34th Annual INCOSE international symposium

hybrid event

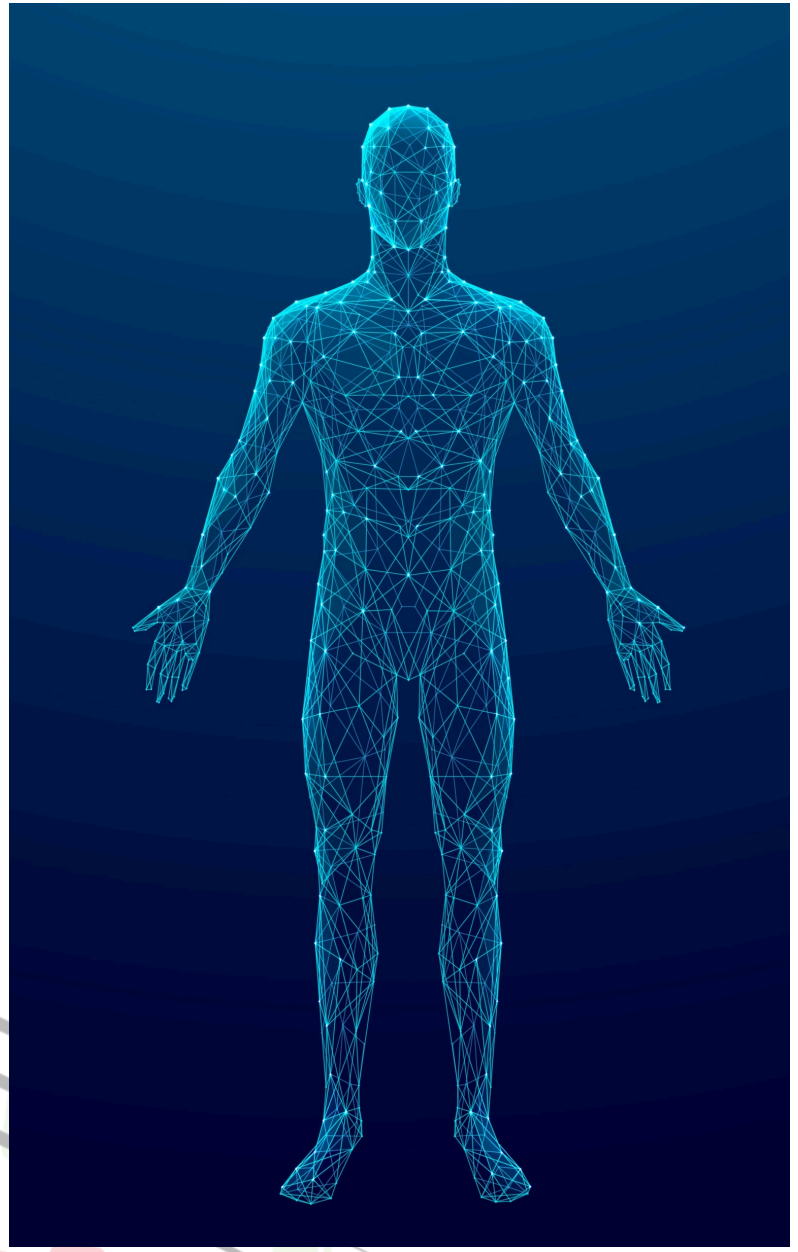
Dublin, Ireland
July 2 - 6, 2024

# From Education to Application in Community Engaged Engineering

# About Me

*A long time ago…*

**BS Biological Anthropology**
**The University of Arizona**



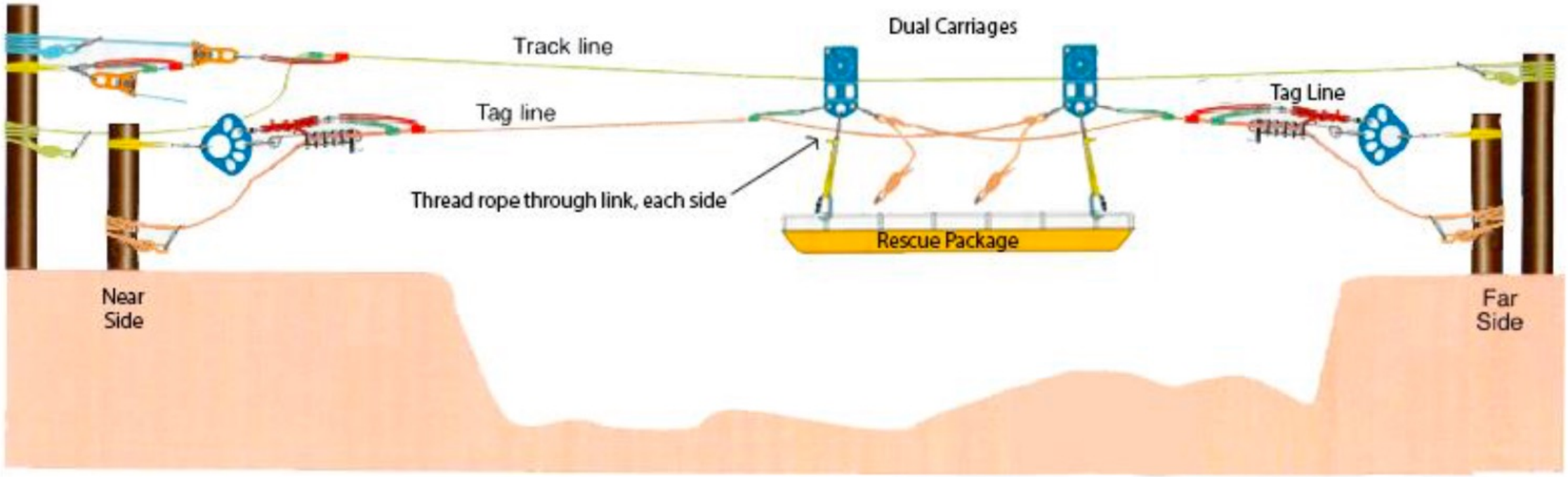
# About Me

**Mountain Rescue Technician**

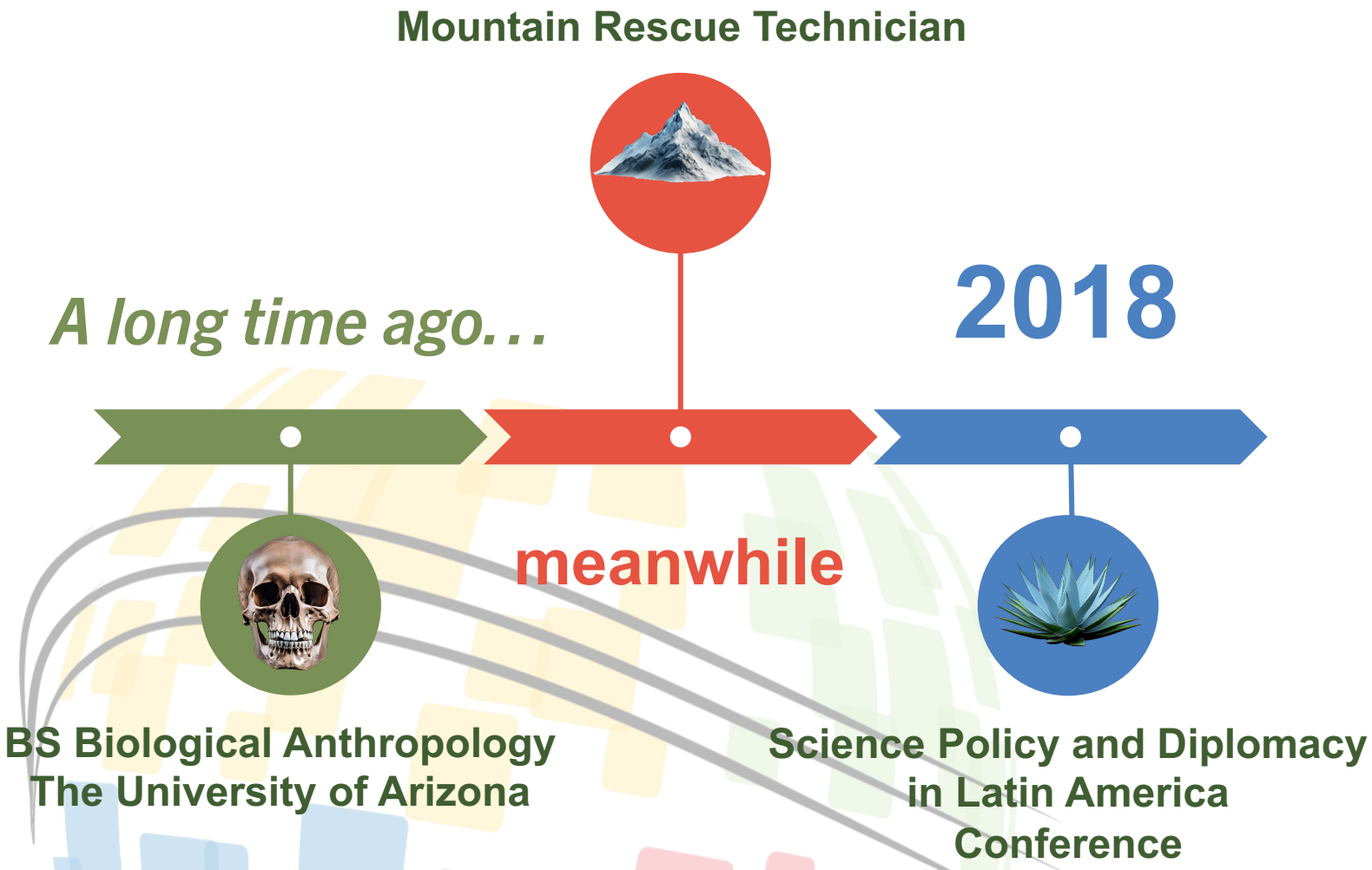
*A long time ago…*

**BS Biological Anthropology**
**The University of Arizona**

**…and then…**


Dual Carriages
Track line
Tag line
Tag Line
Thread rope through link, each side
Rescue Package
Near Side
Far Side

# About Me


Mountain Rescue Technician
A long time ago…
2018
meanwhile
BS Biological Anthropology
The University of Arizona
Science Policy and Diplomacy
in Latin America
Conference

# About Me

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meanwhile

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2018

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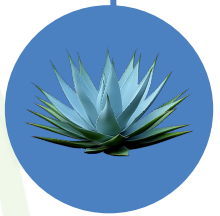
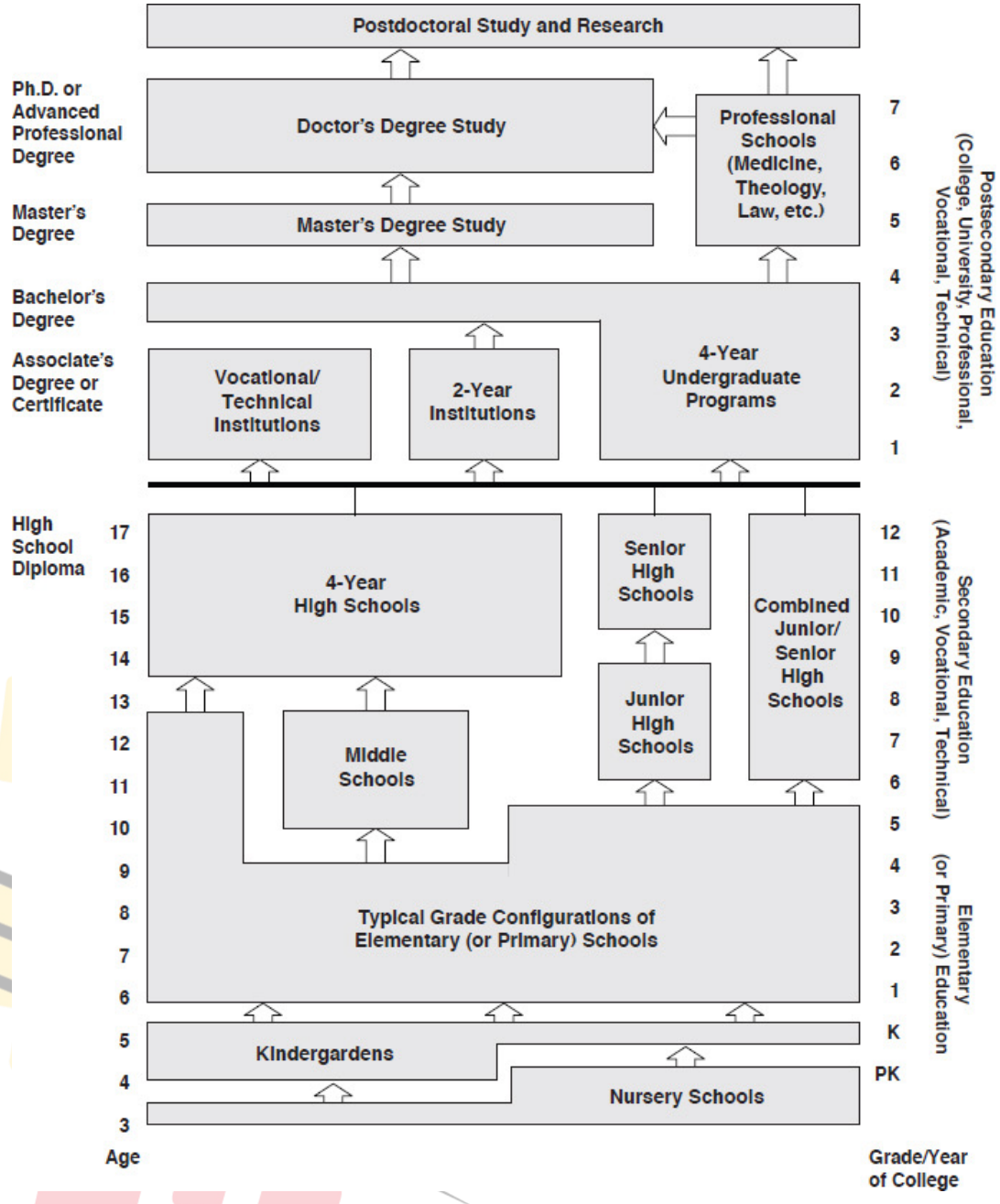


2023

MS Student
Systems Engineering
The University of Arizona




*National Academies of Sciences, Engineering, and Medicine*

# About Me

*A long time ago…*

**BS Biological Anthropology**
**The University of Arizona**

**Mountain Rescue Technician**

**meanwhile**

**2018**

**Science Policy and Diplomacy in Latin America Conference**

**MS Student**
**Systems Engineering**
**The University of Arizona**

**2022**

**2023**

**Co-Investigator**
**Arizona Science & Technology Policy Fellowship Project**

# About You

Engineers!

Not engineers?

Educators? Students?

Policy or diplomacy?

Where are you from?

# Community Engaged Engineering

"Engineering that acknowledges:

- Social injustices behind many of the technical problems engineering interventions aim to address.
- The promise and ability of engineers to help communities redress such injustices through democratic knowledge-making, equitable collaborations of research and action, and respect for community rights and self-determination.
- The limits and limitations of engineering worldviews as well as the technical relevance and moral value of the worldview of the communities engineers care to serve."

*– Online Ethics Center for Engineering and Science*

# Community Engaged Engineering

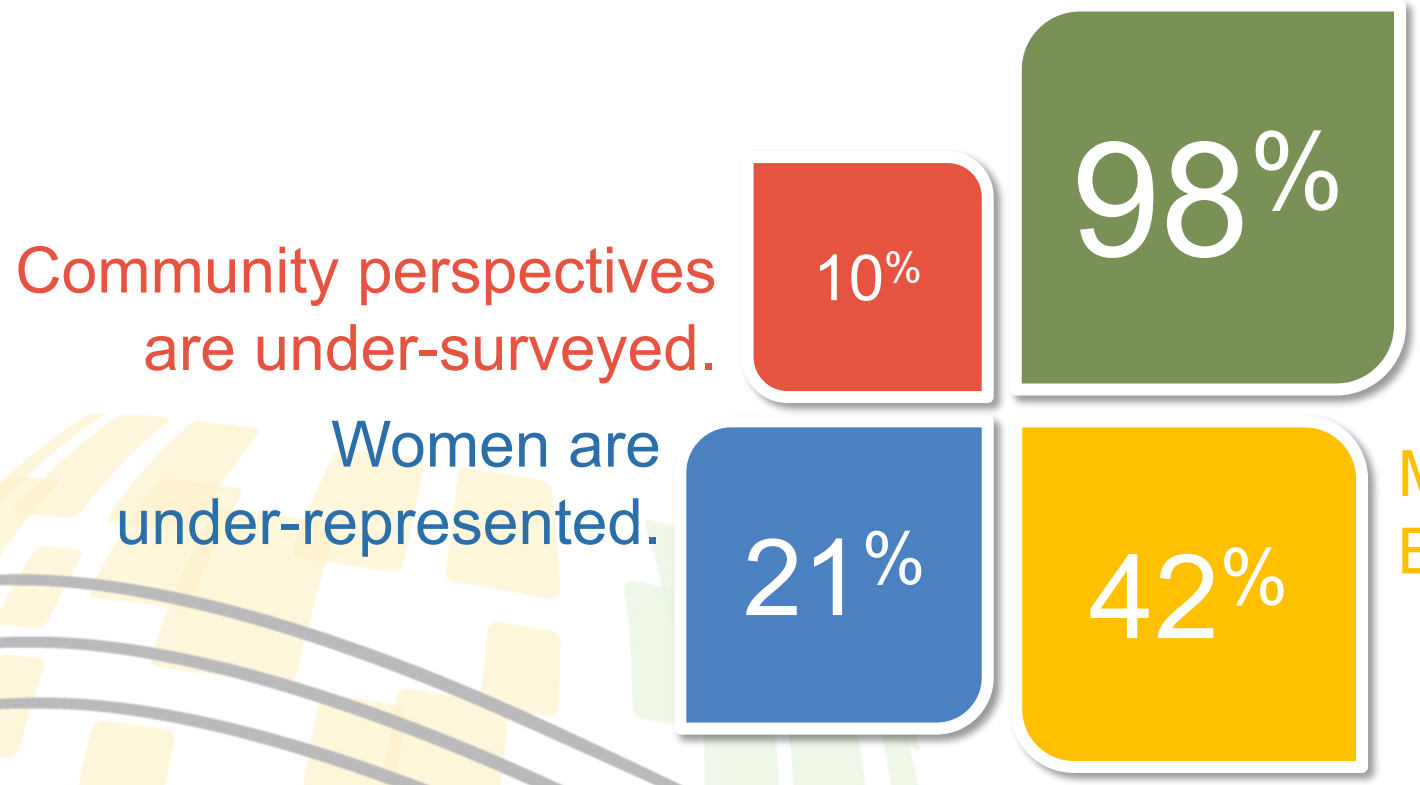
"Service Learning" – "Humanitarian Engineering" – "Citizen Science"

- Engineers "can consciously and unconsciously transform lives and affect generations through their creations." *(Mathias and Madhavan, 2023)*
- Community engagement continues to gain traction among academicians.
- Especially for challenges such as United Nations Sustainable Development Goals.
- So, we need to address the "engagement gap" in engineering education.

# Community Engagement in Engineering Education

- Systematic Literature Review by Natarajarathinam et. al. (2021)
- Surveyed 120 reviews on community engagement educational programs 1980-2019
- Barriers to engagement:
  - Logistical (time, funding, travel)
  - Cultural and linguistic (communication)
  - Perceived disconnects in relevance
- Community partners' perspectives inadequately considered!

# Community Engagement in Engineering Education




Community perspectives are under-surveyed.

Mostly involves under-grads.

Women are under-represented.

Multidisciplinarity is cool. But under-acknowledged.

*Natarajarathinam et. al., 2021*

# Science, Health and Engineering Policy and Diplomacy ENGR 495A/595A


- National and international need for experts capable of interpreting and conveying technical information to policymakers
- Historical perspectives to emerging modern themes in policy and diplomacy
- Open to undergraduate seniors and graduate students ***in any discipline***

**Hassan Vafai**

**Kevin Lansey**

# ENGR 495A/595A Curriculum

## In this 3-unit flex in-person course, students will…

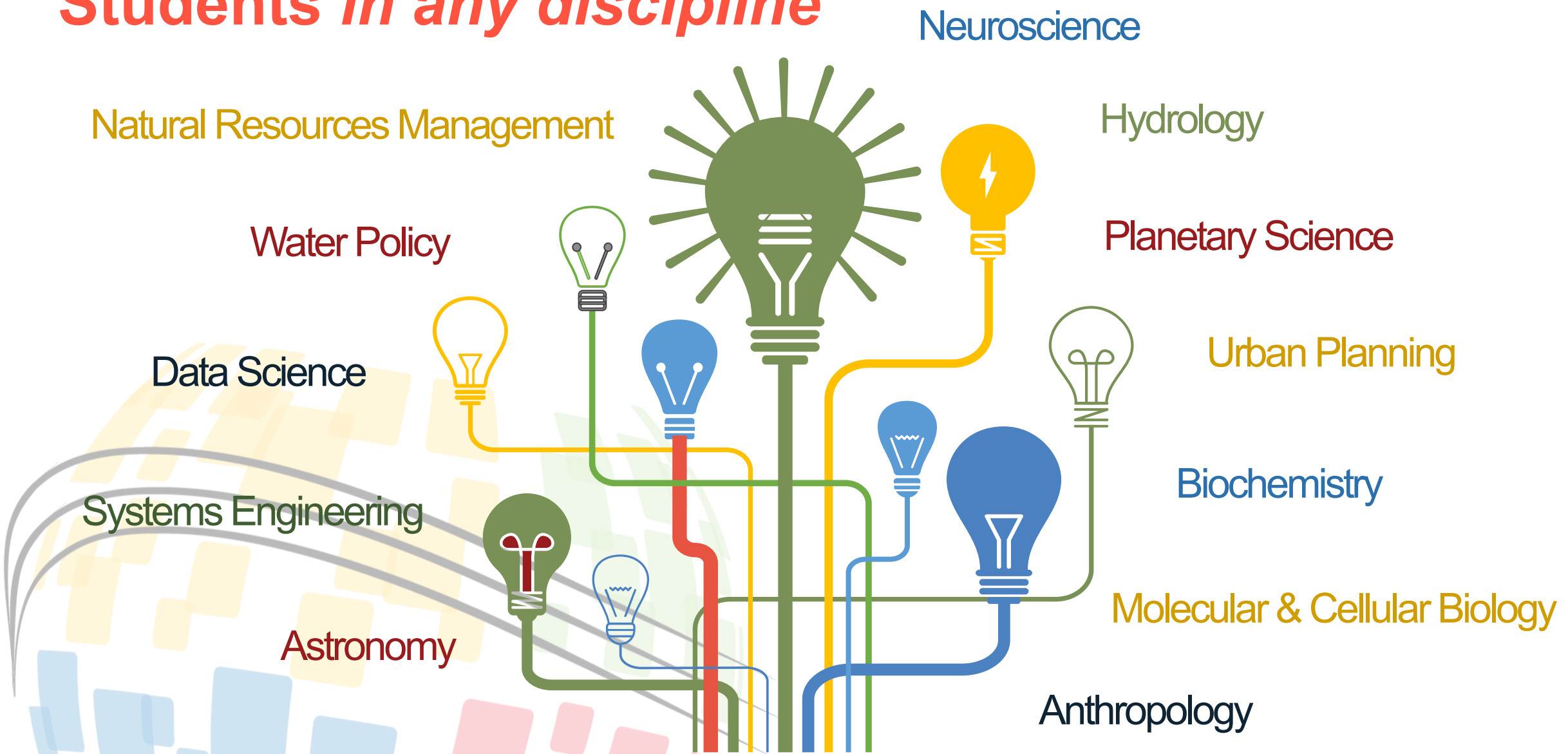
- Watch lectures from science policy and diplomacy experts including representatives from the National Academies, U.S. and international governments, and top universities.
- Engage with emerging topics presented at prior **Science Policy & Diplomacy Distinguished Speakers Series** by world-renowned science policy makers and diplomats.
- Assume the role of a scientific advisor in a Science Diplomacy simulation – **The Mercury Game**.
- Participate in the **Science Diplomacy Lab**; researching and compiling recommendations to address a science-related foreign policy challenge.

# ENGR 495A/595A Distinguished Speaker Series

# ENGR 495A/595A Course Topics

- Ethics and Philosophy of Science
- Defining Science Policy & Diplomacy
- Global Health Diplomacy
- Engineering Policy and Diplomacy
- Climate Science Diplomacy
- Hydro & Ocean Science Diplomacy
- Food Security and Science Diplomacy
- Artificial Intelligence
- Cybersecurity
- Space Diplomacy
- Conflict Resolution & Negotiation
- Future of Science Policy & Diplomacy

# Students *in any discipline*



# Diplomacy Lab


- Public-private partnership between United States Department of State and U.S. higher education institutions
- Enables DOS to “course-source” research and innovation related to foreign policy
- Provides students with real-world experiential learning, multidisciplinary teamwork, communication skills

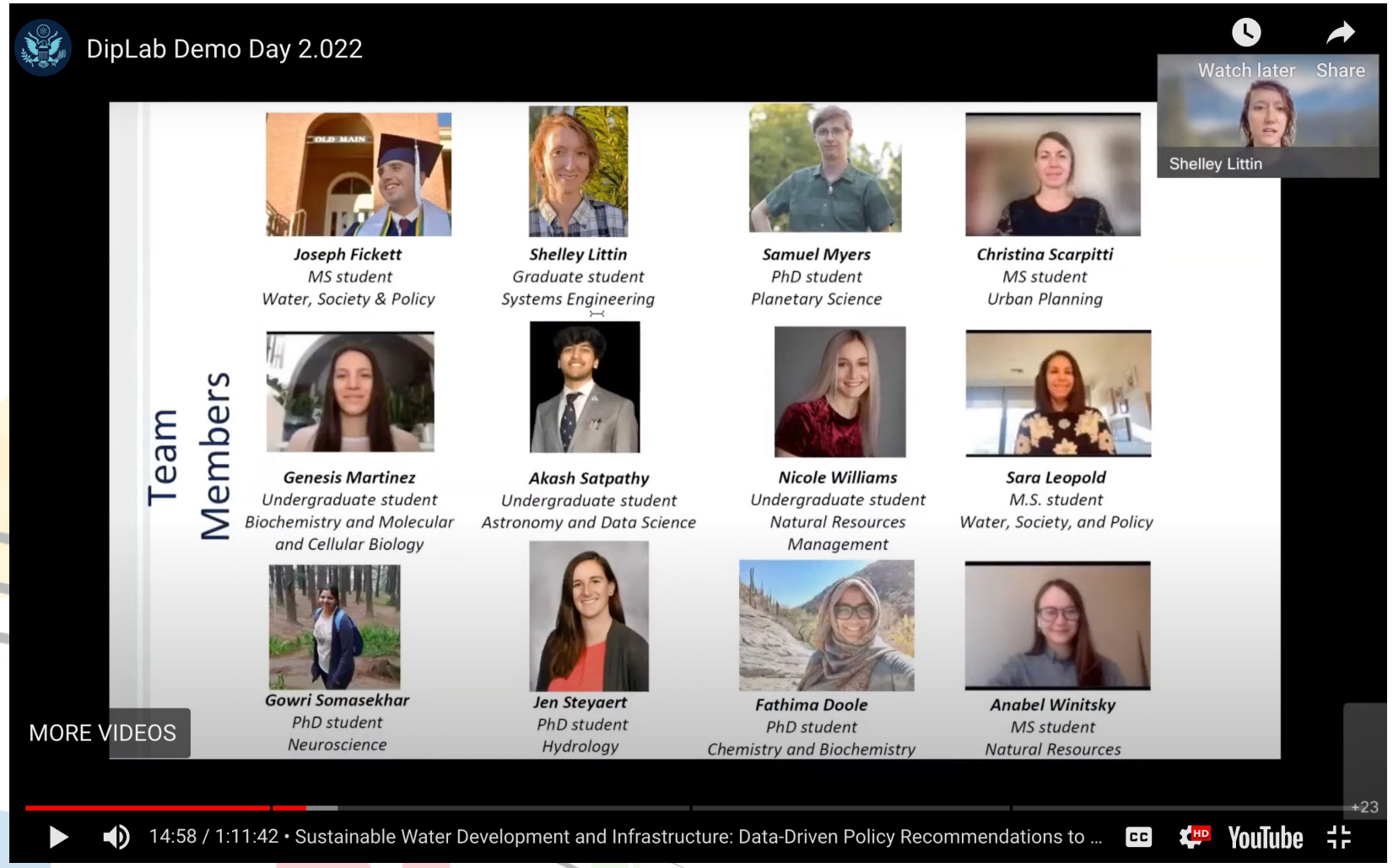
# The Diplomacy Lab Process

# Enhancing Mekong Region Security in a Changing Climate


- Five nations, interdependent nexuses
- Compound effects of climate change
- Stressors to food, energy, water supply
- Complex political relationships
- Asked to recommend solutions based on agriculture, engineering, water resources, and science diplomacy

# Enhancing Mekong Region Security in a Changing Climate

# Enhancing Mekong Region Security in a Changing Climate



# The Mercury Game

UNITED NATIONS ENVIRONMENT PROGRAMME[1]

## International Mercury Assessment


*Table of Contents*

Introduction, Purpose & Scope
**Issue 1:** Institutional Form for Future Action
**Issue 2:** Atmospheric Emissions
**Issue 3:** Demand for Mercury Used in Products & Processes
**Issue 4:** Artisanal and Small-scale Gold Mining


- Created in 2014 by MIT Drs. Leah Stokes, Noelle Selin, and Lawrence E. Susskind
- Multiparty role-play negotiation simulation
- Designed to help participants actively learn about science-policy interactions in the context of global environmental treaty-making challenges

# ENGR 495A/595A Experienced Outcomes

- Accessible
- Virtual platform enables global interaction
- Three quarters of the class in 2021 was female
- Half of the students were graduate students
- We made deliberate efforts to engage with community organizations

- Communications training is beneficial for any future career
- Multidisciplinary teamwork is beneficial when transitioning into industry
- Experiential learning is more memorable and more impactful than “book learning”

# Experiential Learning for Training Future Science Policy and Diplomacy Experts

Fathima T. Doole[1*], Shelley Littin[2*], Samuel A. Myers[3*], Gowri Somasekhar[4*], Jennie C. Steyaert[5*], Kevin Lansey[6*]

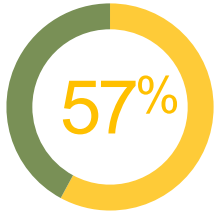
[1]Department of Chemistry and Biochemistry, University of Arizona, Tucson, AZ, USA
[2]Department of Systems and Industrial Engineering, University of Arizona, Tucson, AZ, USA
[3]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ, USA
[4]Department of Neuroscience, University of Arizona, Tucson, AZ, USA
[5]Department of Hydrology and Atmospheric Sciences, University of Arizona, Tucson, AZ, USA
[6]Department of Civil and Architectural Engineering and Mechanics, University of Arizona, AZ, USA
*All authors contributed equally to preparation of the manuscript.

https://doi.org/10.38126/JSPG210103

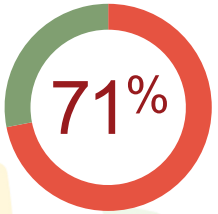
Corresponding author: littin@arizona.edu

Keywords: science diplomacy; experiential learning; Diplomacy La;, training; science policy; Mekong; negotiation simulation

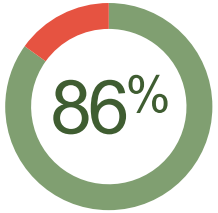
# ENGR 495A/595A Course Findings




Agreed the course improved their appreciation for multidisciplinary projects.




Found Diplomacy Lab experience to be extremely empowering for skills application.




Found the experience increased their appreciation for and interest in science, health and engineering policy and diplomacy.

# ENGR 495A/595A Course Findings

“A lot of people get stuck looking down at the mechanics of a particular challenge, but they’re going to end up working out in the real world with a much larger application.”

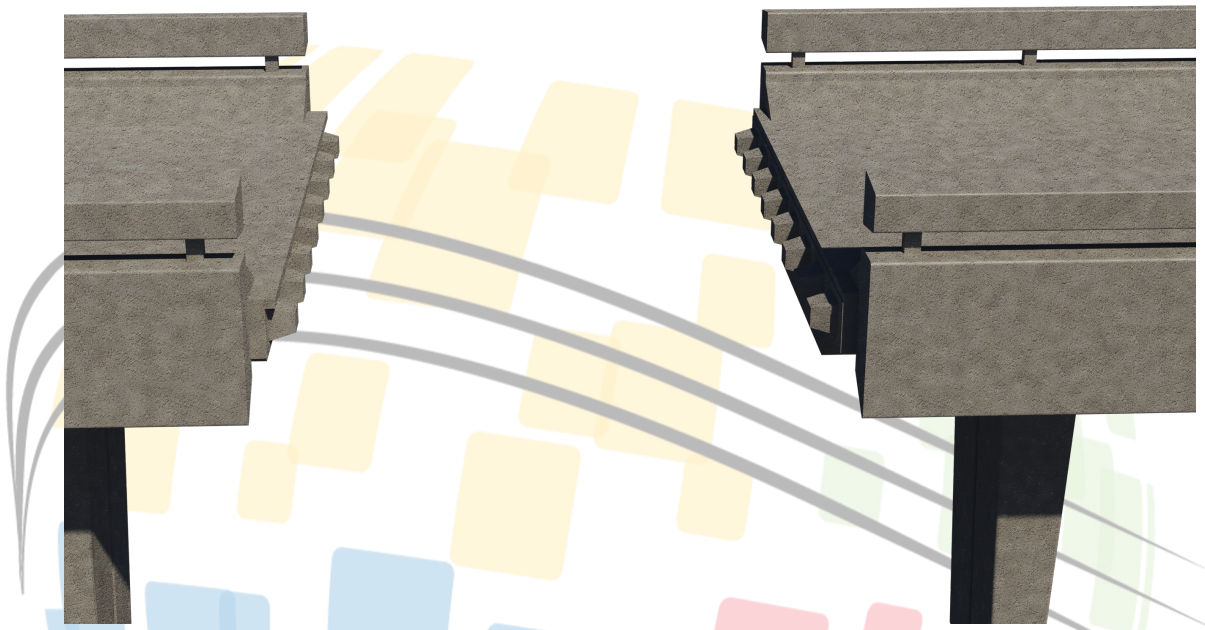
“I thought sparking change is easy. But being put in such a project where we had to focus on three different areas (energy, water, food), I could see how solutions to one area could be a problem for another.”

“This was more fun than a normal day in a classroom.”

# ENGR 495A/595A Course Successes

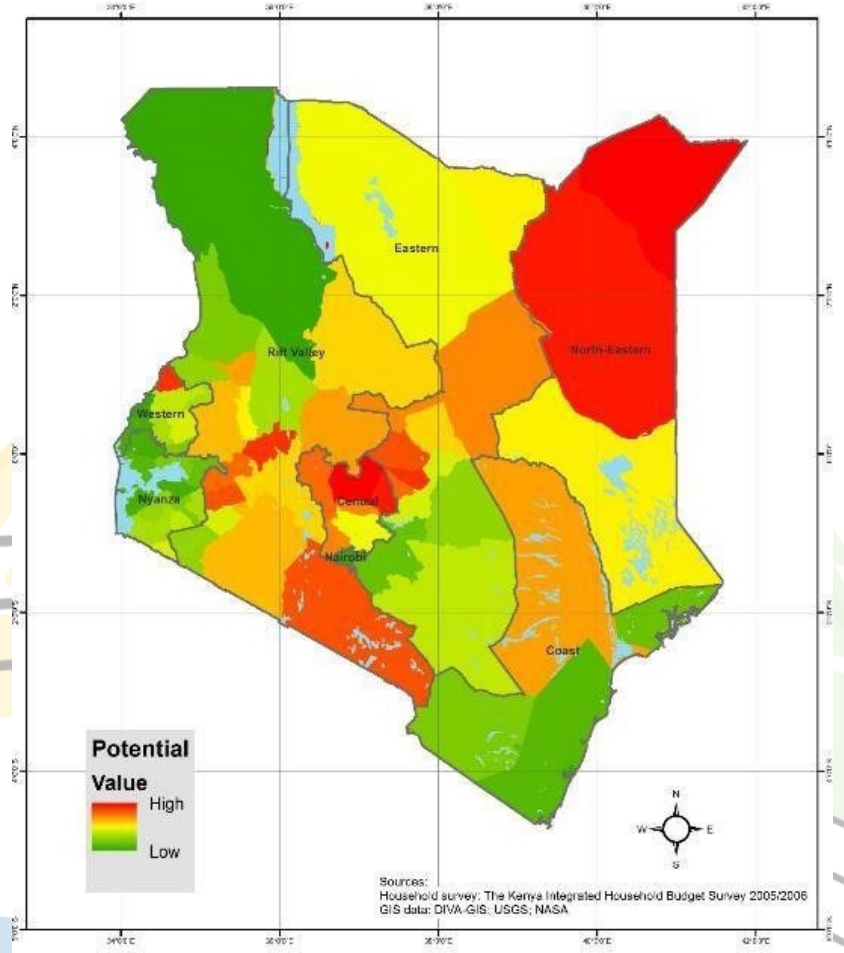
- Conveying impacts of bridging the technical with the political
- Demonstrating relevance of multi-disciplinary teamwork
- Teaching cross-disciplinary communication skills
- Being accessible to both in-person and online students
- Bridging education with application in international context

# ENGR 495A/595A Course Challenges



- Attracting engineering students to enroll
- Acquiring traction across campus
- Working remotely across national borders, cultural communication barriers
- Centering community perspectives
- Follow-through to implementation

# ENGR 495A/595A Continuing…




Diplomacy Lab 2022

- Effects of Climate Change on Agriculture in the Absence of Deliberate Crop Adaptation in Kenya
- Partnered with UJAMAA Cooperative Farming Alliance

Class Project 2023

- Strengthening the Non-Proliferation Treaty Through Science Diplomacy: *Recommendations for a Safer World*
- Partnered with Navajo Nation

# Opportunities for Replication

- Partnerships with Government Organizations
  - U.S. Department of State
  - Corollary entities in other nations
- Partnerships with Non-Government Organizations
  - World Bank
  - Engineers Without Borders
  - Engineers for a Sustainable World
- Partnerships with Community Organizations
  - Freeport-McMoRan and Southern Arizona

# Community Engagement in Engineering Practice

- Consistently considers stakeholder desires and collaborations
- Concerned with addressing Sustainable Development Goals
- Emphasizes responsibility and ethics, governance and policy
- Draws upon systems engineering and social sciences to model complex systems
- Employs sociotechnical frameworks for understanding community interactions

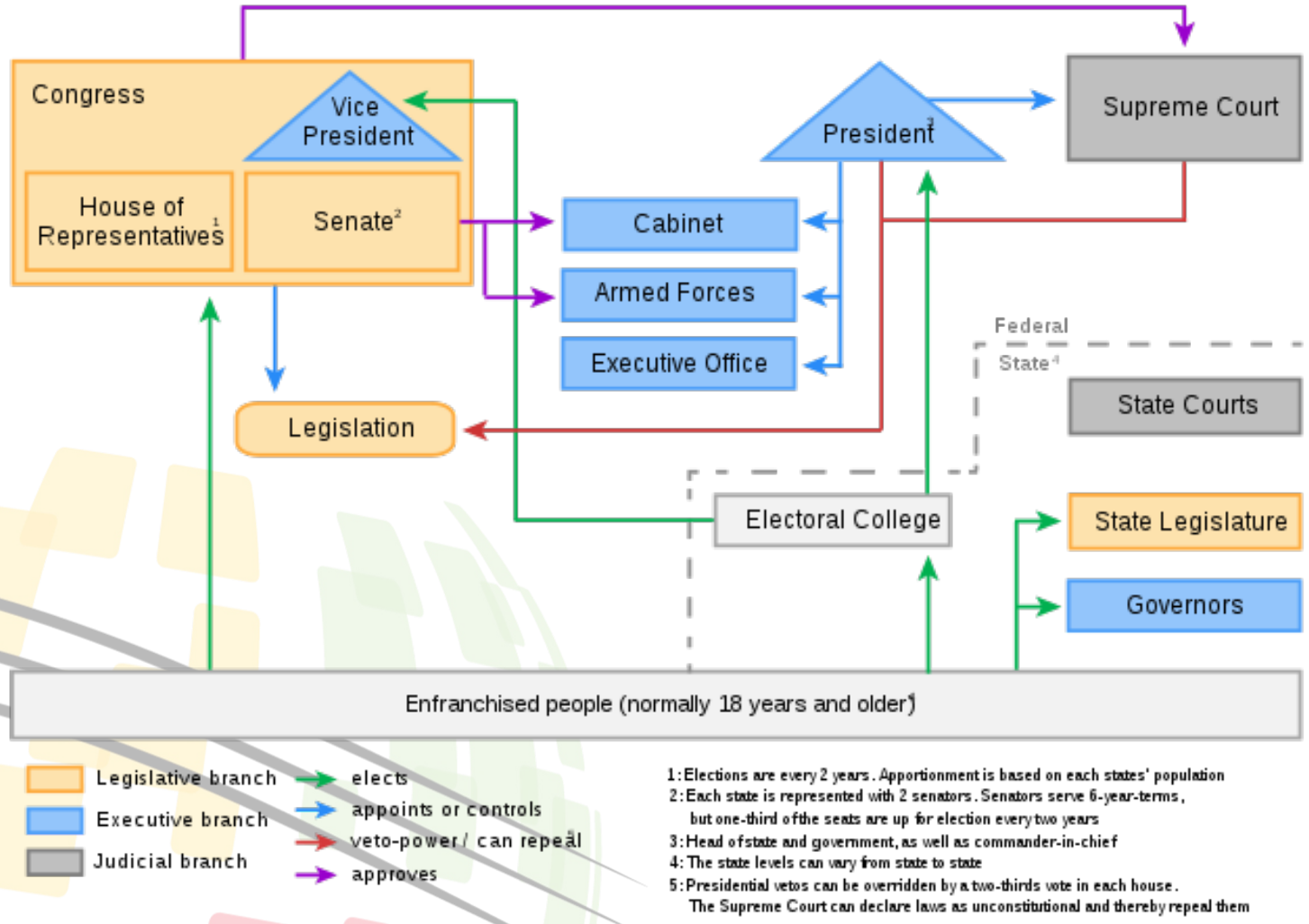
# “Rules of Engagement”

Guidelines for Effective Community Engagement

# Arizona Science & Technology Policy Fellowship

- State Science Policy Planning Grant Initiative
- Funded by the National Conference of State Legislatures, a nonpartisan government entity
- Aims to place postdoctoral scientists, engineers, and public health professionals as advisors to lawmakers
- Fellows will aid in developing practical and economical solutions to current challenges
- Partnering with Arizona State Government

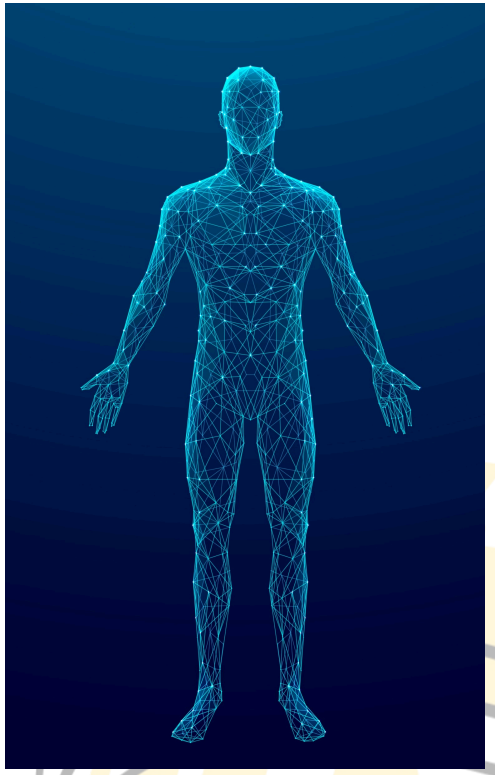
# Arizona Science & Technology Policy Fellowship

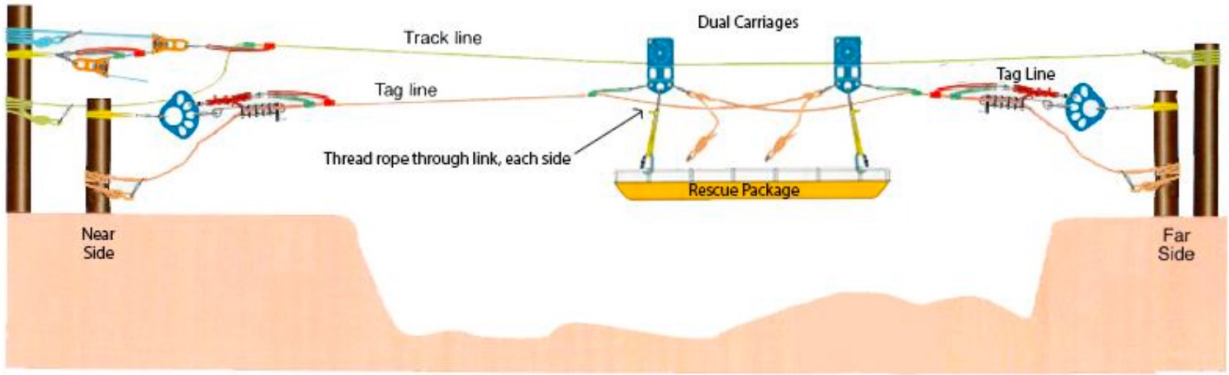


# “Rules of Engagement”

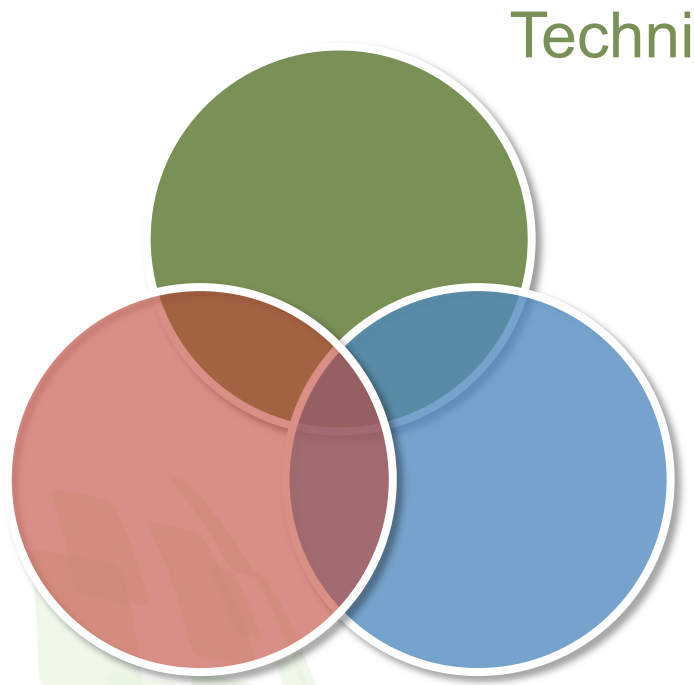
Guidelines for Effective Community Engagement

# Regardless of your system of interest…






# Successful Implementation



# In Summary

Community engagement is increasingly recognized as a critical element in engineering disciplines for client interaction, responsible project implementation, and service.

Various engineering educational curricula include community engagement, but more emphasis and opportunities are needed to prepare students for community interface.

Curricula integrating science, health, and engineering with community applications can benefit students through multidisciplinary training and experiential learning…

…and benefit community through tangible outcomes to environmental, technological, physical, and social challenges…

…while preparing the next generation of engineers (and scientists, lawyers, journalists, diplomats, educators, global citizens, etc.) with a framework for collaborative problem solving.

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# With Gratitude

*2021 University of Arizona Diplomacy Lab Team*

**Fathima Doole**

– PhD Candidate, Chemistry & Biochemistry, The University of Arizona, USA

**Samuel Myers**

– PhD Candidate, Planetary Sciences, The University of Arizona, USA

**Gowri Somasekhar**

– PhD Candidate, Neurosciences, The University of Arizona, USA

**Jennie Steyaert**

– PhD Candidate, Geosciences, Utrecht University, Nederlands

# With Gratitude

*Arizona Science & Technology Policy Fellowship Team*

**Dr. Kevin Lansey**

– Civil & Architectural Engineering & Mechanics, The University of Arizona, USA

**Dr. Caitlyn Hall**

– Biosystems Engineering, The University of Arizona, USA

**Samuel Myers**

– PhD Candidate, Planetary Sciences, The University of Arizona, USA

# With Gratitude

## *My Professors and Advisors*

**Dr. Kevin Lansey**

– Civil & Architectural Engineering & Mechanics, The University of Arizona, USA

**Dr. Hassan Vafai**

– Civil & Architectural Engineering & Mechanics, The University of Arizona, USA

**Dr. Ricardo Valerdi**

– Systems & Industrial Engineering, The University of Arizona, USA

**Dr. Alejandro Salado**

– Systems & Industrial Engineering, The University of Arizona, USA

**Dr. Danielle Wood**

– Media Arts & Sciences, Aeronautics & Astronautics, MIT, USA

34th Annual INCOSE international symposium

hybrid event

Dublin, Ireland
July 2 - 6, 2024

# THANK YOU!

# For Consideration

- How can we enhance community engagement in engineering education?
- How can we integrate community engaged curricula into standard required coursework?
- How to create student-client-community collaborations?
- Beyond education, how can we better move from solution derivation to implementation?

**Shelley Littin**
**littin@arizona.edu**

**Connect with me!**

Science, Health and Engineering Policy and Diplomacy Inititiative (SPDI)