

# RET Sites Best Practices Design, Implementation, and Sustainability

National Science Foundation

Engineering Education and Centers Grantees Conference

October 30, 2017

# **RET Site in Mechatronics and Robotics with Entrepreneurship and Industry Experiences**

**Vikram Kapila**

**Mechatronics, Controls, and Robotics Lab**

**<http://engineering.nyu.edu/mechatronics/>**

**Engineering Education and Centers Grantees Meeting**

**RET Sites: Best Practices—Design, Implementation, and  
Sustainability**

**October 30, 2017—3:00 PM – 4:15 PM**



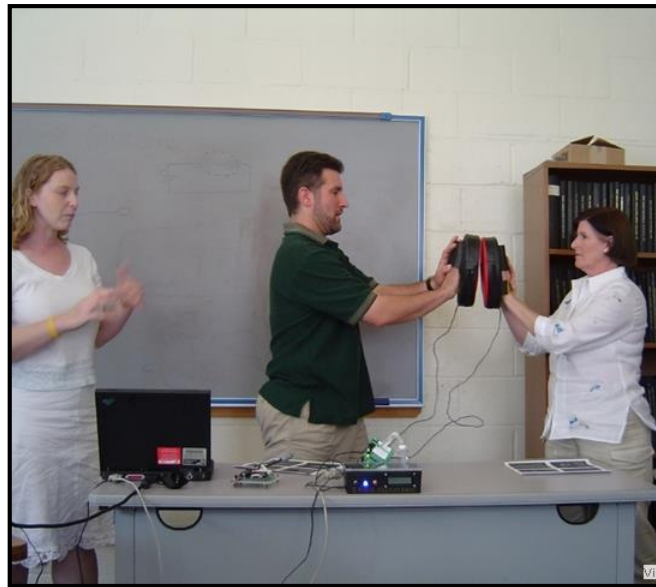
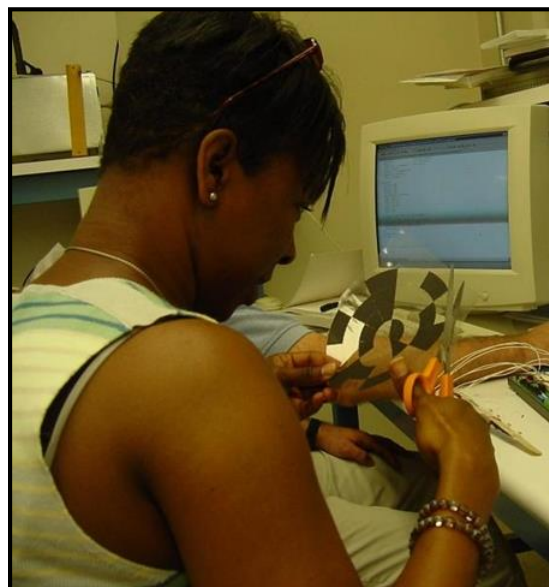
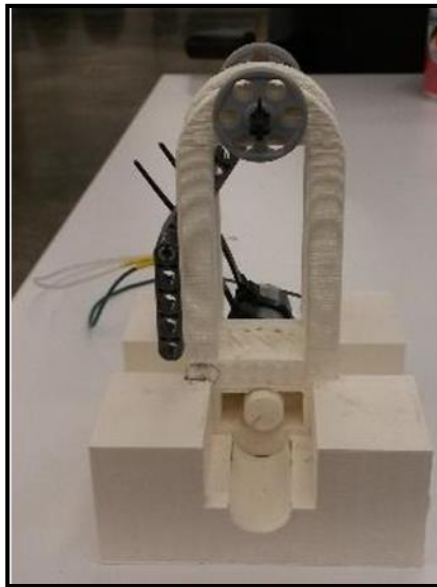
**NYU**

**TANDON SCHOOL  
OF ENGINEERING**

# Rationale for Project Theme

- Mechatronics and robotics are ideal technology platforms on which to construct lasting new businesses and entrepreneurial ventures
- Spark intellectual curiosity and engage the interest of participants in hands-on STEM education, research, and creative and entrepreneurial explorations
- Innovative treatment of STEM curricula to render it relevant to students' interest while addressing workforce demands for graduates with broad interdisciplinary training and practical experience
- Promote interactions with professional engineers to enhance participants' practical knowledge of STEM disciplines and awareness of engineering workplace

# K12 STEM—Engineering in NGSS Demands Learning by Doing: Integrate STEM Disciplines and Align with Standards



**TEACHENGINEERING**  
curriculum for k-12 teachers Check out

BROWSE ▾ EDUCATIONAL STANDARDS ▾ GET INVOLVED ▾ K-12 ENGINEERING ▾

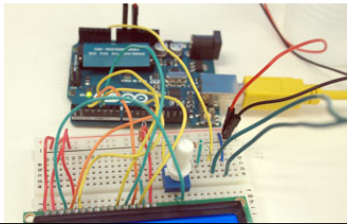
## Hands-on Activity: Build and Test a Conductivity

Contributed by: SMARTER RET Program, Polytechnic Institute of New York University

Home > Brow

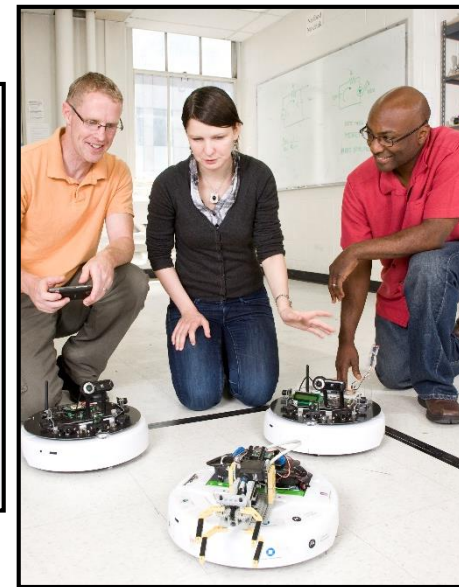
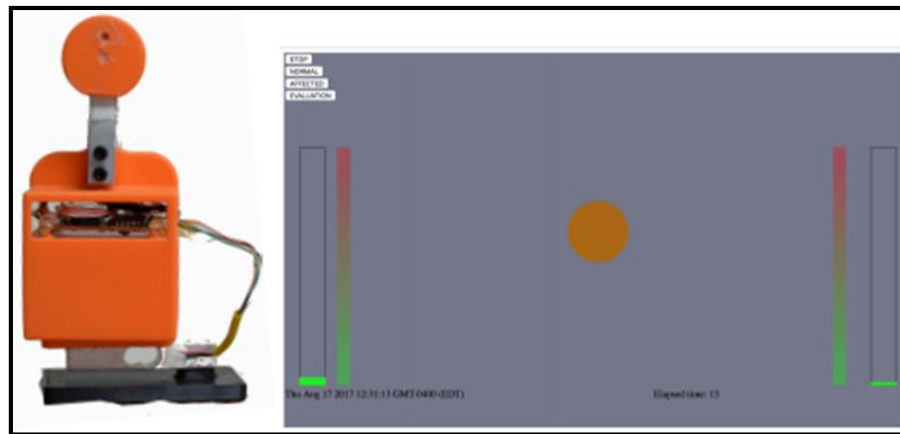
### Summary

Student groups construct simple conductivity probes and then integrate them into two different circuits to test the probe behavior in solutions of varying conductivity (salt water, sugar water, distilled water, tap water). The activity culminates with student-designed experiments that utilize the constructed probes. The focus is



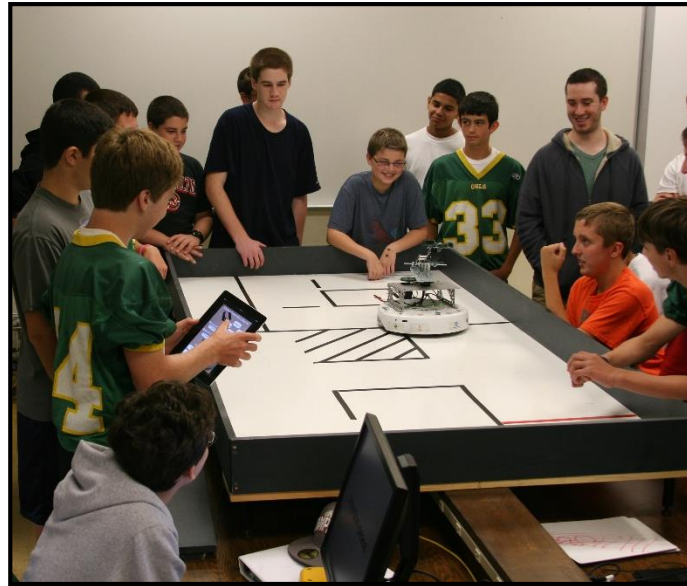
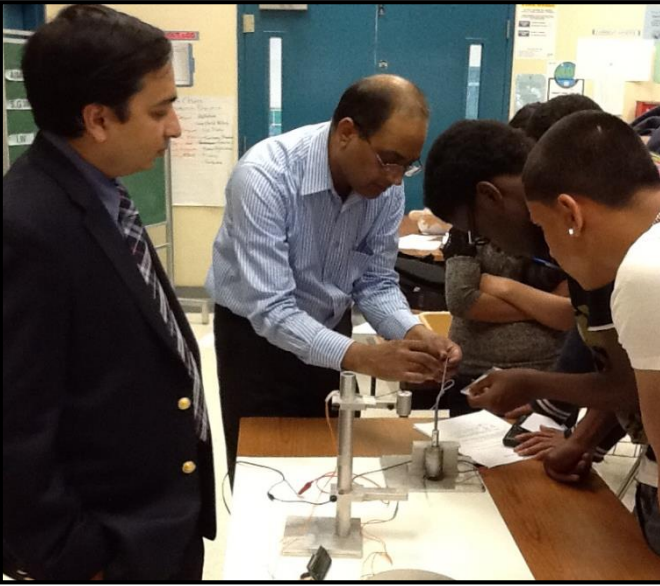


# Research Immersion Cultivates Engineering Habits: Design, Collaborative, Entrepreneurial, Solution-Oriented



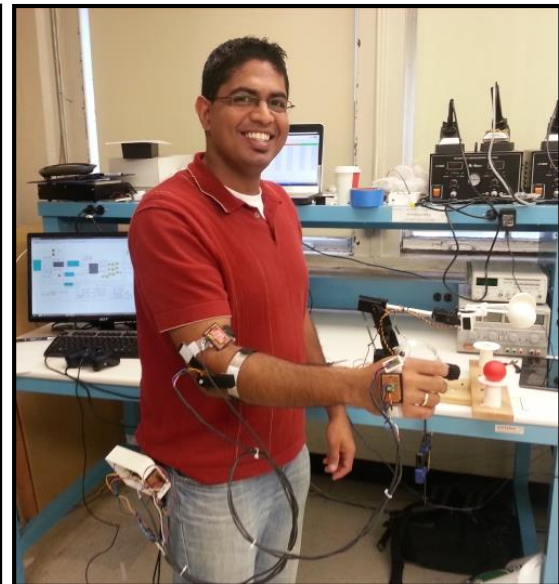
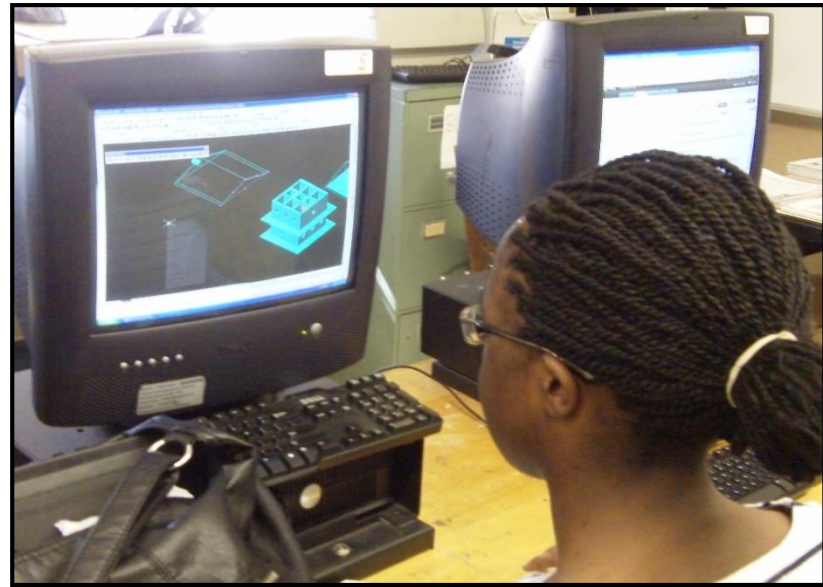


# Follow-up Essential: Classrooms, Colleges, Contests, ...





# Authentic, Exciting, Engaging, and Relevant Tools



# Research Experiences for Teachers Engineering in Precision Agriculture and Sustainability for Rural STEM Educators

Bradley Bowen, Ed.D.

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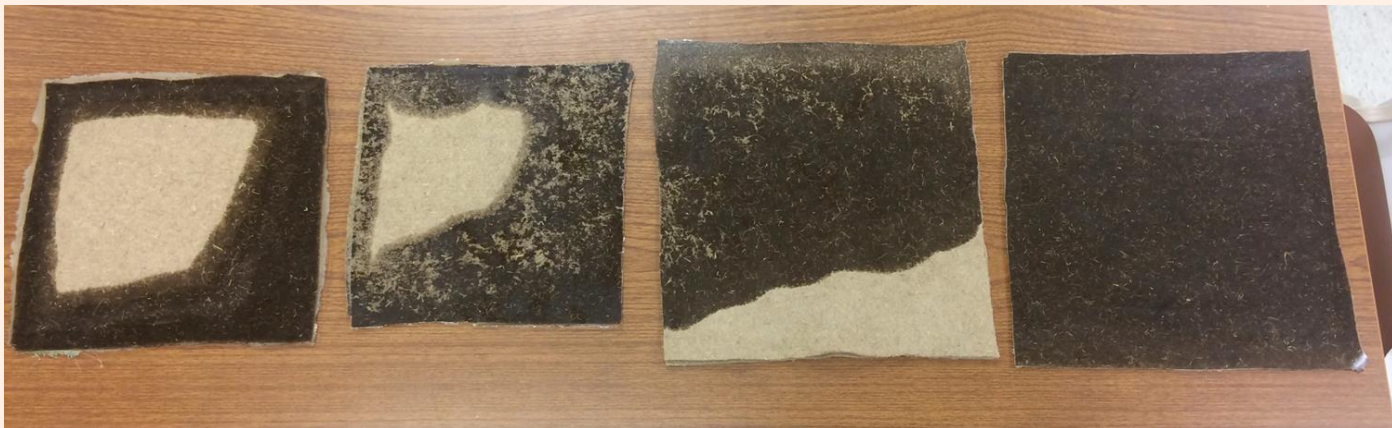


# Project Focus

- Rural Math and Science Teachers
  - Middle or High School
  - Only subject teacher in the school
  - 5 in-service paired with 5 pre-service

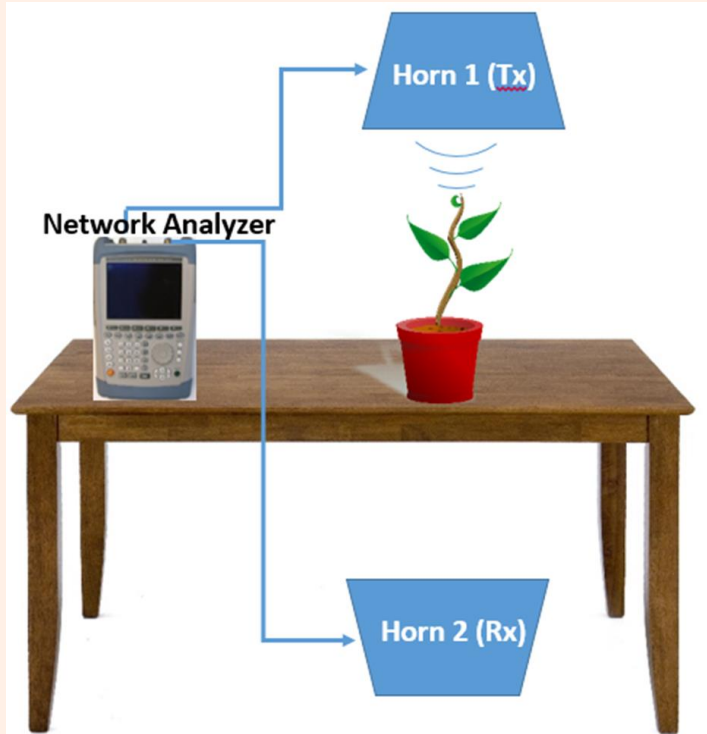


# Bio-based materials





# Electrical Sensors





# Goals and Outcomes

- Sustained shift in teaching practices
- Collaborative network





# USC Research Experience for Teachers Programs

## 10+ years: SRET and ACCESS 4Teachers

*Gisele Ragusa, Ph.D.*  
*Professor, Division of Engineering  
Education*

*October 2017*



## Motivation for USC's RET Program



- Research quantifies influence factors have on student achievement in STEM.
- Important determinants are content knowledge and pedagogical expertise of **teachers**.
- USC RET has foci on **teacher learning/ instructional improvement**.
- Educ. system expects teachers to develop **novel curriculum/innovative instruction** to address student **diversity** and capitalize on **strengths**.
- The “**what’s**” of teaching necessary but not sufficient condition.
- Teachers must know both “**what’s**” and “**how’s**” of teaching so that all students learn/ flourish.
- New standards require this but making teaching difficult.



Teachers Learning “**What’s/ How’s**” of Teaching: RET: Summer 2017



# Key Components



**Goal:** To improve **students' achievement** by assisting middle and high school science and math teachers in designing and implementing innovative curricula using **data-driven, diagnostic instructional methods using lesson study.**

- **Key components:** (1) Five-week summer research immersion with content-to-pedagogy workshops (2) Monthly follow-up after school lesson study at USC and in participating schools
- **By the numbers:** 87 teachers and 12,436 students

★★Facilitates Computer Science & Engineering Design Learning★★

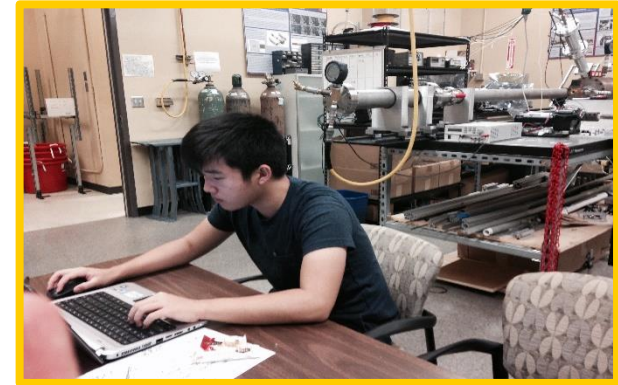


# Cumulative Results



**Results: Teachers Middle & High School**

Metric	Post – Pgm. Subscale Ave.	Nat'l Subscale Ave.	RET % Total Gains
Teacher Performance (TPOR/ PACT)	3.97	2.89	32.7
Science Teaching Efficacy	3.68	2.47	21.5



**Results: Students Gr. 6-12**

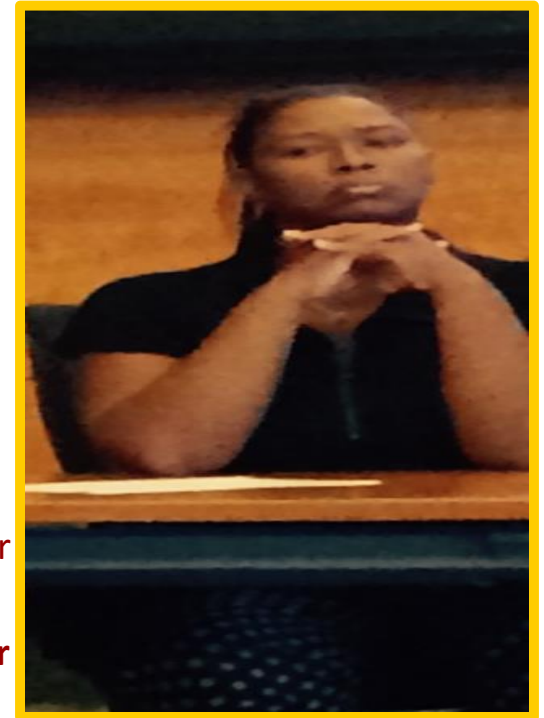
Metric	Pre-pgm. % Score	Post –pgm. % Score	% Gains
Science Knowledge (conceptual understanding)	57.3	92.6	35.3
Science Literacy	51.9	87.3	35.4
Science Interest & Motivation (sum)	54.2	89.3	35.1

\* Teacher performance highly correlated/student achievement ( $r=.479, p<.01$ ) & student interest/motivation for CS/Eng. design ( $r=.672, p<.01$ )

# Teacher Profile: Meet Elana!



- Elana (*a pseudonym*) is a 6<sup>th</sup> grade science/math teacher in RET program and former elementary school teacher.
- Background and college degrees are **not** in science
- Became a middle school teacher by examination and does not have science, math, CS or engineering degree (NOTE: most middle school teachers do not have STEM degrees).
- STEM content knowledge was limited when beginning with RET, has **strong passion for teaching, learning and creating/contributing to improving lives of students.**
- Relates well to her students as she grew up in under-resourced environment and was first in family to attend college.
- Attended both summer intensive RET program and follow-up teacher Lesson study.
- Demonstrated **significant gains** (see results previous slide) in **teacher performance, teaching efficacy, and in STEM content knowledge** resulting from attending RET.
- Now near-peer mentor and **leader** in RET!
- Her **students demonstrated significant achievements gains** !



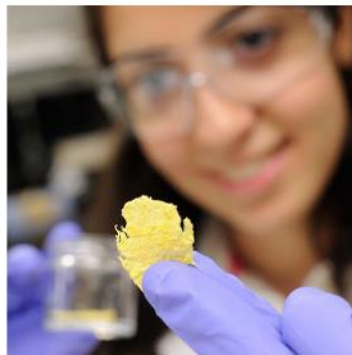
**Elana at RET:  
Summer 2016**

Elana's words: "The RET has helped and will keep helping me and my kids. Love it!"



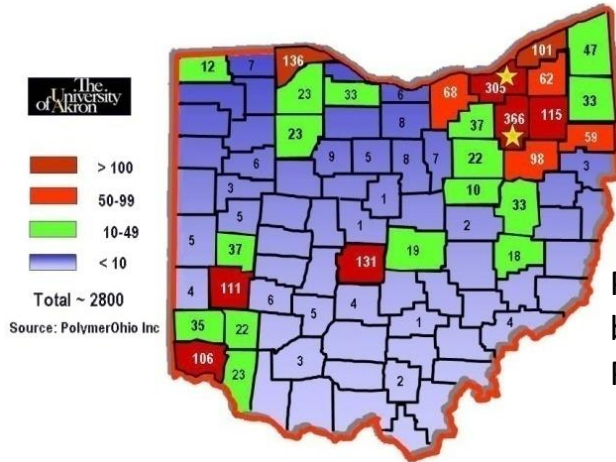
# Research Experience for Teachers Program in Polymer Engineering at the University of Akron

Kevin Cavicchi



The University of Akron  
College of Polymer Science  
and Polymer Engineering

# Polymers in Akron, OH



Polymer Companies by County (Source: PolymerOhio)

EEC – 1161732 (2012 – 2016)    EEC – 1542358 (2016 – 2019)



1870



1898



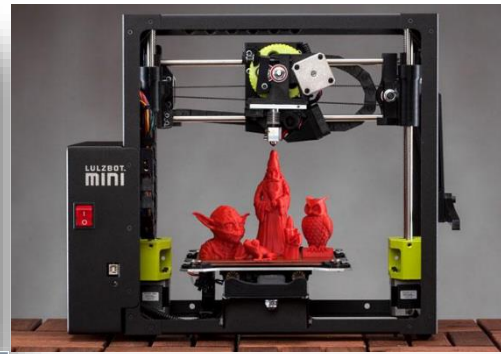
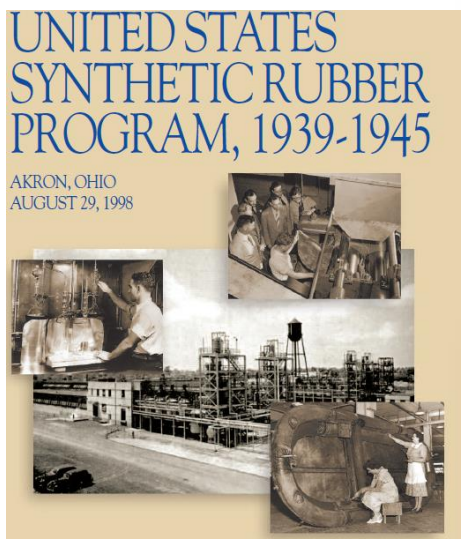
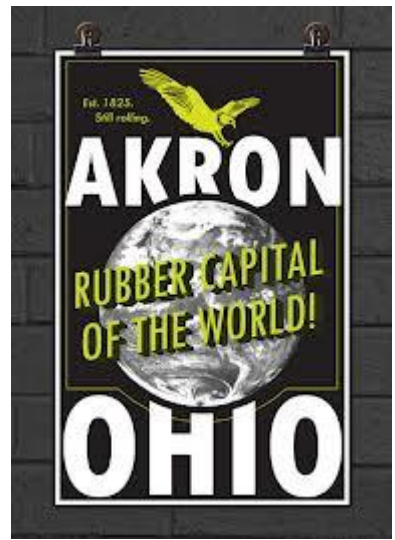
1900



1915



Dr. Charles Knight  
"Chemistry of India Rubber", 1910



# RET Site – Summer Activities

INDIVIDUAL  
INQUIRY  
BASED  
RESEARCH

PROFESSIONAL  
DEVELOPMENT  
ACTIVITIES

- 8 week program
- Meets 4 days per week
- 3 days for research
- 1 day for lesson plan development
- Lectures by faculty and RETs

## Industry Field Trips



## Summer Workshop for Area Teachers





# Innovations Implemented

Research Project and Lesson Plans take Time...We run longer programs with less days per week.

Started grad student boot camp with College of Ed...Students have most contact with teachers, get students thinking about outreach and education

More quantitative assessment of lesson plans

Reached out to local technical societies to run teacher night programming to connect University, Industry and K-12

- Revised Science Lesson Plan Analysis Instrument (SLPAIR)<sup>1</sup>
- TeachEngineering.org quality review for engineering content<sup>2</sup>

1. Jacobs, C. L.; Martin, S. N.; Otieno, T. C.: *Sci. Educ.* **2008**, 92, 1096-1126
2. [https://www.teachengineering.org/documents/TE\\_Engr\\_reviewcriteriarubric\\_v2.pdf](https://www.teachengineering.org/documents/TE_Engr_reviewcriteriarubric_v2.pdf)

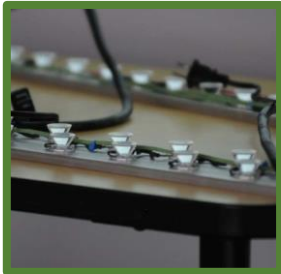


# NSF Research Experience for Teachers in Dayton, Ohio

Margaret Pinnell, PhD  
University of Dayton

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The University of Dayton has hosted two RET sites.



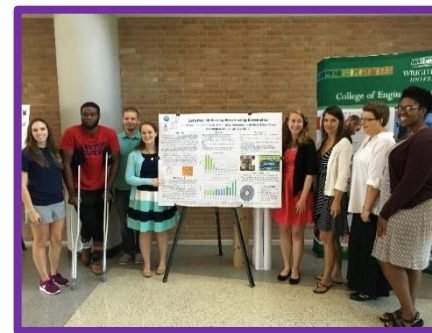
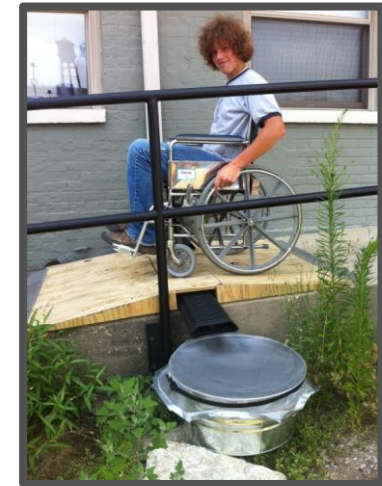
*Engineering Innovation and Design  
for STEM Teachers*

*Collaborative NSF-RET: Inspiring the  
Next Generation of a Highly-Skilled  
Workforce in Advanced  
Manufacturing and Materials*



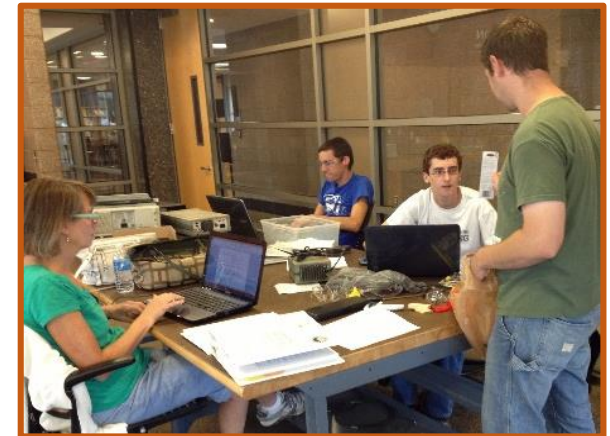
# Key Elements in the Program Design

- Leverage regional strengths
  - Innovation, manufacturing, DRSC, WPAFB, numerous diverse colleges in the area, partnerships with schools and industry....
- Intentional professional development beyond just the research experience
  - Curriculum design, innovative pedagogy, career awareness, technical communications, industry applications, networking, how to talk to students about engineering, library research....
- Hand pick faculty, research and/or industry mentors
- Involve undergraduate engineering students as much as possible
- Build community



# “Big Wins” or Conversation Starters

- STEM for all – the impact of RET experiences on K-8 teachers and special education teachers;
- STEM for literacy, creative confidence, risk taking;
- Community of STEM Advocates – the role of the RET in networking and community building;
- Changing the conversation – RET enhances teachers’ understanding of engineering and engineering careers and increases self efficacy;
- Not only the what, but the how – Teachers embrace innovative pedagogical techniques and try new things;
- Passion drives success – the success of the RET program is highly dependent on the passion of the PI’s, mentors, participating teachers and community stakeholders.



# Panelist Information

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