions to the exact location on the garage floor to the open parking spot. The status of each parking spot was also available on a mobile app so let people know before entering the garage how many spots were available and on what floors. The IoT solution reduced customer wait times, increased safety, and increased parking garage profits.

Instructional Activity Cards:

- Network Communications – Internet of Things
- Automation/Robotics/HMI
- Basic Programming-Python
- Digital Twins
- Network Architecture
- AI and Machine Learning

Business Knowledge and Processes

Understanding the value chain and business practices of an enterprise and applying principles of ethical adoption of new technologies

Business Knowledge & Processes — Student Resource

ENTREPRENEURSHIP

What Is Entrepreneurship?

Entrepreneurship is the concept of developing and overseeing a new business for profit. Working inside a company and thinking like an entrepreneur by asking "how can we improve this process?" is just as important. Entrepreneurship means thinking beyond troubleshooting or problem solving. It involves taking extra effort that yields potential new products, services or processes.

Vocabulary

- **Entrepreneur**—An individual who starts a new business venture. Typically, the individual who takes on most of the risk and develops the business concept.
- **Venture**—A business enterprise in which the expectation of gain is accompanied by the risk of loss or failure.
- **Capital**—The wealth or assets available to invest in a business.
- **Business Model**—A description of how a business will be able to create and deliver value and become profitable.
- **Market Research**—Relevant data that helps demonstrate market potential for a business venture.
- **Intellectual Property**—Works or inventions that is the result of creativity to which one has rights and can apply for a patent, copyright, or trademark.

How will an entrepreneurial mindset be used in the workplace?

An Industry 4.0 technician of tomorrow needs creative and entrepreneurial thinking as a new, expected skill. John Grianne is an automotive technician at Advanced Auto. Lately John and his team have experienced several customer complaints regarding repair times. Using an entrepreneurial mindset, John identified the problem and then researched possible solutions and their value propositions. He asked questions like: how much is customer satisfaction and loyalty worth? and how much time and money can be saved through more accurate diagnosis and efficient repair? He then approached his supervisor about a potential solution he has researched that will provide better customer service, shorter wait times, and fewer errors by the technicians, resulting in higher profits for the business.

In another example, Casey Sanders is a robotics technician at Cooper Biologic, an automated filling and packaging company. Over the last seven days, a robot gripper has been dropping every hundredth vial. The fault affected everything down the line, to the point at which several boxes shipped to a customer were short a few vials. This is clearly not an acceptable business practice. Casey applied troubleshooting skills to

Instructional Activity Cards:

- Entrepreneurship
- Communication
- Lean Processes
- Supply and Demand

At the Project Website:
Preparingtechnicians.org
Tools and Resources to Help You Take Action

- Read and share *A Framework for a Cross-Disciplinary STEM Core*
- Download, share and implement cross-disciplinary instructional cards in your class
- Listen to podcasts featuring cutting-edge industry interviews
- Share recorded webinars

Podcasts

Episode 38: Technicians in the New Blue Economy
Podcast Guest: Justin Manley, President of Just Innovation, Inc. April 2022 |

Read More »

Episode 37: Incorporating the Internet of Things
Podcast Guests: Kristine Christensen, Director of Faculty Development, Professor of MIS, Moraine

Read More »

Episode 36: Supply Chain Automation In Transition
Podcast Guest: Phil Gilkes, Regional Maintenance Manager, Dollar Tree Distribution Centers February 2022

Read More »

What Should Educators Know and Do about Preparing Technicians for the Future of Work?
Podcast Interviews Provide Direction

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i. **Podcasts: Automation, Robotics, and Advanced Manufacturing**
ii. **Podcasts: Digital Skills, Digital Mastery. Digital Twins, Simulation**
iii. **Podcasts: Industry, Factory, and Education Trends**
iv. **Podcasts: New Skills, New Generations of Students**

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i. **Podcasts: Automation, Robotics, and Advanced Manufacturing**

AUTOMATION, ROBOTICS, AND ADVANCED MANUFACTURING		
Topic and Episode(s)	**Discovery**	**Recommended Action**
1. A Robot for Every Technician? PC13 and PC22	A robot for every technician is an emerging trend in the workplace.	Ask yourself if it is possible for you to consider something similar in your education and training space? A robot (or an automated system) for every student, in every learning situation?

Recordings of This Webinar Series

1. Preparing Technicians Using the Cross-Disciplinary STEM Core
2. Professional Development and Instructional Resources
3. Future of Work: Integrating Emerging Technologies

https://www.preparingtechnicians.org/webinars/