

**Preparing Middle School Teachers for Engineering Design Course
Implementation at Two Rural NC Schools during COVID-19**

Today's session is about Partnerships in Education

*Higher Education, K-12 Education, Business & Industry,
and the Community all working together to support
Classroom K-12 Educators*

Preparing Middle School Teachers for Engineering Design Course Implementation at Two Rural NC Schools during COVID-19

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College of Education - William and Ida Friday Institute
North Carolina State University

Donald McCoy

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NC MSEN Pre-College Program, STEM Teacher
K-to-College STEM Education Consultant
Donald McCoy and Associates



Developing STEM Identity in Rural Audiences through Community-Based Engineering Design (DeSIRE)

10TH ANNUAL CONFERENCE | OCTOBER 26-27, 2021 | VIRTUAL

Anthony Bowser

North Carolina State University

- Asst. Coordinator, NC MSEN Pre-College Program

Georgia Institute of Technology

- SECME Program Outreach Coordinator / Student Programs

Durham Public School

- K-12 Middle School STEM Education Educator / Site Club Coordinator

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North Carolina State University

- Contract Employee
- STEM Teacher, NC MSEN Pre-College Program

IBM Corporation (30 years)

- Electrical Engineer
- Program Manager, IBM Corporate Headquarters – Global Workforce Development and Multicultural People In Technology Project Office

Today's Agenda

- **DeSIRE At-A-Glance**
- **STEM Knowledge Transfer Model and Pipeline**
- **Professional Development**
 - Covid-19 Pandemic Impact to DeSIRE
 - Curriculum, Lesson Planning, Project-based Learning
 - Authentic Advanced Manufacturing Applications, Implementation, and Assessment
- **Lessons Learned, Best Practices, and other Takeaways**
- **The DeSIRE Journey Continues**

DeSIRE At-A-Glance...

Leadership Team



NSF project Principal Investigator

Tameshia Ballard Baldwin, Ph.D.

Assistant Teaching Professor
Office of Academic Affairs
NCSU College of Engineering



**Math Science Education Network
(MSEN) Pre-College Program**

Braska Williams Jr.

Program Director
NCSU College of Education



**Program Evaluation
and Education Research**

Callie Womble Edwards, Ph.D.

Associate Director
Friday Institute for Educational Innovation
NCSU College of Education



NSF Co-Principal Investigator

LaTricia Townsend, Ph.D.

Director, Federal Program Monitoring and Support
NC Department of Public Instruction



Women Minority Engineering Programs (WMEP)

Angelitha L. Daniel

Director, Minority Engineering Programs
NCSU College of Engineering

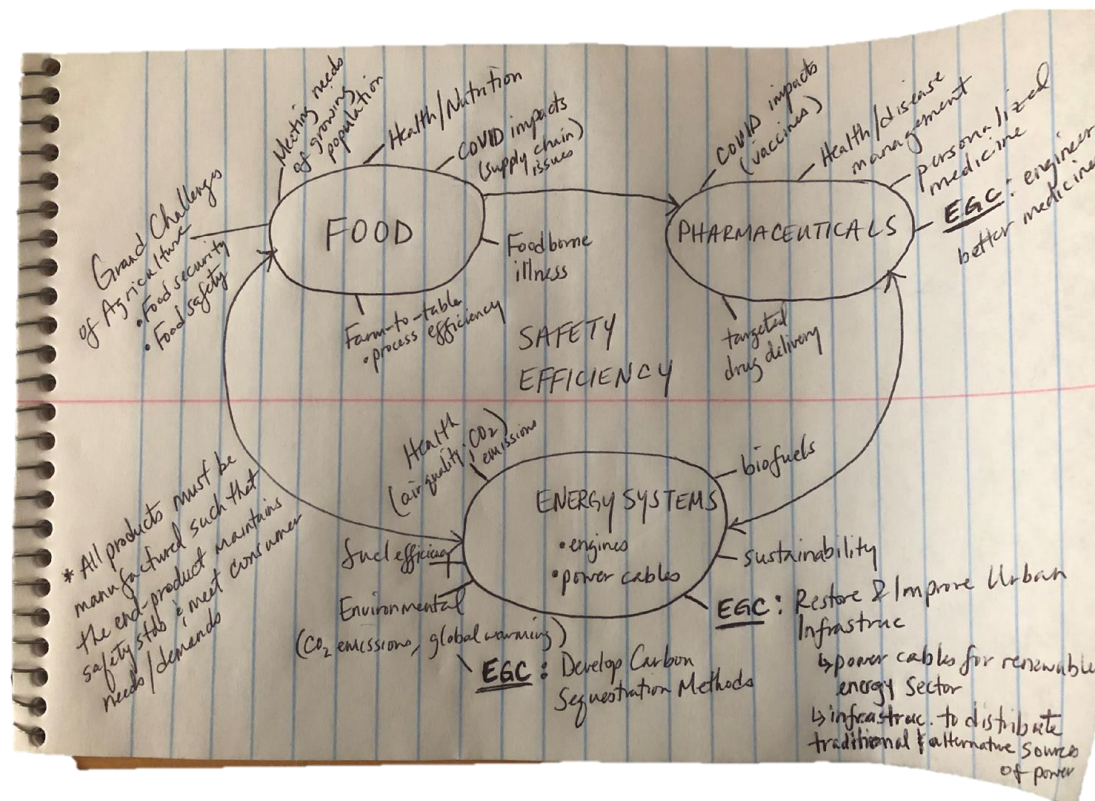
DeSIRE At-A-Glance

DeSIRE - *Developing STEM Identity in Rural Audiences through Community-Based Engineering Design*

- National Science Foundation four-year funded project (Award#: 1949454)
- STEM Education Collaboration and Partnership Model (Business & Industry, Community, Education)
 - NC State University - College of Engineering and College of Education (Friday Institute)
 - NCSU NC Mathematics and Science Education Network Pre-College Program (MSEN)
 - North Carolina Department of Public Instruction (NCDPI)
 - Edgecombe County Public School System (selected Middle Schools)
 - Edgecombe and Nash: Strategic Twin-Counties Education Partnership (STEP) Program
 - NC regional Advanced Manufacturing Business and Industry Leaders

DeSIRE At-A-Glance...

Dr. Tameshia
Ballard Baldwin
2020

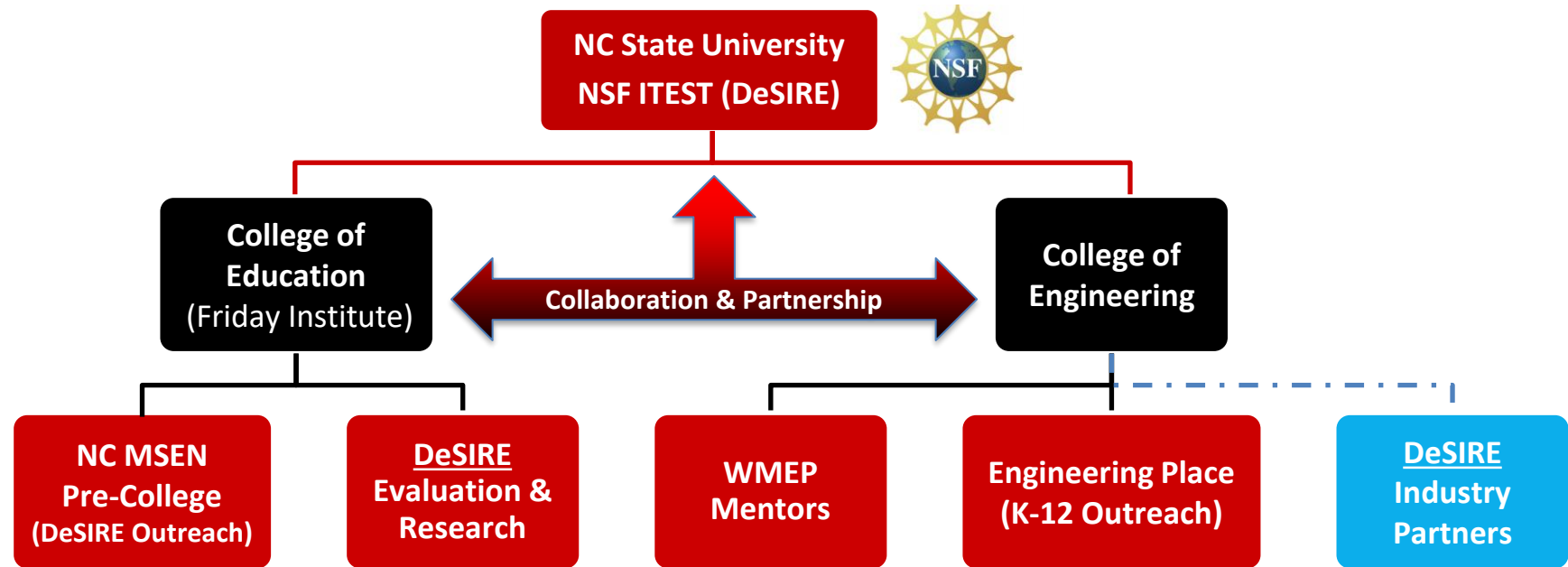


DeSIRE At-A-Glance...



NSF Award April 2020
6th Grade Launch Fall 2020

DeSIRE At-A-Glance...



NC Math Science Education Network (**MSEN**) Pre-College Program, Women and Minority Engineering Programs (**WMEP**)

DeSIRE Course Goals

Provide opportunities for **middle school** students in **Edgecombe County** Public School System to learn about STEM careers in the **advanced manufacturing industries** related to **food, pharmaceuticals and energy systems**.

Increase STEM content knowledge and interest in STEM and **STEM careers** and build **STEM identity** among **rural middle school students**.

DeSIRE At-A-Glance...

Inside the DeSIRE Classroom

- Applied Engineering Design Process through hands-on STEM project-based learning, experiential learning, problem-solving, and critical thinking methods.
- Authentic engineering design practices in a mock Advanced Manufacturing lab
- Meet and interact with STEM Industry and High Education Professionals
- Mentored by NC State students in the Women & Minority Engineering Program



DeSIRE At-A-Glance...

Advanced Manufacturing Industry Partners

NC Regional Site Locations

Energy Systems Industry

- Cummins
- Kaba ilco Corporation
- Keihin Carolina System Technology
- LS Cable & System

Food Industry

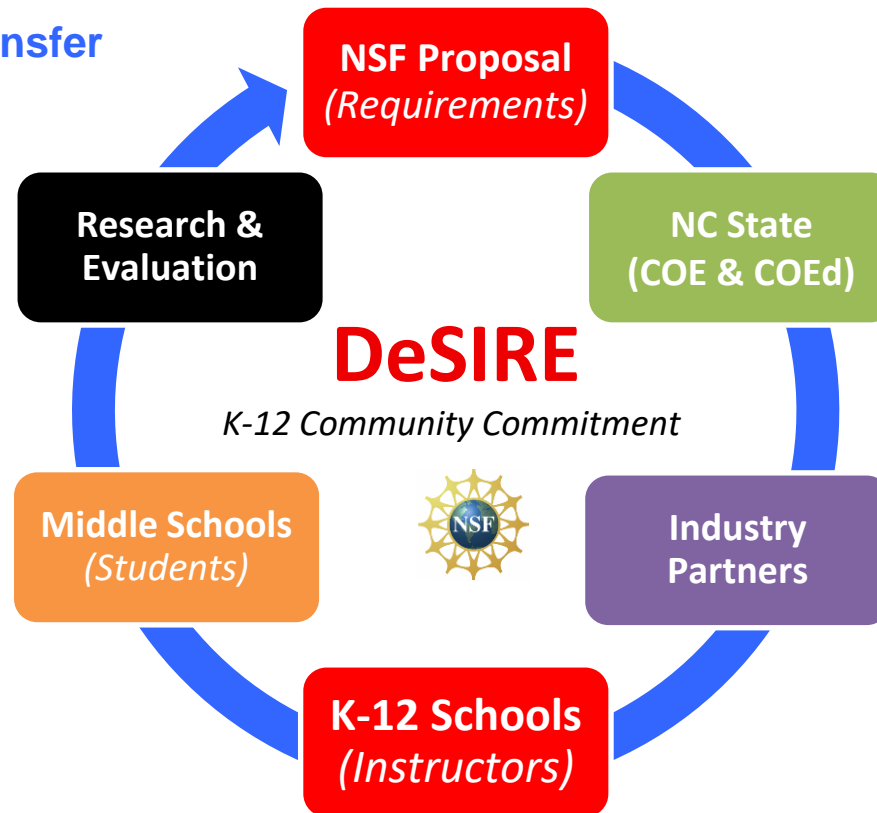
- Poppies International Inc.

Pharmaceutical Industry

- Pfizer, Inc.

**BRIDGING
THE GAP
2021**

STEM Knowledge Transfer Model and Pipeline



**Preparing Middle School Teachers for Engineering Design Course
Implementation at Two Rural NC Schools during COVID-19**

Professional Development for Course Instructors

*Higher Education, K-12 Education, Business & Industry,
and the Community all working together to support
Classroom K-12 Educators*

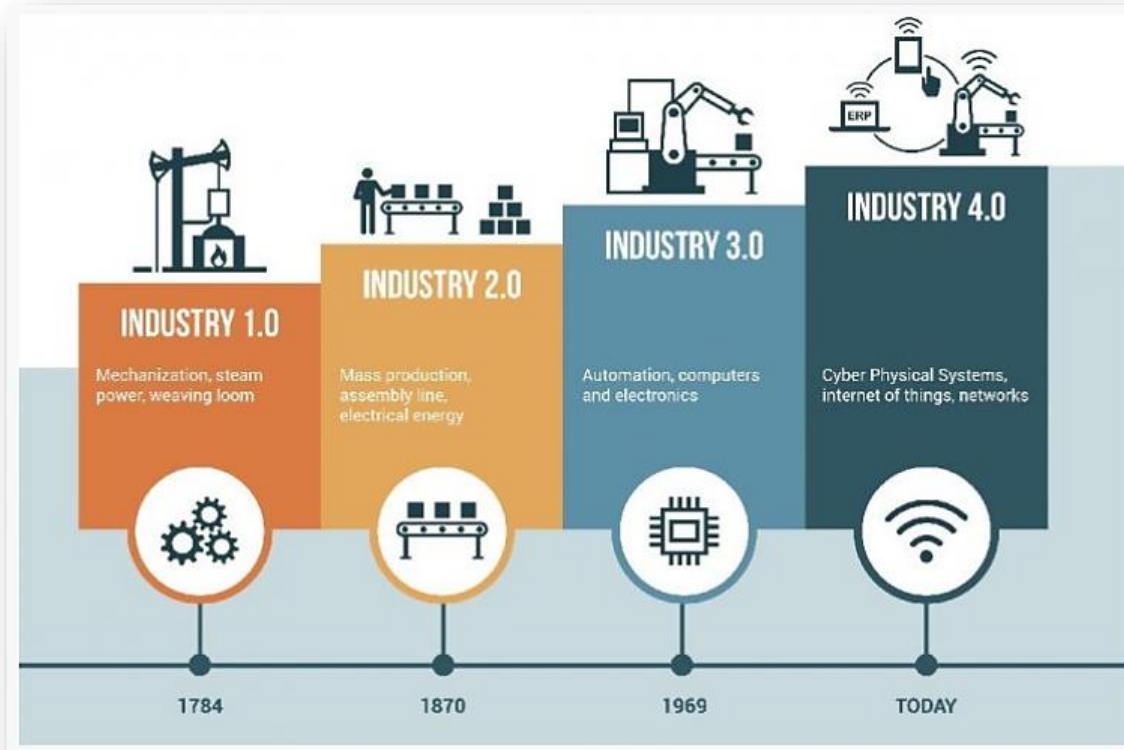
Teaching Advanced Manufacturing to DeSIRE course instructors without STEM backgrounds

Overview

- Pedagogy skillset
- Passionate about learning and youth development

Success Factors and Influencers

- Managed teaching resources
- Scripted STEM Narratives
- Practiced hands-on PBL



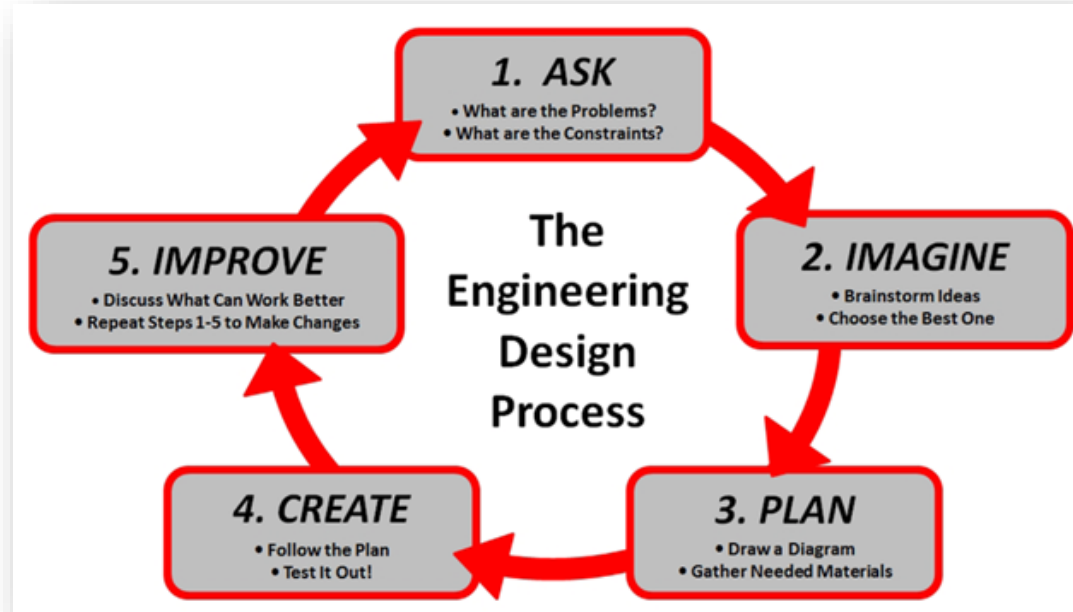
Teaching the Engineering Design Process to DeSIRE course instructors without STEM backgrounds

Overview

- Contextual teaching methods
- Contrast Scientific Method

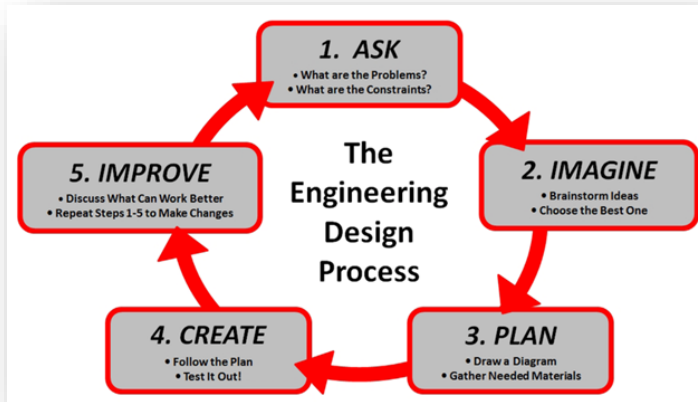
Success Factors and Influencers

- Applied Problem-solving and critical thinking narratives
- Research methods and experiential hands-on PBL



Contrasting Industry Design Processes

Pharmaceutical Design Engineering: *A Drug Discovery and Development Process (High level processes)*



AND DO
TRAORDINARY



Advanced Manufacturing Themed Technologies

Advanced Manufacturing-based Project-based Learning Course Activities...

NCSU DeSIRE
Advanced Manufacturing
Wolfpack@K12, Inc.

Project Based Learning Experiences
Mock Company

Teaching Hands-on Operations and Process Applications

Pre-Pandemic Planner

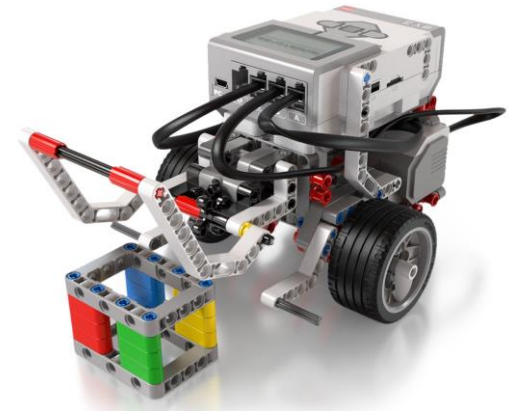
Adjusted to Virtual and Hybrid School Schedules



Advanced Manufacturing Themed Technologies

Advanced Manufacturing-based Project-based Learning Course Activities

Hands-on Systems Design, Automation, and Mechatronics Applications



Pre-Pandemic Planner

Adjusted to Virtual and Hybrid School Schedules

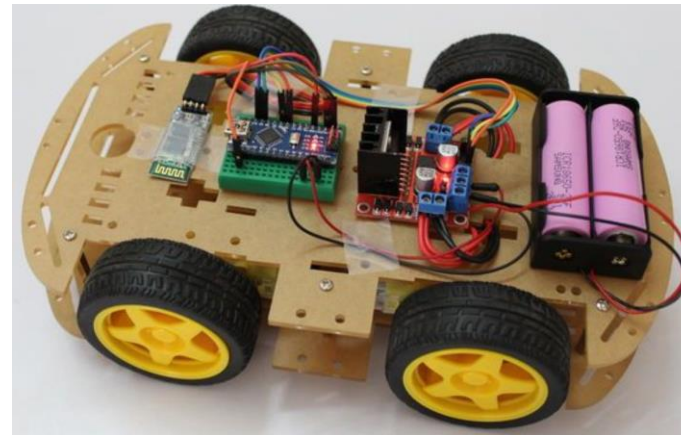
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Education EV3



Advanced Manufacturing Themed Technologies

Advanced Manufacturing-based Project-based Learning Course Activities

Hands-on Systems Design, Automation, and Mechatronics Applications...



Pre-Pandemic Planner

Adjusted to Virtual and Hybrid School Schedules

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<https://education.lego.com/en-us/products/lego-mindstorms-education-ev3-core-set/5003400>

Advanced Manufacturing Themed Technologies

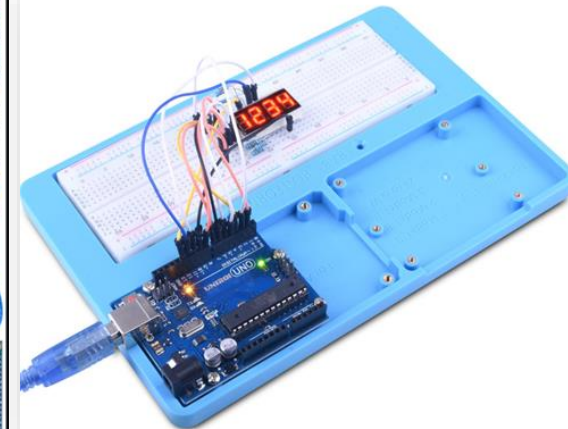
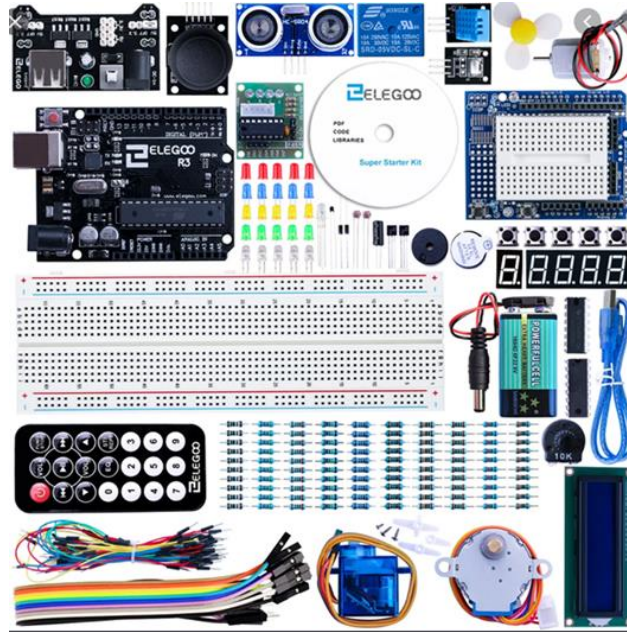
Advanced Manufacturing-based Project-based Learning Course Activities...



Teaching Hands-on Control Systems Applications

ELEGOO UNO (Arduino IDE Microcontroller) - Project Super Starter Kit with Tutorial

Pre-Pandemic Planner



<https://www.amazon.com/ELEGOO-Project-Tutorial-Controller-Pr>

Advanced Manufacturing Themed Technologies

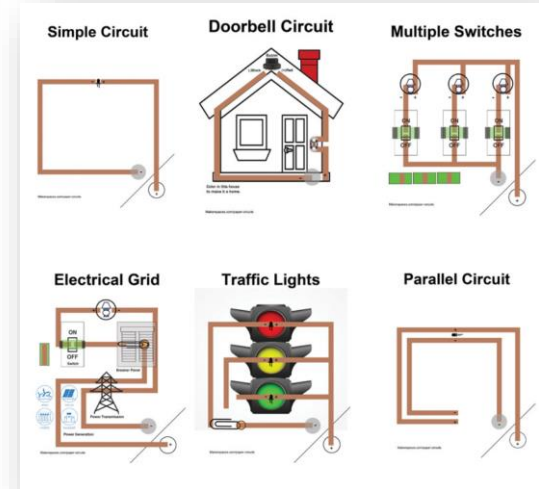
Advanced Manufacturing-based Project-based Learning Course Activities...

Hands-on Design and Control Applications

Learning Outcomes

- Applied Engineering Research
- Engineering Design Process
- Adv. Manufacturing assembly processes and production
- Hardware and Software Coding

Adjusted for Pandemic



<https://www.amazon.com/ELEGOO-Project-Tutorial-Controller-Pr>



Advanced Manufacturing Themed Technologies

Advanced Manufacturing-based Project-based Learning Course Activities...

Hands-on Virtual Circuit Design and Control Applications

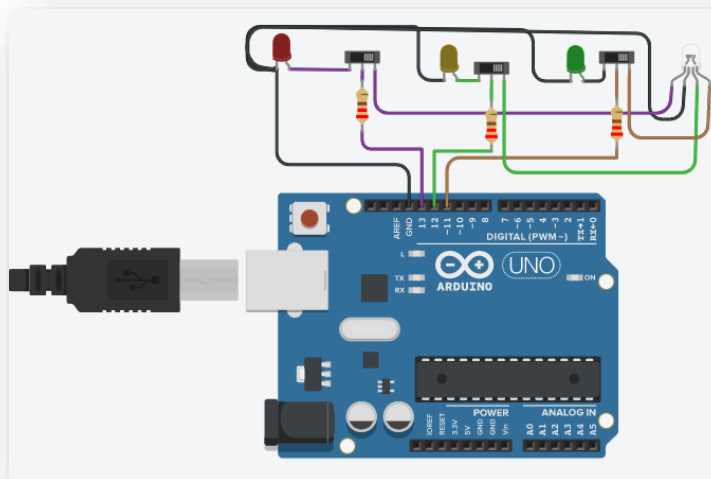
Learning Outcomes

- Applied Engineering Research
- Engineering Design Process
- Software Coding



AUTODESK®
TINKERCAD®

Adjusted for Pandemic



```
const int servoPin = 9;  
const int potPin = A0;  
  
int servoPos = 0;  
int potPos = 0;  
  
Servo servo;  
  
void setup()  
{  
  servo.attach(servoPin);  
  
  pinMode(potPin, INPUT);  
  pinMode(servoPin, OUTPUT);  
  
  Serial.begin(9600);  
}
```

<https://www.amazon.com/ELEGOO-Project-Tutorial-Controller-Pr>



Advanced Manufacturing Themed Technologies

Advanced Manufacturing-based Project-based Learning Course Activities...

Mock Pharmaceutical Company – A Pill Manufacturer

Produce “Baking Soda” Pills in high volume, quality, and efficiency for customers.

Critical thinking: Process design and rates, production safety, and product quality.



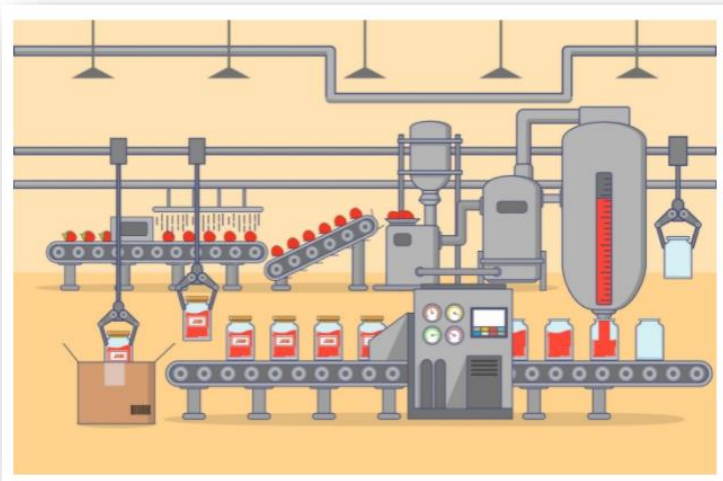
Adjusted for Pandemic



Advanced Manufacturing Themed Technologies

Advanced Manufacturing-based Project-based Learning Course Activities...

Food processing equipment: Processing machines and systems used to handle, prepare, cook, store, and package food and food products.



Preparation Equipment



Various berries being mechanically sorted.

Adjusted for Pandemic

<https://www.thomasnet.com/articles/machinery-tools-supplies/overview-of-food-processing-equipment/>

Lessons Learned, Best Practices, and other takeaways

STEM Knowledge Transfer Model and Pipeline

Course Instructors and KSA's (*Knowledge, Skills and Abilities*)

- Effective communications with course instructors (All virtual using Zoom)
 - Group Collaboration and Focus Groups
 - Research and Evaluation Team survey instruments & interviews
 - Co-development of lesson plans and PBL activities
- Professional Development Workshops - Summer, Fall, Spring (All virtual)
 - Personal Research and Hands-on PBL (10 hours)
 - Course Design and Lesson Planning (15 hours)
 - Lecture & Group Collaboration (15 hours)

Teaching DeSIRE Teachers without STEM Backgrounds

All Successful teachers:

1. Enjoy their work
2. Never stop learning
3. Have a positive attitude
4. Comfortable with the unknown
5. Take time to explore new tools and best practices
6. Bring fun into the classroom

They also...

7. Have a sense of purpose
8. Have clear objectives
9. Adapt to student learning needs and maturation
10. Know how to take risks
11. Give students emotional support



TEACHING DeSIRE PROFESSIONAL DEVELOPMENT WORKSHOPS

The Power of Admitting What We Don't Know

Professional Development session Facilitators

1. Remember, your students are seasoned professionals.
2. Help all students admit what they don't know.
3. Help all students leverage and use what they do know.
4. Learn your students' personal learning style(s) immediately
5. Initially, only teach what the students need to know; then, progress to providing greater depth and breadth.



Common Non-STEM Major Classroom Management Mistakes

NOT THINKING THINGS THROUGH CAREFULLY ENOUGH

1. Ask yourself about the “how” for each project-based learning activity.
2. What are your expectations for how the students should approach or begin the PBL activity? How long should the PBL take?
3. How will students let you know that they are confused?
4. What are some common mistakes or misunderstandings?
5. How will you and the students measure success?

Common Non-STEM Major Classroom Management Mistakes

ASSUMING THE SAME PBL STRATEGY AND APPROACH WILL WORK FOR ALL CLASSES

Have you ever implemented a successful project-based learning activity in your first period class, only to learn the second period class were totally confused? Why? Same resources (materials, allocated time, and instructions) and implementation strategy.

1. We need to remain flexible and responsive to each class and sometimes individual group and student needs.
2. Slowly, but methodically change things up whenever a teaching strategy is not working effectively enough for the students and you.
3. Consider mixing up PBL approaches, even when they are working. This will represent authentic engineering environments and unpredictable challenges.

Advanced Manufacturing Industry Partners



DeSIRE Industry Partners and KSA's (*Knowledge, Skills and Abilities*)

1. What are common Advanced Manufacturing processes and operations?
2. What does students need to know about your Advanced Manufacturing operations?
3. What are some examples of project-based learning activities?
4. What technical and soft skills knowledge do you expect from new hires?

Lessons Learned, Best Practices, and other takeaways Reflections (Year 1)

Successes

1. Committed teamwork and collaboration: Schools, Industry Partners, and NC MSEN on content and STEM PBL activities.
2. **Effective Adv. Mfg. input from Industry Representations up front.**
3. Working with passionate and committed instructors from both schools.
4. **Effective use of Professional Development workshops online**
5. Schools able to pivot with in-person, virtual, and hybrid course learning content during semester.

Challenges

1. Synchronizing lesson plan content at both schools due to schedule differences during pandemic.
2. **Synchronizing schedules between schools for NCSU mentors and industry partners during frequently changing virtual class schedules.**
3. Slow finding baseline and starting point of KSA's (Knowledge, Skills and Abilities) of non-STEM Educated professionals in virtual environments.
4. School challenges (Covid-19 ready facilities, Internet)
5. **Compression of 9-week content in slightly fewer weeks due to pandemic and school outages.**
6. Time management for instructors and mentors to help virtual learners.
7. Balancing hybrid learning environment and tools.

Best Practices

1. Using Zoom for PD sessions
2. Flexible PD scheduling
3. **Learning PBL activities online (Tinkercad tools and safe hands-on resources**
4. Google classroom and tools
5. **Skilled teachers that know pedagogy and recognize student needs.**
6. Scaling up content and tools suitable for non-STEM educated professionals

DeSIRE | Contact Information

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