National Science Foundation
Division of Engineering Education and Centers (EEC)

IUSE/Professional Formation of Engineers: REvolutionizing Engineering and Computer Science Departments (RED)

Kamau Bobb
Program Director
Division of Computer & Network Systems (CNS)
kbobb@nsf.gov

Elliot P. Douglas
Program Director
Division of Engineering Education & Centers (EEC)
edouglas@nsf.gov

Olga Pierrakos
Program Director
Division of Undergraduate Education (DUE)
olpierra@nsf.gov

Webinar Overview

- Program overview and goals
- Elements of RED proposals
- Common weaknesses
- Questions from the audience

National Science Foundation
Division of Engineering Education and Centers (EEC)

NSF 17-501

IUSE/Professional Formation of Engineers: REvolutionizing Engineering and Computer Science Departments (RED)

- **Key Challenges Addressed:**
  - Bridging innovations in introductory- and capstone-level engineering and computer science education across the entire undergraduate experience, including extracurricular professional activities and student transitions in and out of the program
  - Faculty development, faculty reward systems, and academic cultures that encourage engagement of faculty and students of diverse backgrounds in the full undergraduate-level PFE process
- **Funding Level**
  - $1M to $2M for up to 5 years

Deadlines:
LOI 12/9/16
Proposal 1/18/17

RED Outcomes

- Fund programs that can serve as exemplars of change
- Revolutionary change to middle two years of undergraduate curriculum
- Connect engineering education research and practice
- Contribute to the literature on change

IUSE/PFE: RED, What are those Prefixes?

- IUSE: Improving Undergraduate STEM Education
  - NSF-wide umbrella for all undergraduate STEM Ed investments
  - Not a program with funding (programs exist underneath IUSE)
- PFE: Professional Formation of Engineers
  - ENG initiative to understand engineering formation holistically
  - Not a program with funding (programs exist underneath PFE)
- RED has many partners
  - EHR
  - CISE (computer science departments included!)
  - All ENG Divisions

Professional Formation of Engineers

The formal and informal processes and value systems by which people become engineers.

"To form is more ontological than to instruct or educate, for one's entire being is at stake."

Elements of PFE

- Introductions to the profession at any age.
- Acquisition of deep technical and professional skills, knowledge, and abilities in both formal and informal settings/domains.
- Development of outlooks, perspectives, ways of thinking, knowing, and doing.
- Development of identity as an engineer and its intersection with other identities.
- Acculturation to the profession, its standards, and norms.

Michel Fabre, Penser la Formation. Paris: Presses Universitaires de France, 1994.

What informed the design of the RED solicitation?

- Past success in first year and senior year – need now to focus on middle years and technical core courses
  - Attrition is high especially in sophomore year
  - Critical entry point for transfer students
  - Need to integrate professional skills holistically across undergrad experience
- Prior research points to the following needs:
  - Faculty development
  - Faculty reward systems
  - Cultures that support faculty engagement
- Department Head leadership as a lever for change

Reform vs. Revolution

- 10 years ago – Department Level Reform
  - 2003-2005, 20 grants of $0.5-1.5M over 3 years
  - Significant curricular reform achieved, with increased interest/enrollments
    - Multi-disciplinary or systems thinking
    - Emerging technologies
    - Project-based/teams – design, service learning, hands-on
      Contexts: business, entrepreneurship, global, etc.
- NOW: Revolutionary not Reformist
  - Radically, suddenly, or completely new; producing fundamental, structural change; going outside of or beyond existing norms and principles
  - Focus on significant, systemic department change

Why Revolution?

"The system needs to change,
but the status quo
steadfastly resists effective transformation,
and change efforts to date have been
inadequate, ineffective, or both."

– Dave Goldberg, BigBeacon.org

A "typical" attempt at change

"Students always complain about lectures."

"Let's try problem based classes. I heard that's a good way to teach."

"Students are still complaining."

"I guess we should go back to lectures. It's easier for faculty."

"It was worth a try, but lectures have worked in the past so we might as well keep them."

Paying attention to culture

"What do we want our program to be?"

"Students should be engaged with real world content."

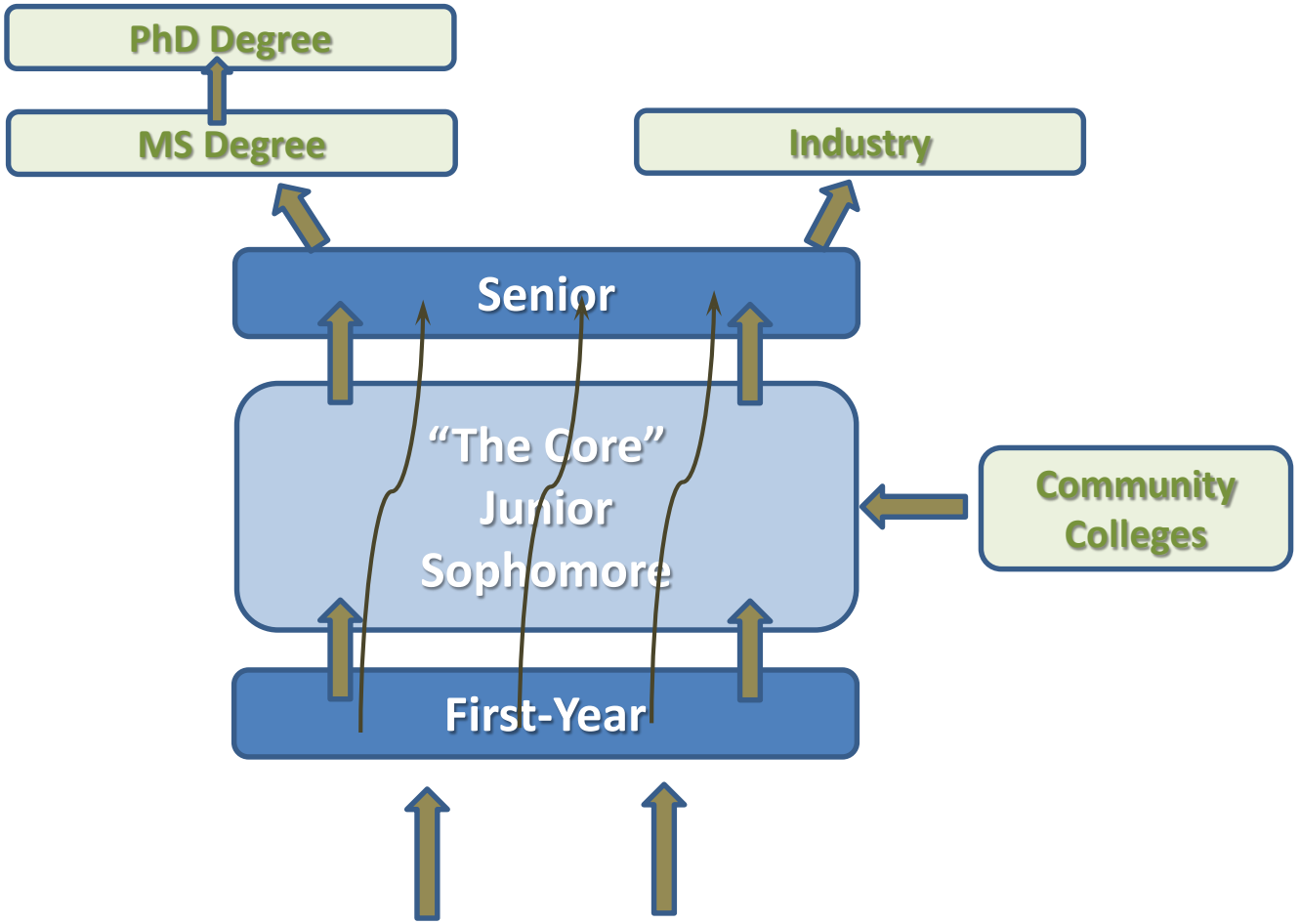
"Let's create field experiences."

"Let's have a faculty retreat to figure out how to change."

"Students still aren't seeing what engineering really is."

"We need another retreat."

RED "target point": the Core



RED "target point": the Core

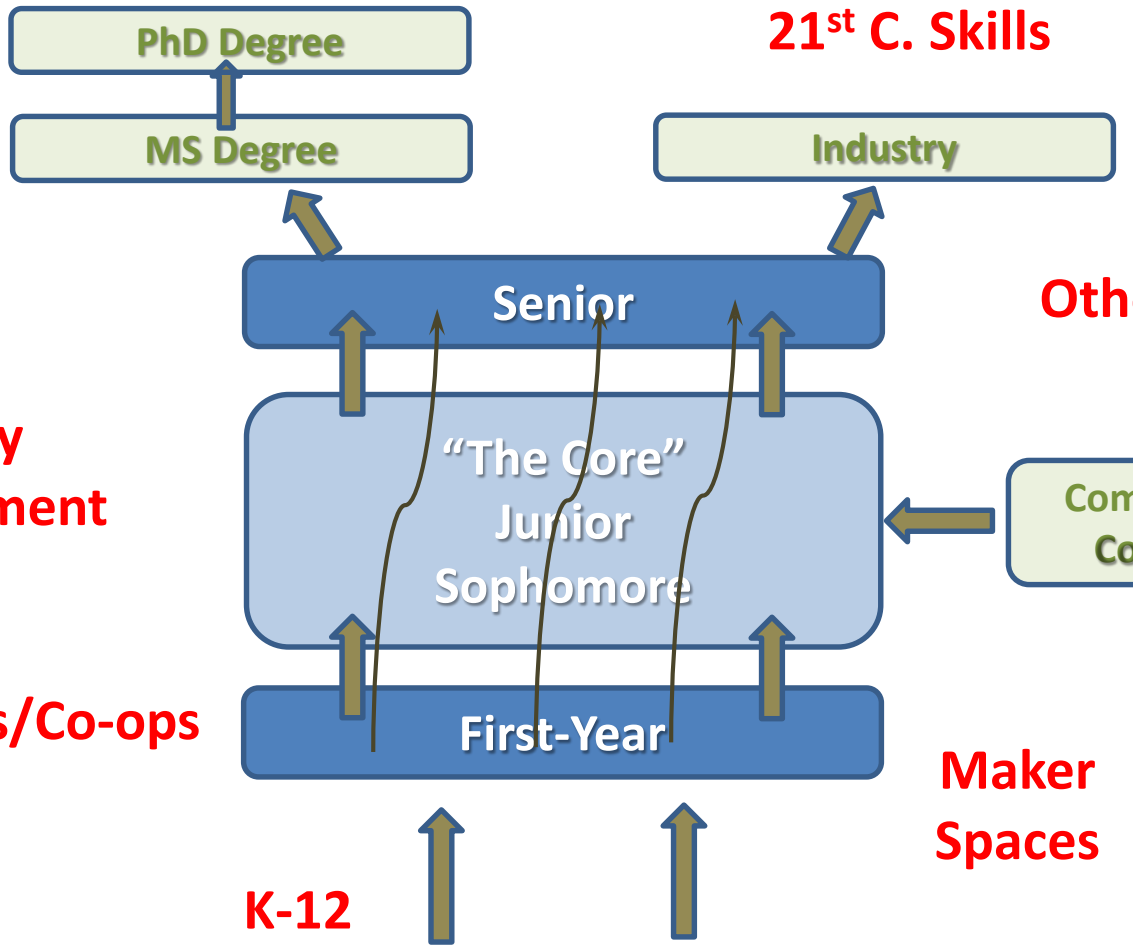
Department Head Role

T-shaped & 21st C. Skills

ABET

Licensure

Department Culture



Other Employment Sectors

Faculty Development

Innovation

Internships/Co-ops

Maker Spaces

K-12

IUSE/Professional Formation of Engineers: REvolutionizing Engineering and Computer Science Departments (RED)

- **Team Members**:

PI – Dept. Chair/Dean

Education Researcher

Social Science Expert

Letter of Intent

- Letter of Intent is required
  - Institution:
  - Engineering Department:
  - PI (Dept. Head/Chair or equivalent), with contact information:
  - RED team members and their roles:
  - Partners/Collaborators:
  - Project Title: The title should begin with “IUSE/PFE:RED:”
  - Synopsis (200-word limit): brief summary of the vision for the department, goals of the proposed RED project, and preliminary plans for sustainability after NSF funding.
- A Minimum of 0 and Maximum of 4 Other Senior Project Personnel are allowed (in addition to PI/coPI team)

Project Description

- Vision for Revolutionizing your Department
- Project Plan and Evaluation Framework
- Supplementary Documents

Vision

- Describe the department and the student professional formation experience “after the revolution.”
- How is success defined?
- Provide a concise answer to the question, “What will be different?”

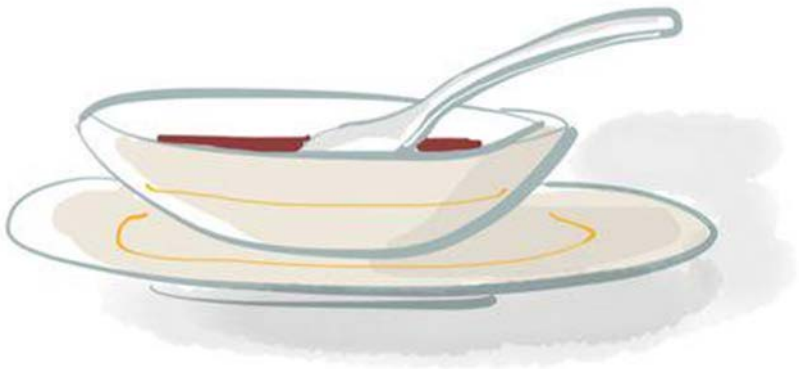
Project Plan and Evaluation Framework

- **Specific Actions:** How will objectives be accomplished? What is the ***theory of change***; how and why should these activities ***effect lasting change***? How will impacts be ***measured***? How will efforts be ***sustained long term***, especially when leadership changes? Explain who will be responsible for which elements of the project.
- **Research Plan:** What will this project add to the knowledge base about creating departmental change? What are your ***research questions***? What ***educational or sociological theories*** speak to your research questions? What ***methods*** answer the research questions posed? How will the achievement of the objectives and goals be measured? These measures can be qualitative or quantitative as appropriate to the question and theoretical orientation.
- **Barriers:** What are ***anticipated barriers*** to achieving objectives? What are anticipated barriers to connecting research to practice? What contingency plans are in place?

Project Plan and evaluation framework

- **Goals:** What outcomes at the end of this project will move the department toward the vision? What will ***change*** about the ***department***? What will change about the ***faculty***? What will change about the ***professional formation of students***? What will change ***nationally***? Who will be impacted?
- **Objectives:** What specific targets will impact achieving the stated goals? For example, if a goal is a faculty both well-equipped and enthusiastic to engage best practices in professional formation, what ***incentives*** are intended to be provided?

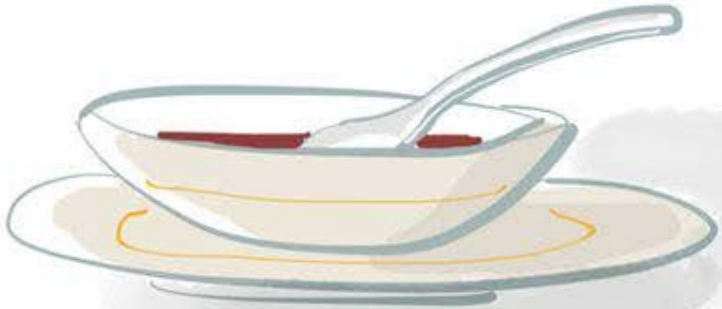
Research vs. Evaluation



- Research
  - What happens to the flavor when I use different ingredients?
  - How does the rate of cooling change when I use different bowls?
- Evaluation
  - Did I use appropriate procedures to make the soup?
  - Did I adequately consider the possible ingredients I might use?

FORMATIVE SUMMATIVE

WHEN THE **CHEF** TASTES THE SOUP



WHEN THE **GUESTS** TASTE THE SOUP

@bryanMMathers

FROM STEVE WHEELER'S BLOG "THE AFL TRUTH ABOUT ASSESSMENT"

http://steve-wheeler.blogspot.com/2014/10/the-afl-truth-about-assessment.html

Supplementary Documents

- Institutional Information
- Letters from Institutional Leadership
- Postdoc Mentoring Plan (if required)
- Data Management Plan (n.b.: Human subjects considerations around privacy and sharing)

Institutional Info (2 pages)

- Demographics of undergrad, grad & faculty – race/ethnicity, gender, ability, academic level/rank
- Undergrad retention data including breakdowns by race/gender/ability
- Overview of current instructional activities – e.g., faculty teaching load, class sizes, who teaches courses, labs, recitations…
- Current department processes, policies, and roles related to faculty development, professional formation of students, and department governance
- Department's prior efforts in engineering or computer science education, including strengths and weaknesses and areas targeted for improvement.

Successful RED Proposals

- **Vision:** ***How revolutionary*** is the vision in light of a well-grounded understanding of the history, context, and culture of the department?
- **PI Team:** Is the RED team ***complete***, with all required expertise? Is each member fully qualified to perform the proposed work?
- **Institutional Commitment:** Do the letter(s) of commitment provide ***evidence of support*** for the project sufficient to achieve the goals and objectives?
- **Connection to Professional Practice:** Is there a sufficient connection in the proposed project to professional practice?
- **Faculty Development Plan:** Is faculty development well planned and ***properly incentivized*** to build department cultures that support the holistic professional formation of engineers or computer scientists?

Successful RED Proposals

- **Potential for Success and Scalability:** How ***achievable and significant*** are the proposed changes in the ***middle two years*** of the technical core? Is the ***theory of change*** valid and well justified? How responsive are the changes to the call to focus on ***professional skills***? Reviewers will take into account justification of the research plan using the ***literature***, comprehensiveness of the plan, institutional leadership commitments, ***sustainability of change*** (including leadership changes and financial sustainability), and the ***propagation*** roadmap/transferability of change strategies.
- **Connection to Research on Engineering Education**: How well informed are the vision and execution plan by the literature and ***prior attempts***, if applicable, to implement change. Is the expectation of success well-justified?
- **Scaling and Adaptation:** How likely is the new knowledge generated about how to change department culture to be received and utilized by others? How well conceived are the plans for accomplishing this goal?

Typical issues with RED proposal

- Fails to address culture
- Missing important elements
  - Structural change, faculty development, specific institutional commitments, plans for sustainability and scaling
- Concept is not revolutionary
  - May be new for the program, but is well known in the literature, other programs are doing it
- Explains what will be done, but not how it will be done
- Lack of appropriate research and/or evaluation
  - Apparent lack of understanding of what they are and how they differ
- Lack of engineering education and/or organizational change expertise on the team

Reading List

- Webinar *Developing a Competitive RED Proposal* presented by current RED awardees, https://academicchange.org/
- *Journal of Engineering Education* Special Issue: The Complexities of Transforming Engineering Higher Education, April 2014, 103(2): 183-361.
- Johri, A. and Olds, B. (2014). *Cambridge Handbook of Engineering Education Research.* New York: Cambridge University Press.
- National Academy of Engineering. (2013). *Educating Engineers: Preparing 21st Century Leader in the Context of New Modes of Learning*. Washington, DC: National Academies Press.
- ASEE. Transforming Undergraduate Education in Engineering: Phase I: Synthesizing and Integrating Industry Perspectives, May 9-10, 2013. Workshop Report. http://www.asee.org/TUEE_PhaseI_WorkshopReport.pdf

Reading List

- Jamieson, L., and Lohman, J. (2012). *Innovation with Impact: Creating a Culture for Scholarly and Systematic Innovation in Engineering Education*. Washington, DC: American Society for Engineering Education.
- Watson, K. (2009). Change in Engineering Education: Where does Research Fit? *Journal of Engineering Education*, 98(1): 3-4.
- Spalter-Roth, R., Fortenberry, N., and Lovitts, B. (2007). The Acceptance and Diffusion of Innovation: A Cross-Curricular Perspective on Instructional and Curricular Change in Engineering. Washington, DC: American Sociological Association and National Academy of Engineering Center for the Advancement of Scholarship in Engineering Education.
- National Academy of Engineering (2005). *Educating the Engineer of 2020: Adapting Engineering Education to the New Century*. Washington, DC: National Academies Press.