UTeach*Engineering* & NASA Efforts in STEM Education Policy

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Presentation Overview

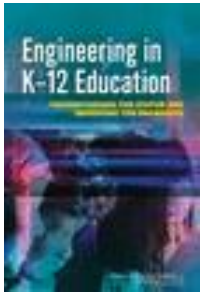
- Motivation for teaching engineering
- What is UTeach*Engineering*?
- UTeach*Engineering* high school course V2.0
- NASA involvement in UTeach*Engineering*
- NASA engagement in STEM education policy

The National STEM Conversation is Happening Now

- *Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category 5*
- *Report to the President – Prepare and Inspire: K-12 Education in STEM for America's Future*
- *Change the Equation*, a CEO-led initiative to cultivate widespread STEM literacy

National Policy Picture

- In the national STEM conversation, what is the role of engineering?
  - How can engineering be more than the “silent E” in “STEM”?

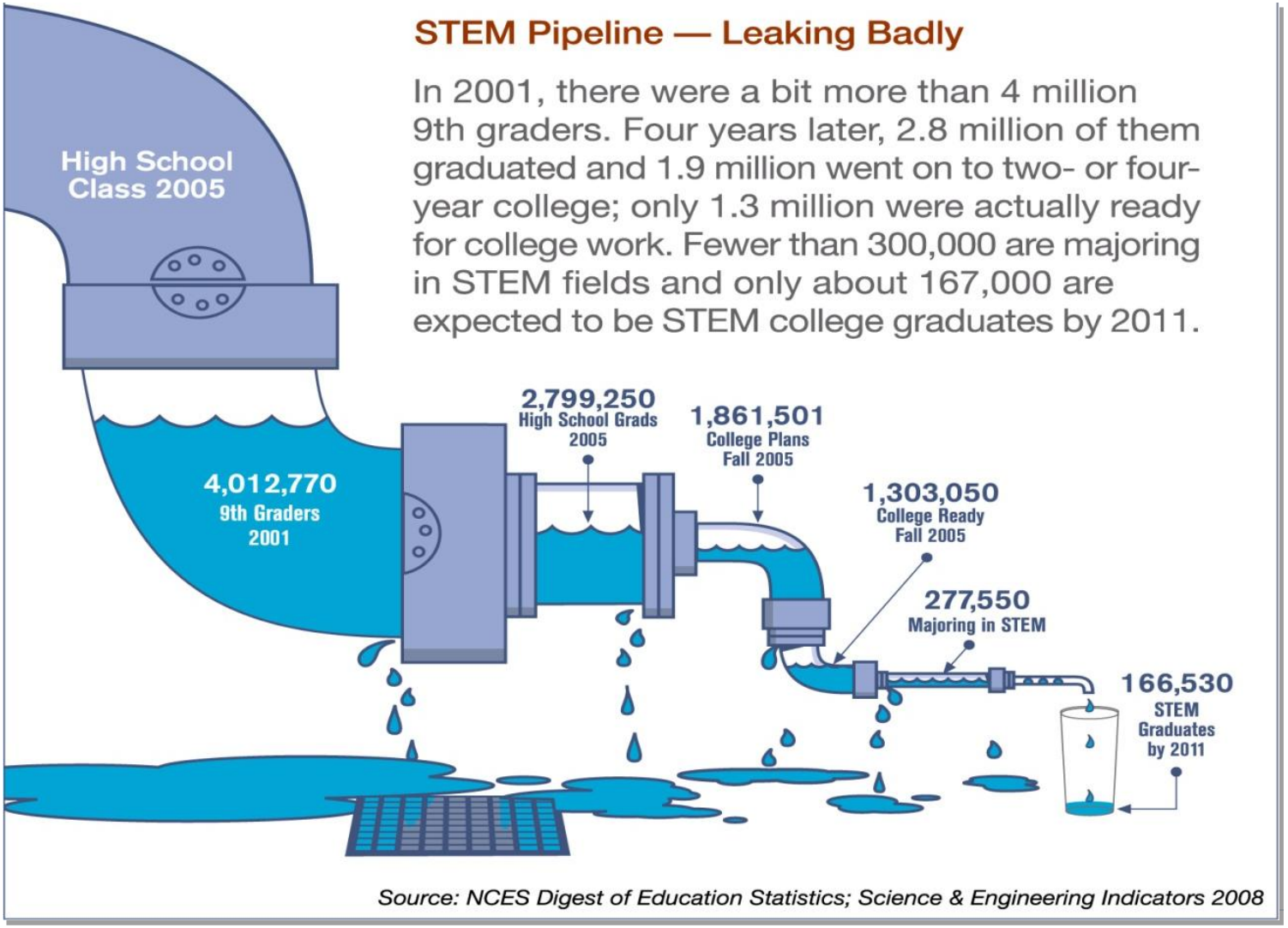


Engineering in K-12 Education
National Academy of Engineering (NAE), 2009

Standards for K-12 Engineering Education?
NAE, 2010

Integrating engineering standards;
To be reviewed & released, 2012

National Need



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What is UTeach*Engineering*?

UTeach
THE UNIVERSITY OF TEXAS AT AUSTIN
NATURAL SCIENCES

+ Cockrell School of Engineering
THE UNIVERSITY OF TEXAS AT AUSTIN

+ Austin Independent School District

UTeachEngineering
Preparing Secondary School Teachers to Deliver Design-Based Engineering Courses

- Funded by the National Science Foundation through a $12.5M grant from the Math-Science Partnership program
- Grant period of performance: 2008-2013
- 1 of 3 NSF MSP grants to focus on K-12 engineering education
- A unique partnership
  - Respond to the current opportunity in Texas; 4x4 requirement (short-term)
  - Develop and evaluate a model for addressing national engineering needs (long-term)

What is UTeach*Engineering*?

- A model high school engineering course
- Teacher preparation
  - In-Service Teacher Programs
    - Engineering Summer Institutes for Teachers (ESIT)
    - Master of Arts in Science and Engineering Education (MASEE)
  - Pre-Service Teacher Programs
- Meaningful research in an emerging field

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UTeach*Engineering*
High School Course Development

2009-10

Develop

- Develop Design Challenge Materials for Testing (V1.0)

2010-11

Test & Redevelop

- Pilot, Assess and Evaluate V1.0 Materials in Classrooms
- Develop Unified Course Framework and Design V 2.0

2011-12

Test & Refine

- Pilot, Assess and Evaluate V2.0 Materials in Texas Classrooms
- Refine into V 2.1

2012-13

Finalize

- Pilot, Assess and Evaluate V2.1 Materials in Classrooms — Texas and other states
- Initiate teacher mentor model
- Generate Final Course Product

Red=NASA involvement

UTeach*Engineering*

V2.0 Course Framework

UTeach*Engineering* High School Course - Version 2.0

Critical Aspects of the UTeach*Engineering* High School Course

	Fall Semester				Spring Semester		
	Fundamental Scaffolding				Experiencing Design and the Breadth of Engineering		
Engineering and Its Role in the World	**Engineering Impacts Our Everyday Lives**	**Engineering Has Impacted Lives for Many Years; Engineers Work in Teams as Products Evolve in Parallel with Science, Technology and Societal Needs**		**Engineering Can Improve Lives (and I Can Play a Role)**	**Through Automation, Engineering Opens New Frontiers**	**Free Design**	**Special Topics in Engineering**
Unit Title (V2.0)	*Reverse Engineering Your World*	*From Pinholes to Pixels: The Evolution of Imagery*	*Change Your World View: Aerial Imagery*	*Thirsting for a Better World: Wind Power Moving Water from Source to Need*	*Automation and Control (Robotics)*	*Variety of Topics*	*A Collection of Short Engineering Activities*
Unit Duration	*2 weeks*	*5 weeks*	*5 weeks*	*6 weeks*	*6 weeks*	*6 weeks*	*6 weeks*
1. What do Engineers Design?							
Great Achievements							
Grand Challenges							
Practice (disciplines, careers, multidisciplinary nature of practice)							
2. What Skills Do Engineers Use to Design (Engineering Habits of Mind)?							
Systems Thinking							
System context and top-down perspective							
System decomposition (system, subsystem, element, component)							
Functional models, including input/output							
Systems understanding & quantification							
Information gathering / Research (background, context, benchmarking)							
Understanding/application of domain-specific math/science knowledge (challenge-dependent)							
Data acquisition and analysis							
Modeling							
Understanding/application of engineering tools and techniques							
Common engineering software tools (challenge-dependent)							
Instrumentation and experimentation							
Engineering project management							
Creativity							
New design, redesign, reverse engineering	*reverse engineering*	*new design*	*design modification*	*redesign*			
Techniques for concept generation and selection							
Innovation and design evolution							
Collaboration							
Teamwork (e.g., types of teams, group dynamics team composition)							
Communication							
Engineering notebooks and configuration management (cm)		*individual notebook*	*team notebook*				
Specifications							
Data representation for decision making							
Formal documentation (e.g., reports, presentations)							
Ethics							
Engineering ethics and codes of practice (per engineering discipline)							
Engineering standards and regulations, including the role of government							
Legal aspects including intellectual property, patents, and trademarks							
Safety & risk analysis							
Safety considerations w/ respect to the system, the engineer & the user							
Understanding failure modes in system design							
3. What Process Do Engineers Use to Design?							
 Identify							
Describe							
Generate							
Embody							
Finalize							

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NASA involvement in the V2.0 Course

Unit 3 — Change Your World View: Aerial Imagery

Teamwork
System decomposition
Design at the subsystem level
Requirements
Operations planning
Remote sensing

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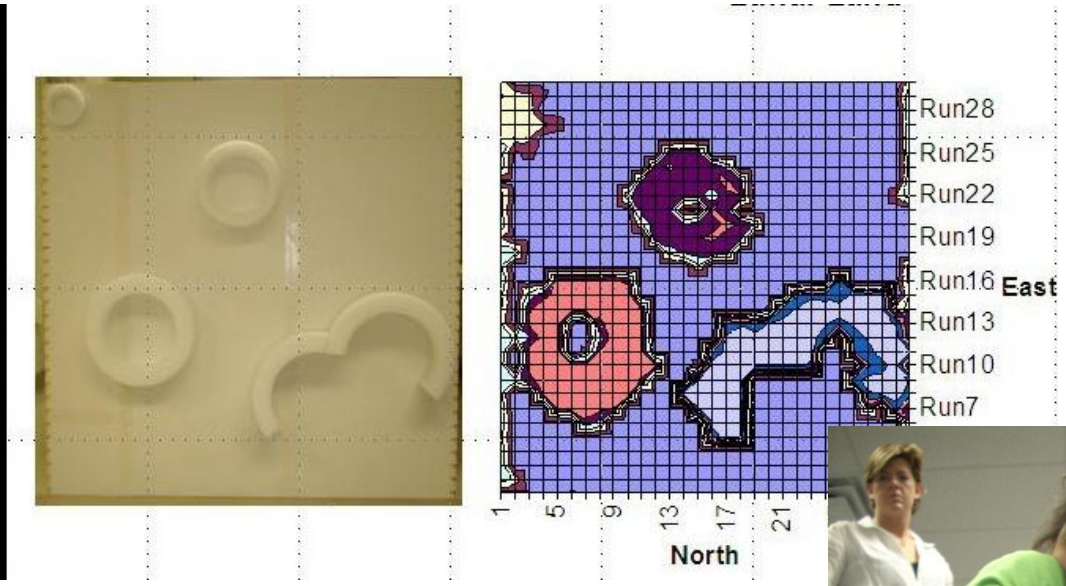
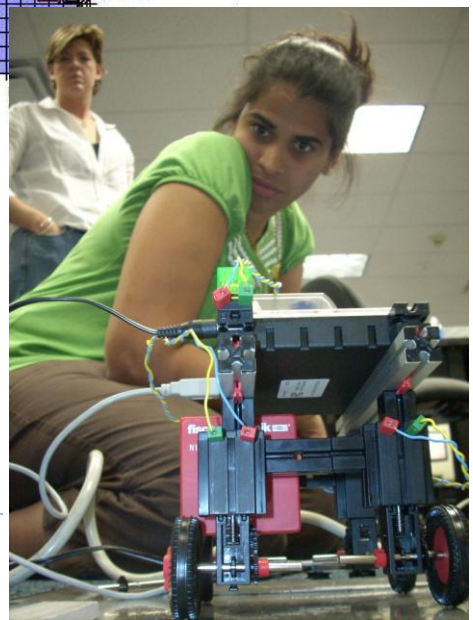
NASA involvement in the V2.0 Course

Unit 5 — Robotics: The Search for Lunar Ice





Automation and control
Programming basics
Data acquisition
Specifications
Operations planning
Topography

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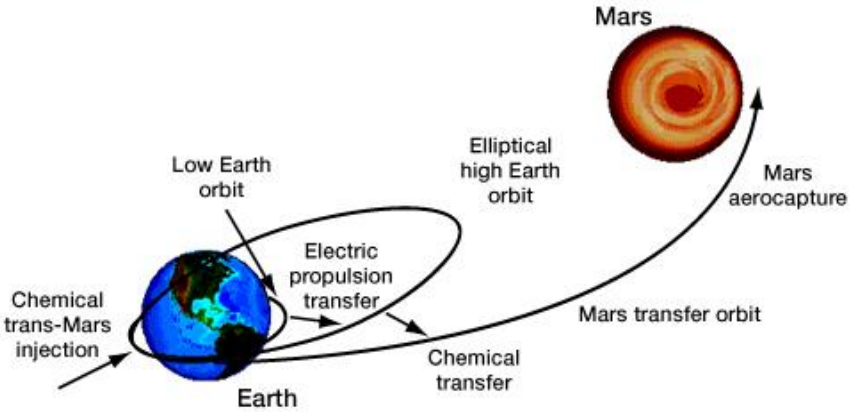
NASA involvement in the V2.0 Course

Unit 6 — Open Design Challenge: Mission to Mars



More complex unit; less structured
Uses all the engineering critical aspects
Introduces risk analysis
Introduces project management skills

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NASA involvement in the V2.0 Course

Supplemental materials

Basics of rocketry
Digital Learning Network units
e.g., Can a shoebox fly?
Engineering ethics lessons
Failure case studies

NASA involvement in UTeach*Engineering*

- Example of federal agency partnership
  - *Math-Science Partnership (MSP) grants a viable mechanism for further partnerships*
  - *NSF, DoEd, and NASA*
- Example of opportunity for NASA technical talent
  - *Enable use of content in education curriculum*
  - *Mentor teachers*
- Example of NASA education policy involvement
  - *K-12 Engineering education; AP possibilities*
  - *Contribute to new FY13 Annual Performance Goals*

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FY 13 Performance Goals and APGs
Outcome 6.2.1

Strategic Goal 6

Share NASA with the public, educators, and students to provide opportunities to participate in our Mission, foster innovation, and contribute to a strong national economy.

Outcome 6.2

Promote STEM literacy through strategic partnerships with formal and informal organizations.

Objective 6.2.1

Develop NASA's leadership role in national STEM improvement efforts, as demonstrated by provision of meaningful educator professional development and student experiences, adoption of education technologies, and contributions to STEM education policies and strategies.

Performance Goal

Increase NASA engagement in national STEM education policy discussions to improve curricula, inform national standards in STEM subjects, and to ensure coordination and sharing of best practices across federal STEM agencies to avoid duplication.

APG

NASA will participate in no less than 20 STEM education advisory boards, STEM-related committees, or other events or activities related to national STEM education policy.

Recommendation 3 from Education Design Team

Participate in national and state STEM education policy discussions.

- 3.1. The Office of Education should develop an Agency position on STEM education topics such as the need for common core standards and the development of an engineering curriculum for high school students, to enable staff to consistently provide input to STEM policy discussions and debates.
- 3.2. The Office of Education should provide guidelines and training on how, when, and to what extent the Center education staff should engage in STEM education policy discussions.
- 3.3. The Office of Education should identify opportunities for NASA STEM subject matter experts to participate in key STEM education advisory boards, STEM-related committees, and other organizations addressing STEM education.

	National Role	Baseline Model
	HQ Education Leadership	Center Offices of Education
Education policy coordination	Lead NASA Education Policy Working Group; Policy WG reports to ECC. WG develops NASA policy agenda, position, and messaging for Centers to implement.	Participate on WG with core staff from those Centers experienced and passionate about policy. Diversity of membership; not just education professionals. If available, always have an Einstein fellow (or equivalent quality teacher) assigned to the WG.
Education policy engagement	Engage key *national* organizations in DC, such as Council of Chief State School Officials. Push topics and trends at national level to Policy WG to Center state liaisons. Ex. Communicate which states investing in virtual schools; or working next gen science standards.	Engage at least one *state* in Center's service region that is actively part of the specific policy implementation topic. Establish a liaison to each state within service region (i.e., networking).
Education policy connections	Make connections across federal government agencies with a STEM interest. Communicate federal interests to Centers. Ex. Co-STEM involvement; Dept of Ed & its Race-to-the-Top	Seek opportunities to serve and connect with education leaders through Legislative Affairs. Ex. Space Day in Center's resident state.
Education policy relationships	Extend education policy reach through organizations committed to STEM at national level, such as STEM Ed Coalition, STEM Connector. Enable NASA awards and grants to include STEM policy interests.	Extend education policy reach through NASA education projects and sponsored organizations (e.g., AESP; Space Grant).
Subject Matter Experts involvement in education	Recommend, through ECC, policy assignments and strategic opportunities for Center SMEs.	Identify/coordinate Center SMEs for assignments, possibly IPA opportunities.

Opportunities for Space Grant
STEM education policy

- Communicate to NASA how your state is responding to current STEM policy topics
  - *E.g., K-12 engineering ed; next gen science standards*
- Make state connections to extend NASA's reach beyond field center states
  - With state education leadership; key STEM organizations; interested school districts
- Coordinate with MSP grant universities in your consortium
  - *Example NSF MSP grantees for engineering ed: UT-Austin, Purdue, Steven's, University of Cincinnati*
  - *Hot topics: teacher PD for engineering; implementation of next gen science standards; content for K-12 engineering*

For more information

UTeach*Engineering* high school course — Engineer Your World

- **www.engineeryourworld.org**

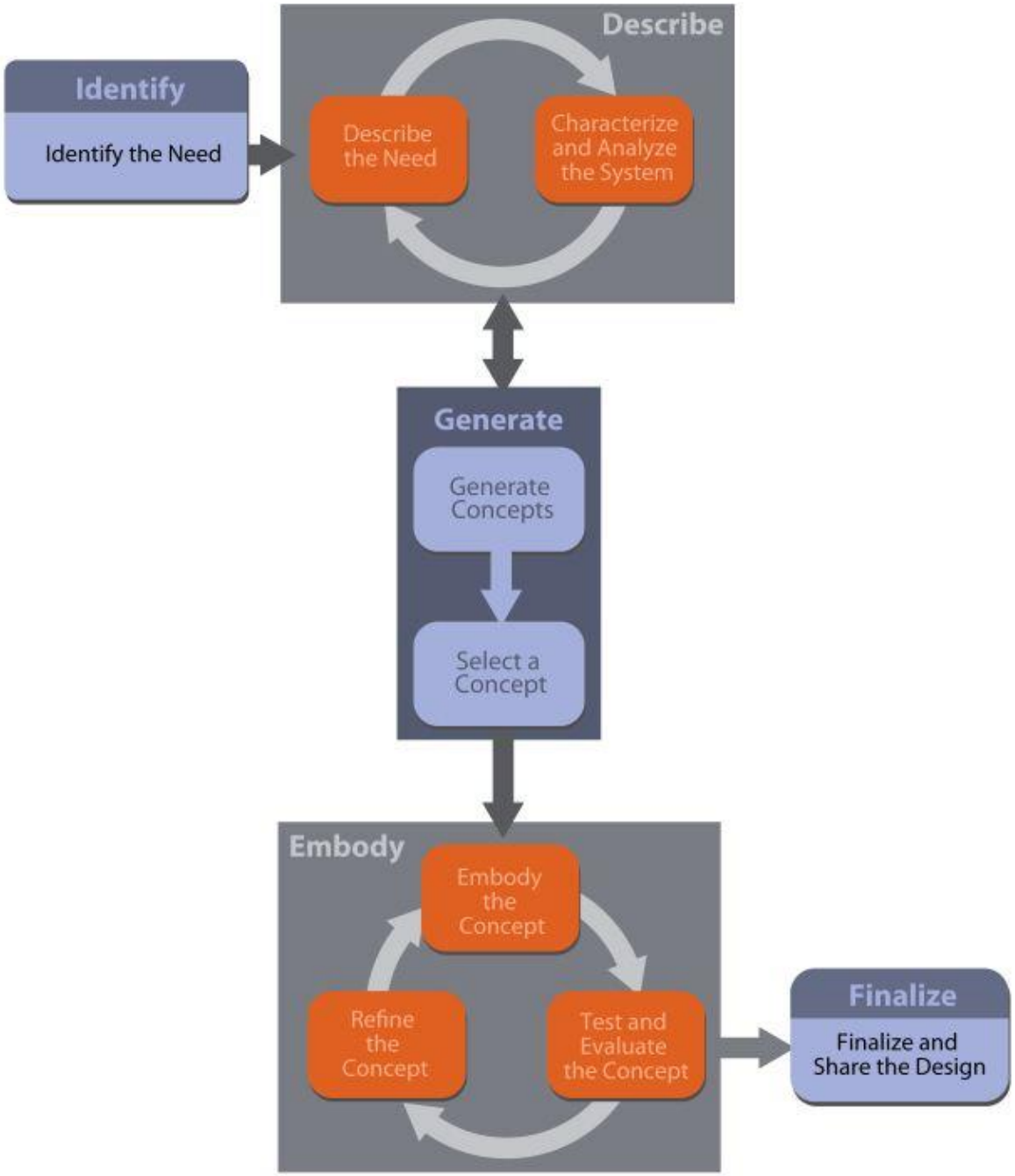
- **Lisa.a.guerra@nasa.gov**

Back-up Slides

UTeach*Engineering*

V2.0 Course Objectives

1. Attract high school students (including, particularly, those from historically underrepresented populations) to engineering and positively impact their interest in engineering.
2. Introduce students to multiple disciplines and a variety of career paths within engineering.
3. Enable students to make informed decisions regarding engineering as a profession.
4. Encourage engineering literacy by teaching the engineering habits of mind.
5. Encourage a growth mindset by highlighting that engineering design and problem solving are skills that can be learned, practiced, and improved.



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What process do engineers use to design?

Engagement in Education Policy

Current Model:

- Ad hoc approach; no agency-wide coordination or discussion
- Centers choose to participate at the local, state or regional levels
  - 4 of the 10 NASA Centers are actively engaged in education policy (according to ECC survey distributed by the Policy Working Group)
  - Center concerns related to engagement: takes resources; lack policy expertise; should focus on workforce needs; work only at county level.