Educational Programs and Workforce Development for Industry 4.0

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CATALYST CONNECTION
Your Strategic Partner for Manufacturing Growth

Outline

- Needs of Manufacturing Industries
- Different forms of education/levels of training:
  - Executive Education
  - Graduate Degrees
  - BS Degrees
  - Associate Degrees
  - Workforce Training Programs
- Conclusions

Needs of Manufacturing Industries

- **Until recently, manufacturing industries has been lacking skilled workers** i.e. welders, CNC machinists..
- Like every new technology, new type of jobs are being created requiring new skill sets (reinventing work, not displacing)[1,2]..
  - **Collaborative Robots, IIoT, Data Analytics, Machine Learning, and Digital Twins will make manufacturing safer, more efficient, and productive..**
  - **To address the needs of Industry 4.0 workforce, companies need to retain, retool of the existing skilled workforce, and recruit a new one..**

Needs of Manufacturing Industries

- Training is required anywhere from **executives' need of understanding the nature and power of Industry 4.0, to preparing engineers who design and help build**, and **technicians who build and maintain the infrastructure**, **along with data analysts/computer scientists dealing with big data and AI applications.**
- The following section details small number of existing programs directly targeting the Industry 4.0 workforce development, mainly in IoT.

Executive Education

- **Business Implications and Opportunities of IoT[3]**
  - MIT Management Executive Education Program
  - Self-Paced Online Training – 6 weeks, 6-8 hours/week
- **"IoT is not a technology, it is a leadership opportunity; a mechanism to transform businesses."**
- Aims to help executives envision/lead IoT-based transformations – by **achieving strategic advantage IoT drives**.

Executive Education

- The course provides:
  - "Introduction to the **technologies, skill components, enablers and constraints** for using IoT in business.
  - **Examples where IoT is already transforming customer experience, operations and business models**
  - Explains the **elements of leadership capability that makes transformation possible**.
  - **Real-world case studies, senior executive interviews, self-assessments and practical assignments** guide the participants as they construct **a roadmap to gain strategic advantage from IoT**".

Graduate Degrees

- **University of New Mexico (UNM) Online** is offering an **MS degree in Computer Engineering with a specialization in IoT^4**:
- **31 credit program/8 week courses**
  - "Students will learn **how to develop the software and hardware sys**tems that **allow devices to collect and exchange data on a massive scale**...
  - Students who successfully complete the curriculum will be prepared **for entry into the computer industry or related fields of study such as autonomous and electric vehicles, smart grid, situational awareness for smart health, crowdsourcing based services, and security for smart cities**."

UNM Online MS in CE - IoT

- **Required Courses (13 credit hours):**
- ECE 517 Machine Learning
- ECE 531 Introduction to Internet of Things
- ECE 537 Foundations of Computing
- ECE 540 Advanced Networking
- ECE 590 Graduate Seminar (1)

- **Additional Elective Courses (18 credit hours):**
- ECE 439 Introduction to Digital Signal Processing
- ECE 514 Nonlinear and Adaptive Control
- ECE 522 Hardware Software Codesign with FPGA's
- ECE 525 Hardware-Oriented Security and Trust
- ECE 529 Introduction to Cybersecurity
- ECE 530 Introduction to Cloud Computing
- ECE 535 Satellite Communications
- ECE 595 ST: Stochastic Processes (1.5)
- ECE 595 ST: Optimal Estimation and Filtering (1.5)
- ECE 595 ST: Cybersecurity II
- ECE 595 ST: Radiation Effects on Electronics

BS Degrees

- **Florida International University (FIU) Online has been offering a 120 credit Online BS Internet of Things degree since 2017[5].**
  - General Education/Mathematics & Science Courses (60-61 credits)
  - IoT Core Courses (49-50 credits)
  - CS/EE/CE Electives (10 credits)
  - Stand alone – similar to ECE preparation with a concentration/specialty in IoT
  - Practically oriented technology type of curriculum due to presence of higher level math and having non-calculus based physics
- Devry University is offering **a BS degree in Mobile and Networked Devices** encompassing[6]
  - Concepts and techniques to navigate information technology and mobility, networked devices and embedded systems, the ecosystem of the IoT, information security and mobile devices.

FIU Online BS in IoT

- **General Education/Mathematics & Science Courses (60–61 credits):**
- SLS 1501 First Year Experience (1)
- ENC 1101 Writing and Rhetoric I
- ENC 1102 Writing and Rhetoric II
- Humanity G1 – Suggested HUM 1020 Introduction to Humanities
- Humanity G2 – Suggested AFH 2000 African Civilizations
- Social Science G1 - SYG 2000 Introduction to Sociology
- Social Science G2 - LBS 3001 Introduction to Labor Studies
- Art – Suggested COM 3404 Nonverbal Communication
- Electives – ELE UCC1 (19 credits)
- Math 1 – MAC 1105 College Algebra
- Math 2- MAC 1114 Trigonometry
- Science 1 – PHY 2053 Physics without Calculus I (4)
- Science 1 – PHY 2048L General Physics I Lab (1)
- Science 2 – PHY 2054 Physics without Calculus II (4)
- Science 1 – PHY 2049L General Physics I Lab (1)
- COP 2250 Java Programming

FIU Online BS in IoT

IoT Core Courses (49-50 credits):

- CTS 1120 Fundamentals of Cybersecurity
- CGS 2518 Data Analysis
- EEL 2880 Applied Software Techniques in Engineering
- CGS 3721 Introduction to Human Computer Interaction
- CGS 3767 Computer Operating Systems
- TCN 4211 Telecommunications Networks
- EEL 4730 Programming Embedded Systems
- EEL 4734 Embedded Operating Systems
- EEE 4717 Introduction to Security of IoT and Cyber-Physical Systems
- TCN 2720 Introduction to IoT (2)
- EGN 2271 Introduction to Circuits and Electronic Hardware
- CDA 3104 Introduction to Computer Design
- CNT 3142 Microcontrollers for IoT Devices
- CNT 3162 Introduction to Wireless Communications for IoT
- CNT 3122 Sensors for IoT
- CNT 4165 Network Protocols for IoT
- TCN 4940 Senior Project

FIU Online BS in IoT

- **CS/EE/CE Electives (10 credits):**
- Network Forensics and Security:
  - TCN 4081 Telecommunication Network Security (Prereq: TCN 4211)
  - TCN 4212 Telecommunication Network Analysis and Design
  - TCN 4431 Principles of Network Management and Control Standards
  - CNT 4185 IoT Privacy (Prereq: EEL 2880)
  - CNT 4188 IoT Forensics
- Cyber Security:
  - EEL Ethical Hacking and Countermeasures
  - EEL 4802 Introduction to Digital Forensics
  - EEL 4802 Introduction to Malware Reverse Engineering
- Entrepreneurship:
  - EEL 4933 Engineering Entrepreneurship
  - EEL 4951 Engineering Business Plan Development
  - EEL 4851 Introduction to Business Decisions

FIU Online BS in IoT

- Data System Software:
  - MAD 2104 Discrete Mathematics
  - COP 2210 Computer Programming I
  - COP 3337 Computer Programming II
  - COP3530 Data Structures
  - COP 4338 Computer Programming III
  - COP 4604 Unix Programming
  - COP 4610 Operating System Principles

Associate Degrees

- Miami Dade College (MDC) started offering a 60 credit AS degree in IOT Applications in 2018[7].
- The industry itself faces the challenge of finding enough people with IoT skills to develop, deploy and support connected devices. The program overcome prepare graduates for career opportunities like:
  - IoT Programmer, IoT Developer, IoT Consultant
  - Product Application Assistant, Rapid Prototyping Assistant
  - Connected Devices Support Specialist
  - Embedded Software Developer, Embedded Application Programmer

MDC AS in IoT

- **General Education Requirements (15 credits)**
- 1. COMMUNICATIONS
- ENC 1101 - English Composition 1
- 2. ORAL COMMUNICATIONS
- SPC 1017 - Fundamentals of Speech Communication
- 3. HUMANITIES
- PHI 2604 - Critical Thinking/Ethics
- 4. BEHAVIORAL/SOCIAL SCIENCE
- CLP 1006 - Psychology of Personal Effectiveness
- 5. MATHEMATICS
- MAC 1105 - College Algebra
- COMPUTER COMPETENCY
- Test type(s) needed:
- Computer Competency Test (CCT)
- ---or---
- CGS 1060C - Introduction to Computer Technology & Applications

MDC AS in IoT

- **Major Course Requirements (21.00 credits)**
- CGS 1060C - Introduction to Computer Technology & Applications (4 credits)
- CGS 1540 - Data Concept Design (4 credits)
- CIS 2331 - Systems Analysis, Design and Implementation (5 credits)
- COP 1334 - Introduction to C++ Programming (4 credits)
- COP 2800 - Java Programming (4 credits)

- **Program Electives (24.00 credits)**
- **Must take 16.0 credits from the following group.**
- CEN 2211 - C/C++ Programming for Embedded Devices (4 credits)
- CEN 2212C - Introduction to Programing the IoT (4 credits)
- CET 2186C - Design and Prototyping of Connected Devices (4 credits)
- CTS 2466C - IoT development with C# (4 credits)
- **Must take 8.0 credits from the following group.**
- CGS 2091 - Professional Ethics and Social Issues in CS (4 credits)
- COP 2335 - Object Oriented Programming using C++ (4 credits)
- COP 2842 - Developing Websites using PHP/MYSQL (4 credits)

Workforce Training Programs

- The Cisco Learning Network has been offering multiple IoT certifications[8].
- SME's Tooling U. has been addressing some of the new skill gaps[9].
- RMU Digital Manufacturing training with 42 hour training courses
    - Computer-Aided Design
    - Computer-Aided Manufacturing and CNC Machining
    - 3D Printing/Additive Manufacturing and 3D Scanning
- RMU has a Mechatronics minor, but mainly used in students preparation in ECE subjects.
    - Previous work in AR/VR Applications in IoT
    - Planning to develop new certification programs under the PA training grants.

Conclusions

- IoT workforce **need will grow by 50% by 2020[10].**
- Industry 4.0/IoT training needs are being addressed by **a wide range of efforts, varying from executive education to workforce training.**
- **Manufacturers are engaging public private partnerships in development of standard skill certifications and advanced manufacturing career pathways[11].**
- Number of academic programs **directly targeting IoT is very small**. A few started since 2017.
  - **Growing number of EE, CE, or ECE programs are offering at least one course** in IoT design and applications.
  - Most of the development efforts are focused on **professional and career development types in technologist and technician programs.**
  - FIU, Devry, Miami Dade College

Thanks for your time!
Questions?