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Integrating Art, Microcontrollers, and Social Awareness to Understand the Lifecycle of Microelectronics (Resource Exchange)

Dr. Cristian Eduardo Vargas-Ordonez, South Dakota School of Mines and Technology

Cristian Vargas-Ordonez is an Assistant Professor of Mechanical Engineering at the South Dakota School of Mines. He has a Ph.D. in Engineering Education from Purdue University, a Master in Education from the University of Los Andes in Colombia and a Master in Science, Technology, and Society from the National University of Quilmes in Argentina.

Yash Ajay Garje, Purdue University at West Lafayette (COE)

Yash is a Ph.D. student at the School of Engineering Education at Purdue University. His research aims at broadening student participation in STEM through robotics education. His research focuses on enhancing STEM participation through robotics education, employing learning technologies and storytelling to craft inclusive educational experiences that foster student belonging.

Shauna N Adams, Purdue University at West Lafayette (COE)

Shauna is a PhD student and graduate research assistant in Engineering Education at Purdue University. Shauna uses both qualitative and quantitative methods to look at historically excluded and underrepresented groups in engineering in both formal and informal settings within assessment, program evaluation, and program design. Currently, she is researching volunteers in informal pre-college engineering programs. She previously worked for 10 years as a systems surety engineer has volunteered for over 15 years in various capacities for pre-college engineering programs. Shauna earned her Bachelor of Science in Mechanical Engineering from North Carolina Agricultural and Technical State University and her Master of Science in Mechanical Engineering from Ohio State University.

Mr. Bruce Wellman, Purdue University at West Lafayette (COE)

Bruce Wellman is a National Board Certified Teacher (NBCT, Chemistry) who taught high school chemistry and engineering for 22 years. He is currently a doctoral student in the Engineering Education Department at Purdue University

Dr. Morgan M Hynes, Purdue University at West Lafayette (COE)

Dr. Morgan Hynes is an Associate Professor in the School of Engineering Education at Purdue University and Director of the FACE Lab research group at Purdue. In his research, Hynes explores the use of engineering to integrate academic subjects in K-12 cla

Introduction to Microelectronics:

Integrating Art, Microcontrollers, and Social Awareness to Understand the Lifecycle of Microelectronics

Recommended Grades: 7-12

Description

The Introduction to Microelectronics curriculum is from a 2-week summer program for high-school participants as part of the [Program name]. The curriculum aims to create a holistic impression of the rising semiconductor and microelectronics ecosystem, building basic capacities and skills to develop a more competent future workforce in the US. The content is organized into 5 units integrating electronics, design, and social awareness. We adopt a STEAM education approach to emphasize the life cycle of microelectronics. In the last two days of the program, the participants integrated their learnings through a design project using microcontrollers to address social needs. Three units are included in this exchange.

Unit 1: Introduction to Circuits (Not included)
Unit 2: The micro:bit Shuffle – Intro to Microcontrollers (front)
Unit 3: Mapping the Machine – Understanding Socio-Technical Systems (back)
Unit 4: Mining, Extraction, and Core Cutting of Microelectronic Materials (Cupcake Geology, 2018, and Education Activities - Women In Mining Education Foundation (WIMEF), 2023)
Unit 5: Tech Tales: Narrative Murals of Electronic Lifecycle (back)

The micro:bit Shuffle – Intro to Microcontrollers

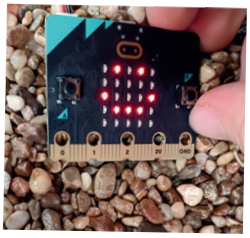
Duration: 20 minutes per module (**120 minutes total**)

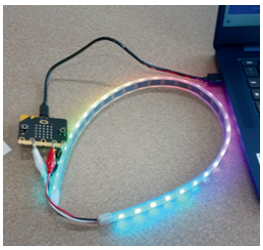
Learning Outcomes:

1. Recognize the real-world applications of microcontrollers
2. Assemble / Couple sensors and actuators with the BBC micro:bit
3. Summarize the logical operations performed by the Scratch code.
4. Use the input and output capabilities of a BBC micro:bit to detect different modalities and perform a simple computational task

Standards: IDOE HS.AM.4

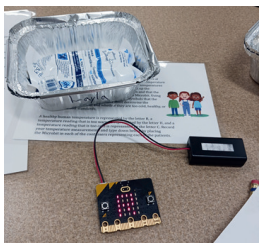
Description: Nurses with broken thermometers, a fit and healthy community, and undercover agents communicating with each other! What do they have in common... Microcontrollers!





This 6-module unit introduces BBC micro: bits as a hands-on starting point to operate microcontrollers.

- Thermo:Bit – micro:bit as an Electric Thermometer
- Magno:Bit – micro:bit as a Metal Detector
- Glow:Bit – micro:bit for LED and Light Sensing
- Fitness:Bit Jr. – micro:bit as an Accelerometer (Foot step counter / Fitness Tracker)
- Music:Bit Maestro – micro:bit for Sound and Music Creation
- Morse:Bit – micro:bit for mimicking Morse Code (Communication using Bluetooth)



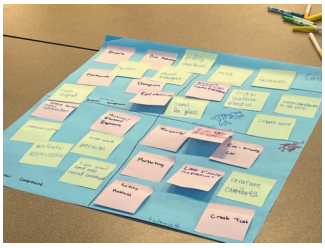
Mapping the Machine – Understanding Socio-Technical Systems

Duration: 80 minutes

Learning Outcomes:

1. Identify stakeholders in the semiconductor industry
2. Describe how the "ecosystem" of the industries interacts with one another.

Standards: IDOE HS.IDL.3



Description:

This unit introduces participants to the concept of socio-technical systems, bridging their understanding of both technical and social components in the design and development of everyday electronics.

- Participants are introduced to the elements of socio-technical systems —organizational, physical, cognitive, and practical.
- In teams participants conduct research on the socio-technical components involved in their product, and map out how these components interact at different stages of the product lifecycle, identifying awareness of the engineering challenges and constraints that arise in the design of modern technologies.

This unit encourages open-ended research and collaborative problem-solving, offering participants a hands-on opportunity to explore the broader ecosystem of engineering design.

Tech Tales: Narrative Murals of Electronic Lifecycle

Duration: 80 minutes

Learning Outcomes:

1. Recognize the complex environmental footprint of Microelectronics usage and disposal.
2. Design a narrative mural to illustrate the storyline using first-person characters.
3. Integrate the learnings from previous modules of the program into a society-centric storyline

Standards: IDOE HS-ENV5-3 (NGSS HS-ESS3-4), IDOE HS.CC.1

Description:

This unit focuses on raising awareness about the product life cycle of electronic devices.

- Participants will watch short videos on the lifecycle of electronic devices that highlights the ecological responsibilities of users, and the social and environmental implications associated with electronic devices.
- In teams participants will engage in a collaborative mural project where they will depict their understanding of the videos content. Participants will develop characters and stories that connect to their themes.

This hands-on unit encourages creative expression and emotional engagement, enabling participants to express their thoughts, feelings, and emotions on the implications of the semiconductor industry. Group sharing of murals is encouraged

Question on Resources:
Shauna Adams, adams532@purdue.edu
Yash Ajay Garje, ygarje@purdue.edu
Morgan Hynes, morganhynes@purdue.edu

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