



Engineering  
Change Lab  
USA

»»» *Inspiring Leaders of Change*



## 2022 Engineering Ideas Institute

The Engineering Community  
as Leaders of Change

Boulder, CO – Sept. 26–28, 2022





# The Engineering Community as **Leaders of Change**

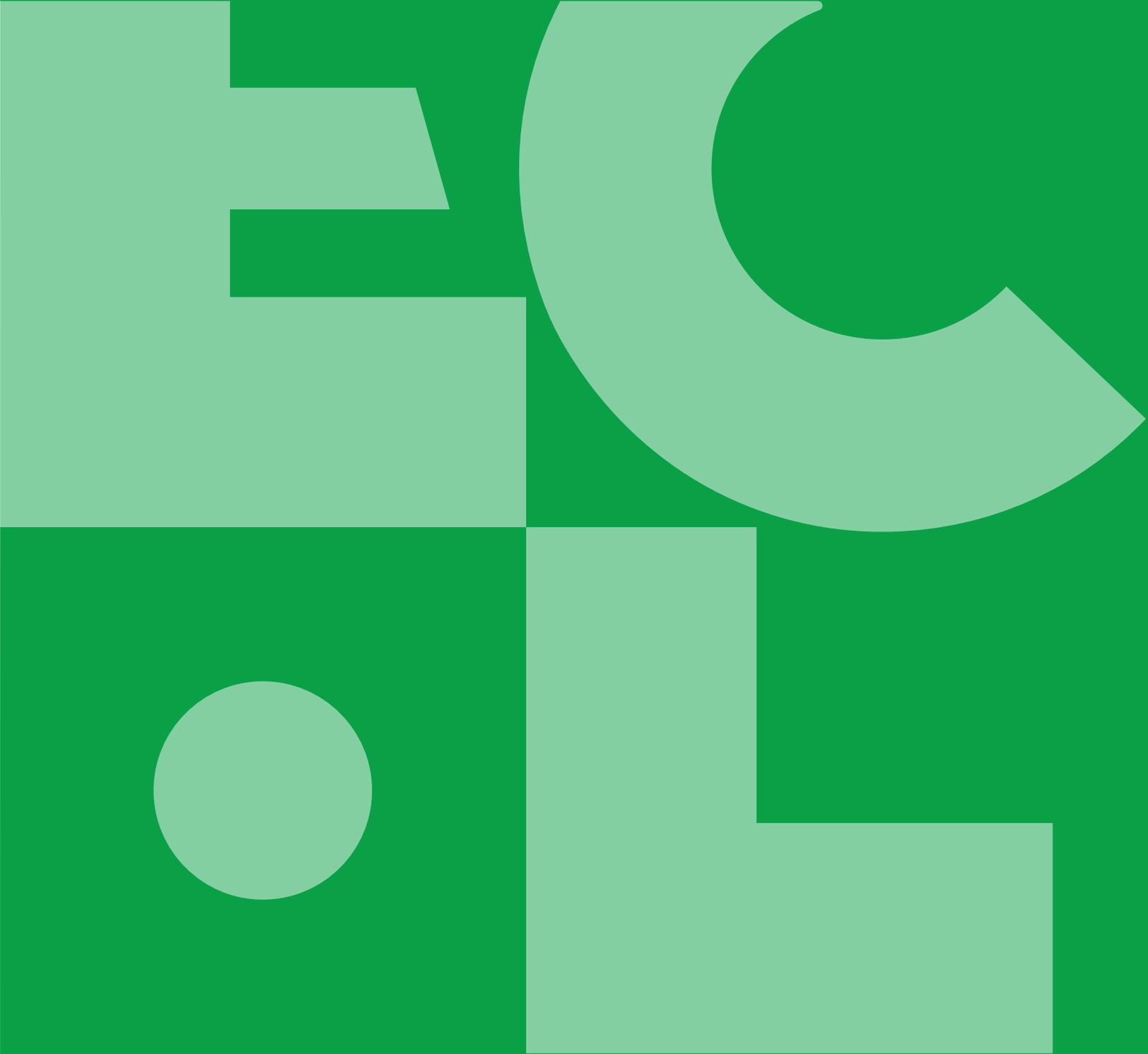
## Sustainability is not enough.

Escalating climate, infrastructure and social crises are outpacing efforts to address them with sustainable practices. The engineering community has the tools and strategies to take us beyond sustainability – both to address dire challenges and to restore natural and living systems.

To contribute at the highest levels, the engineering community must have the commitment and courage to go beyond our traditional technical role as problem solvers and engage in the challenging work of leading change to benefit society. This change leadership can occur in a variety of settings – from practice to education to public policy.

These propositions were at the heart of the 2022 Engineering Ideas Institute convened by Engineering Change Lab – USA (ECL) in Boulder, Colorado. This summit drew on provocations, exercises, nature walks and dialogues to shift minds and prompt participants to think differently about the future of engineering.





Provocation

## Provocation – Engineers Can Be Change Agents



**JERRY BUCKWALTER,**  
**Chief Innovation Officer, American Society of Civil Engineers**

Jerry Buckwalter is responsible for helping to shape the strategic direction of ASCE. He oversees the Future World Vision initiative, a strategic assessment project creating a computer model to visualize built environments 50 years into the future. Jerry also leads Strategy Essentials, a consulting firm specializing in strategic planning. He came to ASCE from Northrop Grumman, where he was Director of Corporate Strategy. Jerry has served on the National Infrastructure Advisory Council under Presidents Barack Obama and George W. Bush. He was an Engineering News-Record Top 25 Newsmaker in 2019.

As a futurist, strategic-thinker, and change leader Jerry Buckwalter has spent his career looking into the future, anticipating change, and imagining strategies that can create future value in the face of change. He began his provocation with his conclusion that change does not unfold in a linear fashion. He noted that “the types of outcomes that users desire rarely change, what changes are:



**THE WAY DESIRED OUTCOMES ARE GENERATED**



**THE QUALITY OF THE OUTCOMES THAT ARE GENERATED**



**THE COSTS INCURRED TO GENERATE THOSE OUTCOMES**

He offered examples from business leaders of change strategies.

**Tailor change strategies to the needs of customers.**

**Look for the obvious – visibility, minimal adoption trade-offs, and market pull.**

**Look for reinforcing trends, such as in digital technologies.**

## Provocation – Engineers Can Be Change Agents

Buckwalter then highlighted ASCE’s Future World Vision Initiative as an example of the use of **scenario planning to both inspire change and prepare for future change today**. ASCE’s extensive pre-work identified six key trends that will have the largest impacts on the future of civil engineering (see exhibit). ASCE concluded that the overlapping and cascading impacts of these trends would create a view of a future that is dramatically different than today.

### STATEMENT OF URGENCY

**Change is coming**, and it’s **on a scale** that can drive confusion and dysfunction unless cities, industries, organizations, and individuals are **prepared to tackle new realities**.



The digital platform for Future World Vision includes plausible alternatives for five future communities (Mega City, Rural City, Floating City, Frozen City, and Off Planet City). These future world alternatives are intended to be deliberately provocative and to spur civil engineers to ask themselves questions about the future. ASCE’s Future World Vision scenario planning has identified the transformational imperatives for civil engineering.

### ENGINEERING TRANSFORMATIONAL IMPERATIVES

Prepare for resilience for extreme environments and anticipate changes in demographics and urbanization.

Increase pace of innovation and lead in change, risk management and ethics.

Incorporate advances in materials, computing power, technologies and engineering/ construction processes.

Create alignment and collaboration with varied engineering disciplines and non engineering partners for non-traditional projects

Embrace digital models and big data use, including digital security, intelligent systems, autonomy and virtual reality.

Attract new talent, continuously train and grow careers

Understand system dynamics and nature of systems integration.

## Provocation – Engineers Can Be Change Agents

Buckwalter then offered his thoughts on the roles of innovation and strategy in creating change. With respect to innovation, he encouraged participants to discard our traditional ideas about innovation, such as that it results from a moment of brilliance from an individual genius, that it comes from technology only, and that it requires big bets. Instead, he offered that innovation results from having the right culture set in the right environment, with the right structures and processes. He emphasized that the focus of innovation should be on underlying user needs and not on what you are good at. Innovation stems from mosaic thinking – seeing the connections between seemingly unrelated ideas.

### ENABLE INNOVATION



Buckwalter described strategy as being about increasing your odds of success but not guaranteeing success; as requiring rigor and creativity; and as fundamentally about making choices, choosing to do some things and not others. He suggested that the best determinant of success is to base strategy on outside-in thinking centered on customer needs. He emphasized a set of fundamental strategic-thinking competencies.



#### Outcome-Based Innovation Mindset

First focus on most important outcomes that need to be generated for the customer, then focus on how to generate those outcomes.



#### System Thinking

Understand the “system” by examining the linkages and interactions between the components that define the system.



#### Future-Based Perspective

Focus strategic actions based on clearly articulated assumptions about future uncertain scenario construct.

Buckwalter concluded by reminding participants that, when the future is uncertain, creating scenarios that look back from the future can help in creating the future you want. This was the basis of the ASCE Future World Vision initiative. Being an agent of change requires understanding why we resist change and mastering the essentials of embracing change.





Provocation

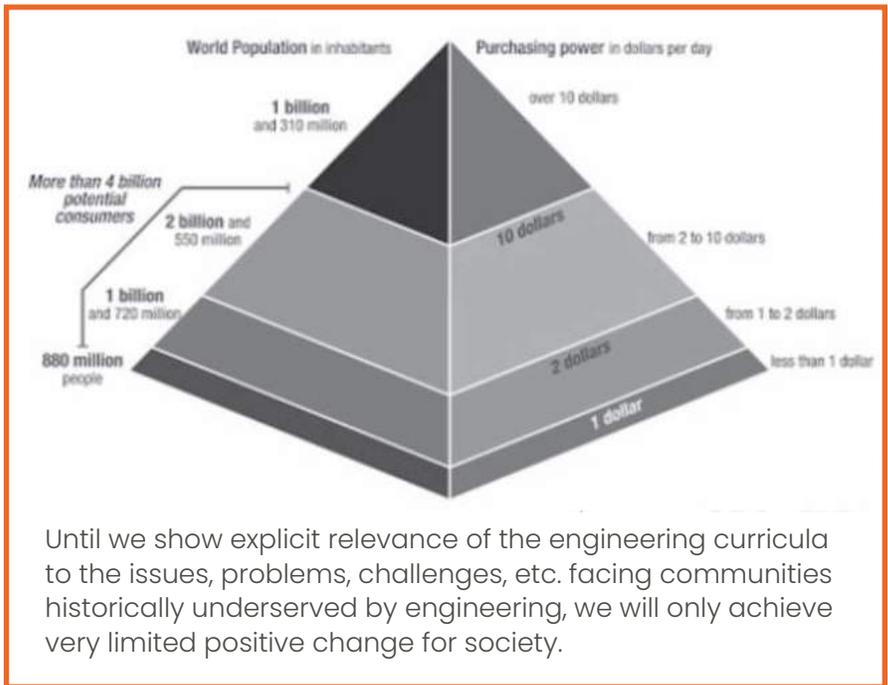
# Provocation – Leadership for Social Justice, Engineering Strategies for Making Social Justice Visible & Valuable



**JUAN LUCENA,**  
**Director, Humanitarian Engineering Undergraduate Programs Colorado School of Mines**

Juan is Professor and Director of Humanitarian Engineering Undergraduate Programs at the Department of Engineering, Design & Society of the Colorado School of Mines. Juan obtained a Ph.D. in Science and Technology Studies (STS) from Virginia Tech. His books include Engineering Justice: Transforming Engineering Education and Practice (with Jon Leydens, IEEE-Wiley, 2017). Born and raised in Colombia, he learned to value, interact and learn from people from the poorest sectors of Colombian society. As an engineering student, he learned the strengths and limitations of engineering assumptions and methods for engaging communities, particularly those historically neglected by engineering. The main driver for his teaching and research is to challenge students to ask, what is engineering for?

Juan Lucena offered Institute participants the opportunity to **see the potential for change through the engineering education system**. He stressed that the main point of his provocation was that change in the contributions of engineering to society depends on demonstrating the explicit relevance of engineering to the challenges facing communities historically underserved by engineering. His view is that “people” is the least emphasized of the three P’s (people, planet, profits).



Until we show explicit relevance of the engineering curricula to the issues, problems, challenges, etc. facing communities historically underserved by engineering, we will only achieve very limited positive change for society.

Lucena described a set of engineering mindsets that have gotten in the way of more emphasis on people.

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**Centrality of corporate / military organizations.**
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**Uncritical acceptance of authority.**
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**Technical narrowness.**
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**Positivism and the myth of objectivity.**

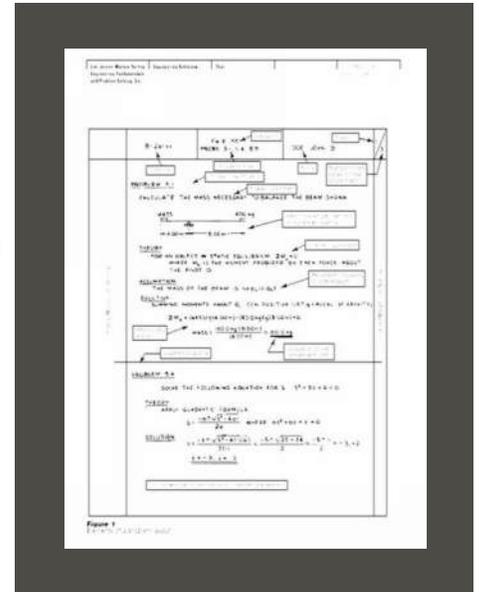
He summarized these mindsets as the “ideology of depoliticization” and “culture of disengagement” within engineering, the valuing of the technical side to a greater degree than the social side. He maintains that these mindsets are **“recreated and perpetuated through a process of acculturation in engineering education / practice.”** On the positive side, he acknowledges an engineering mindset focused on the desire to help coupled with persistence of effort to deliver that assistance.

# Provocation – Leadership for Social Justice, Engineering Strategies for Making Social Justice Visible & Valuable

For Lucena, the key to change is recognition that engineering is socio-technical, the challenges in engineering involve people and technical issues simultaneously. His work is centered on challenging these traditional engineering mindsets in academia. One area that he is focused on is “problem space,” the textbook problems that are the most basic unit of teaching in engineering science courses. He described the traditional seven steps for engineering problem solving.

## ENGINEERING PROBLEM SOLVING (EPS)

1. Given: Problem statements given to students
2. Find: students asked to find a numeric solution
3. Free-body diagram: An abstract model of the problem
4. Science: Identify scientific principles that apply to the problem at hand
5. Assumptions: Learn to make assumptions to simplify problem
6. Math: Use math and tricks to solve equations
7. Solution: Reward or punishment for ONE solution (must have units!)



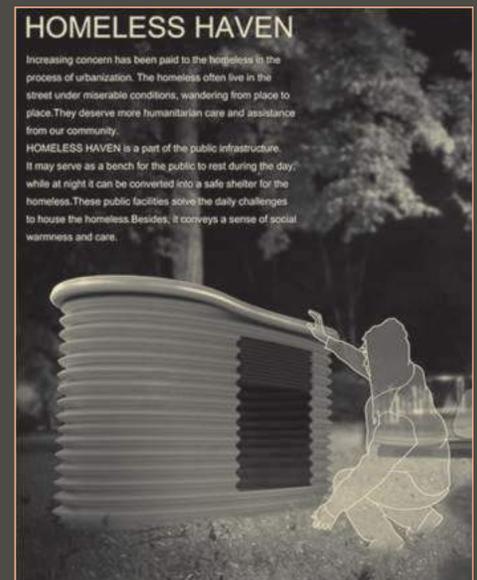
Currently, mastering these steps is the key to academic success. He described that the bulk of engineering curriculum is technical, closed-ended, decontextualized problem-solving. Students do not know what to do with open-ended scenarios. Typical problems are isolated from social context, e.g., building a bridge to connect communities at war. Problems have a “one-solution” requirement.

## Provocation – Leadership for Social Justice, Engineering Strategies for Making Social Justice Visible & Valuable

In his program, Lucena is working to re-frame problems. He cited the example of problems associated with understanding the principles of heat loss. The typical problem involves calculations for an iron block. Lucena has re-framed the problem to apply to heat loss by a homeless person sleeping on a park bench. With the basic understanding of the principle, students then design a movable shelter that allows a homeless person to safely sleep outside. This re-framing provides students with a stronger sense of purpose in learning a basic engineering principle.

### REWRITING PROBLEMS TO COUNTERACT IDEOLOGIES AND MINDSETS OF ENGINEERING

Because many homeless persons are afraid of sleeping in shelters, they prefer to continue sleeping in the street. Design a movable shelter that allows a homeless person sleep through the night with a decrease of body temperature of 1F per hour



When asked about employment trends for graduates from the Humanitarian Engineering program, Lucena responded that CEOs are seeing value in graduates who are trained in designing for affordability, multiple stakeholders, and thinking about societal impacts rather than just self-interest.



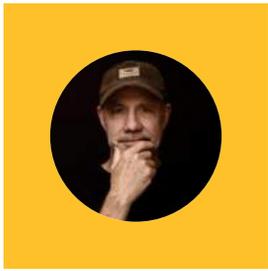
**The best part about these problem rewrites was that they are involved with what I am studying, and it opened opportunities for me to finally figure out how I can “make a difference” using my engineering skills. Although these are just problem rewrites, they have opened my mind to how I can incorporate social justice into my engineering career, and there is not a better feeling than finally understanding that it is indeed possible to do good with my career.**

(Student reflection, Spring 2021)



Provocation

# Provocation – Leading Societal Change, The Mindshift Process



## REX MILLER, MindShift

Rex is a coach, researcher, and practitioner who has coached and trained more than 15,000 people. He is an expert in building high-performing teams and resolving conflict. He has written eight books and won the CoreNet Innovator Award. His notable clients and projects include, Google, Facebook & GoDaddy. In 2013 he launched his consulting firm, MindShift, and in 2022, he opened the River Rose Leadership and Retreat Ranch in Glen Rose, TX.

Rex Miller offered participants techniques for **leading change through collaboration with multiple stakeholders**. He described his MindShift change methodology as a “barn raising approach to solve gnarly (complex) problems and rebuild trust.” Gnarly problems have no clear answers, involve an uncertain future, require feedback loops, and entail accepting disruption. Miller offered several examples of gnarly problems, including the Lewis & Clark expedition’s challenge of crossing the Rocky Mountains.

Recognizing that “the system is the problem,” the Mindshift process convenes system stakeholders to have a conversation and think together, revealing and understanding the system and multiple forces driving and shaping the problem. The process simultaneously builds (rebuilds) relationships and trust among these stakeholders, helping to give birth to a cohort of committed people capable of working together to change the system.

The birth of MindShift came from Miller’s work in the building design and construction industry. Miller found this system to be designed to create distrust and maintain silos. Miller set out to expose these system dynamics and discovered the key steps needed to create a positive change with respect to the gnarly problem.

**Go / No Go** – test the idea of addressing the gnarly problem with a trusted group.

**Who** – identify and recruit the right people who have a stake in the outcome, bring diverse subject matter expertise, and are willing to engage in discovery.

**Why** – gather data and map the current system to find hidden links and create understanding of the gnarly problem. Find “yoda’s” and outliers to help guide you.

**What** – create a future state picture of the system.

**How** – identify and prioritize catalytic projects, tell the story, and commit to continuous improvement.



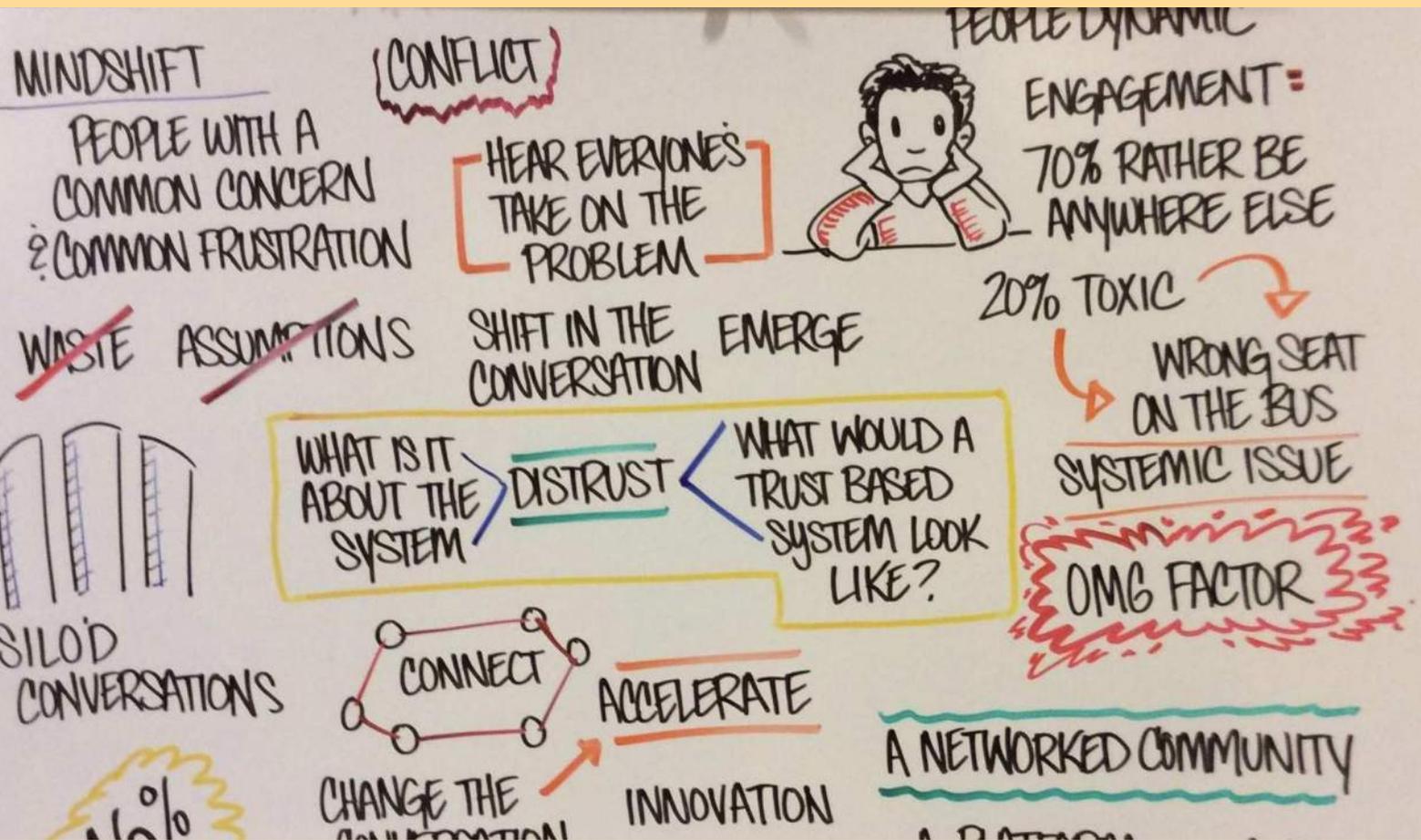
# Provocation - Leading Societal Change, The Mindshift Process

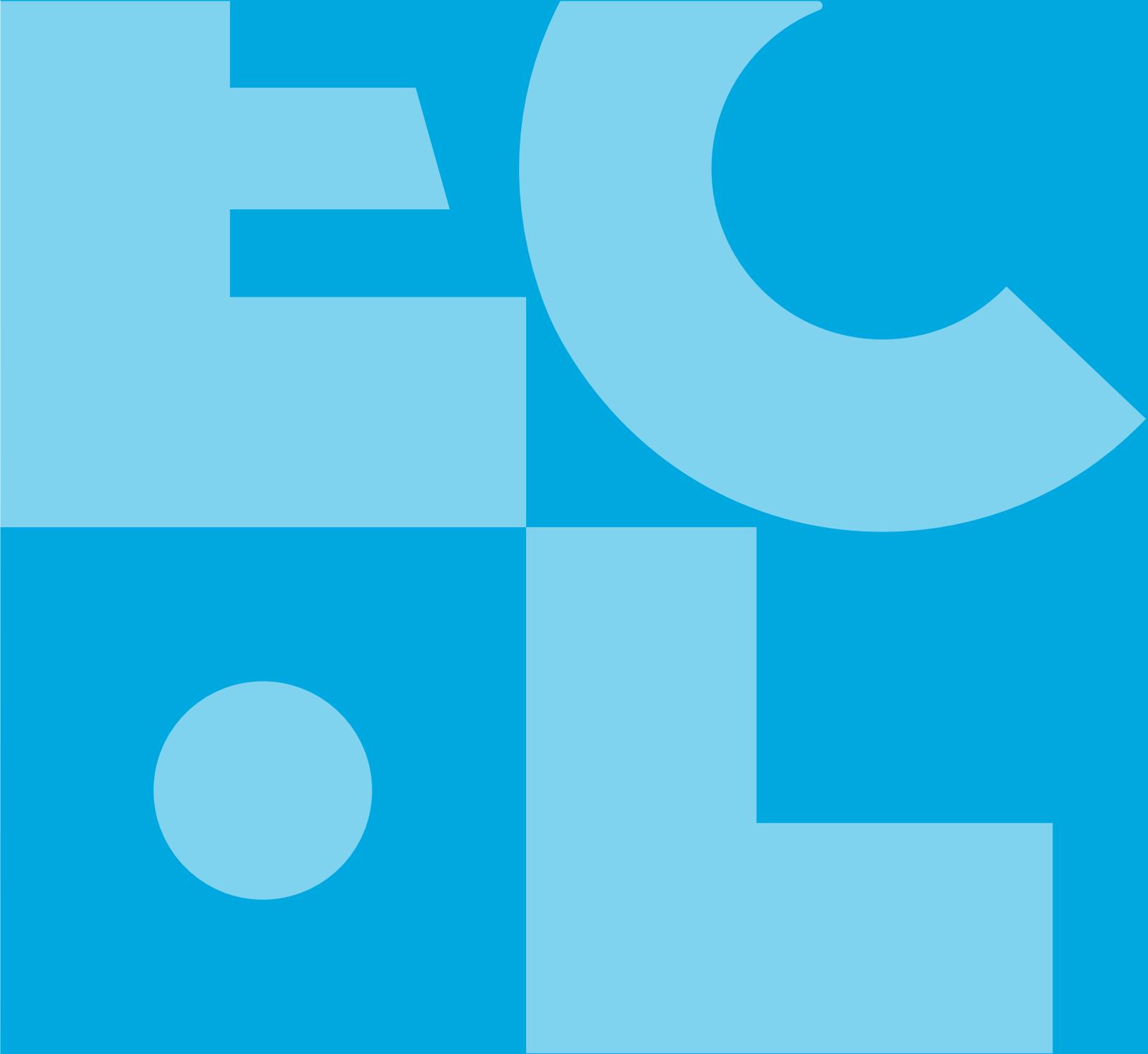
## ENGINEERING COMMUNITY AS LEADERS OF CHANGE REFLECTIONS

Having heard three examples of leading change, Institute participants offered their initial reflections on the engineering community as leaders of change.

- Change starts with shifts in individual and collective mindsets and hearts.
- Providing space to build trust is important to the change process.
- An effective leader who is committed to and engaged in the process of change is needed.
- Change leaders need to understand the different types of problems.
- Problems / projects need to be reframed to include a social aspect of systems.
- Dealing with pain and trauma will be part of the process.

Miller's problem solving mindshift process example



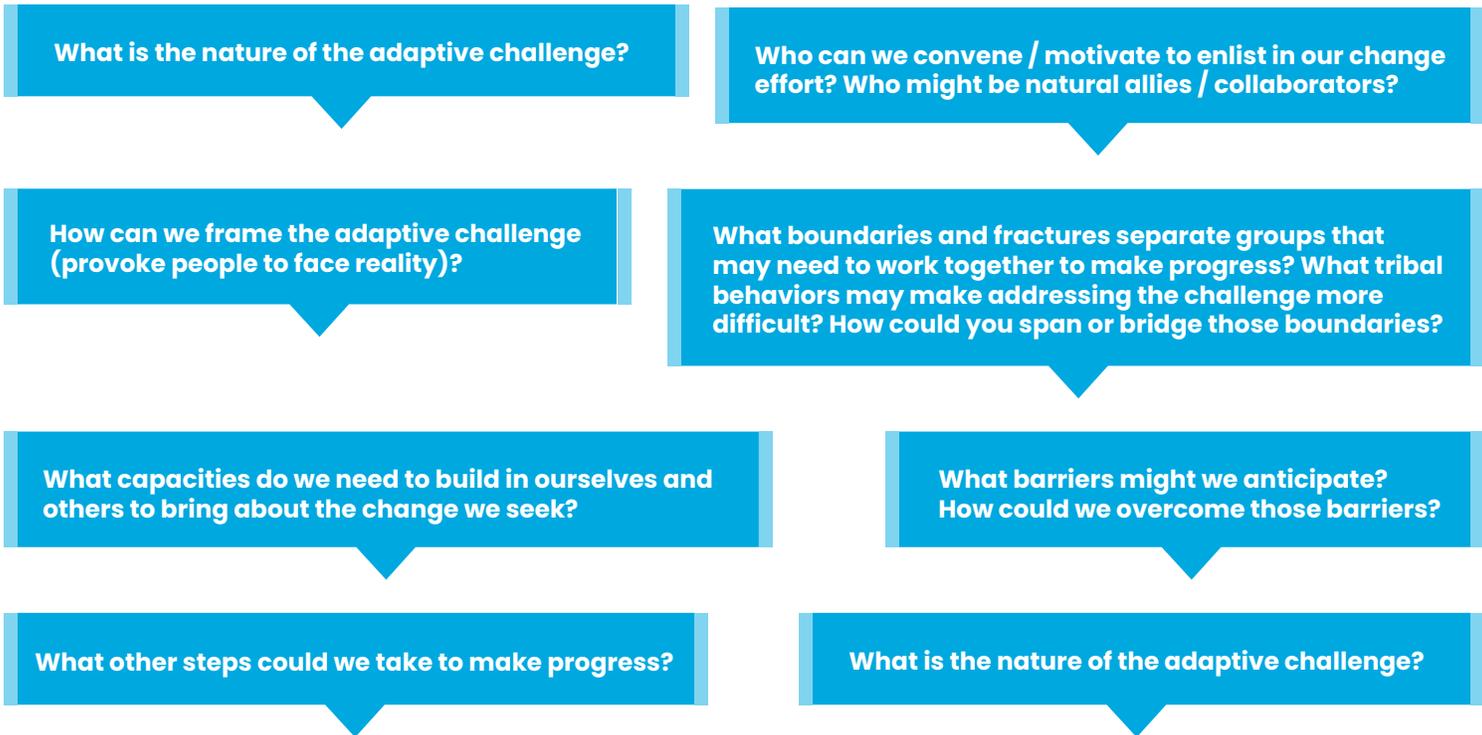


Group Exercise

## Group Exercise – The Change Game

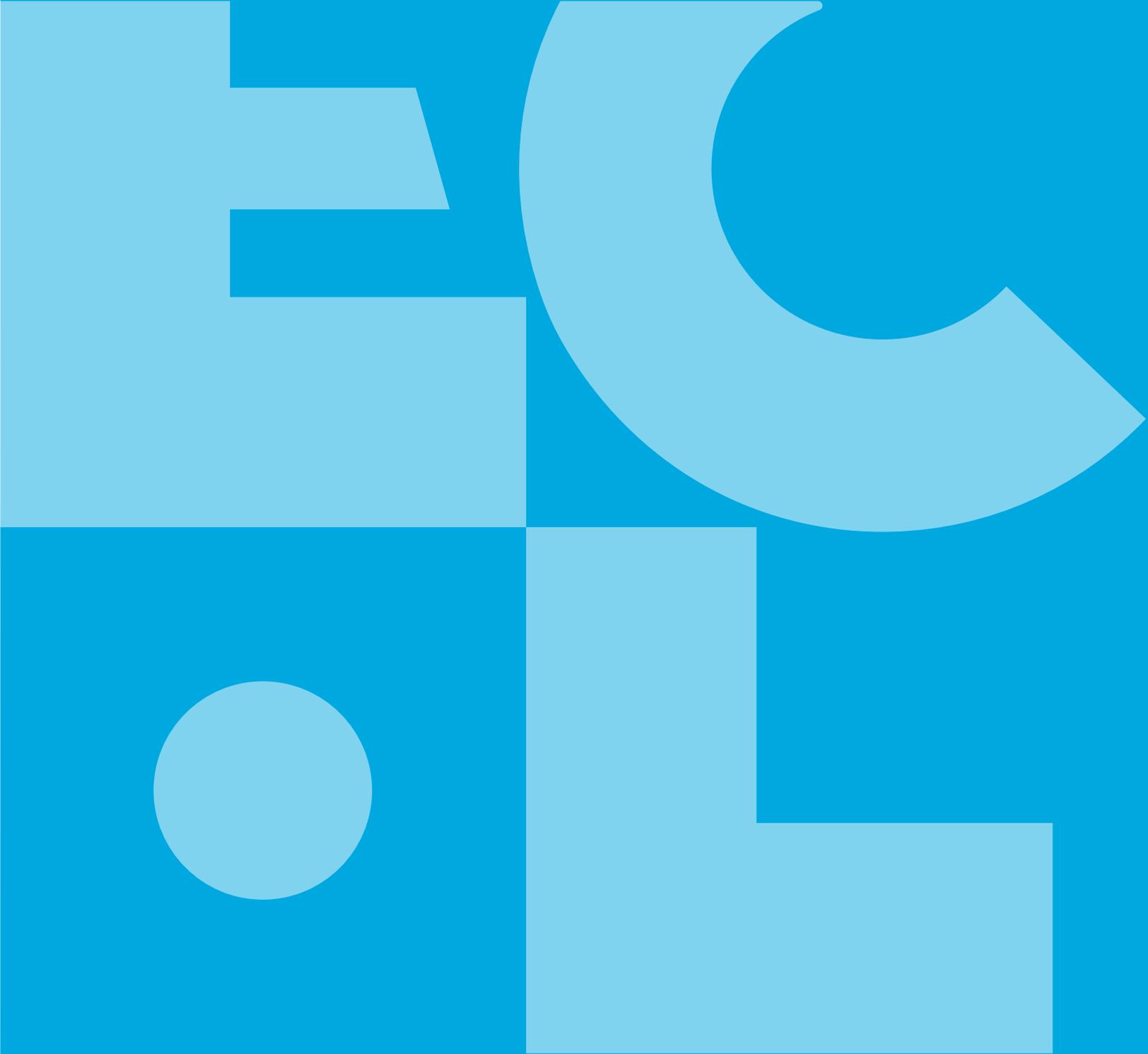
In a group exercise, participants explored the potential for members of the engineering community to act as change leaders to address 21st Century global imperatives confronting humanity and the world. Participants were asked to imagine how members of the engineering community might lead change within different arenas of practice (academia, private practice, industry, professional society/association, government) and in different settings (company, community, state, federal, global).

Working in teams, participants selected an arena of practice and a societal / environmental adaptive challenge. They then developed a strategy for taking action as a change leader to address their selected social / environmental challenge, considering the following questions:



Key takeaways from the exercise were presented in a whole group discussion.

- **Significance of stakeholder engagement and understanding the narratives of different “tribes.”**
- **Process entailed zooming in and zooming out.**
- **Answers come out of the process, not from coming in as the expert with all the answers.**
- **Bringing research alive in a way to engage stakeholders and the public – putting a face on data.**
- **Looking for multiple benefits, particularly when polarities are present.**



Group Dialogue

## Group Dialogue – The Engineering Community as Leaders of Change

In an extended group dialogue, participants reflected on this question.

**WHAT DO I THINK I HAVE LEARNED ABOUT THE ENGINEERING COMMUNITY AS CHANGE LEADERS ON BEHALF OF SOCIETY?**

Key points from the dialogue are noted below.

- Presumption of trust in the engineering community.
- Engineers are good at leading engineers, but our voice is noticeably absent in policymaking.
- Start at the university level with the bounded problem sets.
- Importance of reflection.
- Need to dive deeper particularly on the social and environmental systems we impact.
- Humility is important. Accepting that I do not understand the voice of all stakeholders.
- Concept of designing for people is inspiring.
- Engineering is not outside of society.
- Recognizing our essence.
- Engaging with communities to a greater degree is needed to lead change.
- We need to help create leaders from the engineering community.
- Importance of the first follower.
- Change is an ongoing process in systems.
- I cannot lead change until I can better frame the problems we are trying to solve.
- I perceive that we do not have a role in problem definition. Whose fault is that?
- I am not an expert. I do not have all the answers and that is OK.
- Clients need to be engaged in these discussions of the future.
- Nature abhors a vacuum. If engineers do not make decisions, someone else will.
- If you have passion, it will be contagious.
- Expressing passion is showing vulnerability.
- Fear of failure is not a good excuse for not trying something.
- Failing forward – growth and wisdom result from trying.
- Try to understand the mindset that comes from the engineering education process. What mindsets get in the way of leading change? How can we change mindsets?
- Words matter (e.g., engineers solve problems). We need to change this language.
- Fear of failure should not be obstacle to progress.
  - ◊ Is this part of the educational process? Failure is a difficult word for students. We should allow opportunities to revise and fix mistakes.
  - ◊ How do you deal with failure in business? It is pass/fail.
  - ◊ Education can suck out the spirit of innovation in students.
- Design codes limit innovation.
- Need reward systems for taking risks.
- There are a lot of C students who drop out and would have been great engineers.
- Engineers contribute at a high level to society and do not get enough credit. Failures draw more attention than successes.
- I have had greater success in leading change when working with a diverse group rather than a group of only engineers.
- To lead change requires a team.
- The engineering community is trusted.
- Engineers could do more to convene groups to take on challenges.
- Why are most elected officials lawyers and not engineers?
- How do I expand what I am doing and what are the costs? Uncertainty causes struggle to reach positive outcomes. We do have to make choices and understand the costs of taking on new roles.





Video Case Study &  
ECL-USA : The First Five Years

## Video Case Study – Macro-Ethics & Taking a Stand, Frances Haugen & Facebook

In a final example of leading change, participants heard the story of Frances Haugen, the Facebook whistleblower. Haugen witnessed business practices and a culture within Facebook that created a “conflict of interest between what was good for the public and what was good for Facebook” and “lying to the public about making significant progress against hate, violence, and misinformation.” Seeing no other avenue to create change, Haugen chose the route of a whistle-blower, a route that entailed great personal risk, to shine the light on the harmful impacts of Facebook’s algorithm and to advocate for regulatory change. You can see the full story of Haugen’s actions at the link below.

### [Frances Haugen on 60 Minutes](#)

#### **Participants engaged in discussion of this approach to change, considering the following questions.**

- What were the pros and cons of the approach to change that Frances Haugen took in this case?
- What were her aspirations as a change leader?
- What leadership attributes has she displayed?
- What risks did she take in acting as she did as a change leader?
- What other lessons or insights about “engineers as change leaders” can we take away from her experience?

#### **Key takeaways from the discussion are summarized below.**

- Haugen demonstrated poise and communication skills. Change leaders with excellent communication skills can be more effective.
- There is a need to find partners in leading change who have complementary skills.
- Haugen’s actions demonstrated that she was morally and ethically grounded. How did she get there? Was her education at Olin College of Engineering a factor?
- She exposed the harmful “social” impacts of Facebook’s products. Choose your issue to focus on.
- She exhibited concern for public health, safety, and welfare.
- She had the conviction to take action.
- She had a clear strategy that included taking her time, developing an organized approach, and seeking counsel from others, both family and legal.
- Even though Facebook did not have a strategy for fixing problems, they took steps in 2018 that made the problem worse.
- IEEE’s Ethically Aligned Design applies as a potential strategy that Facebook could adopt.
- Being a woman brought on additional risks because of the “bro” culture of Silicon Valley.
- The problems of Facebook’s algorithm will spread to other areas of engineering and create similar problems.
- Leaders of change cannot have ulterior motives or should at least understand their flaws or shortcomings.
- Haugen’s story is a great illustration of the shift from micro-ethics to macro-ethics.



# ECL-USA: The First Five Years, Insights & Lessons Learned

In the final exercise of the Institute, participants examined ECL’s role as a change leader over our first five years and envisioned ECL’s role over the next five years. To set the stage for this exercise, Kyle Davy, ECL’s Creative Director and Lead Facilitator, reviewed the foundations of the ECL change model.



- **Our work is adaptive not technical.**

- **Social change lab model.**



- **Deep “U” process.**

- **Leveraging the diffusion of innovations.**

- » If you reach 20% adoption, eventually everyone will follow.

- » We are still trying to reach all the innovators.



- **Open-source network hub.**

- » Connect, collaborate, communicate.



- **Be an effective “first follower.”**

- » Complement, but do not duplicate good work by others.



- **Seek regeneration.**

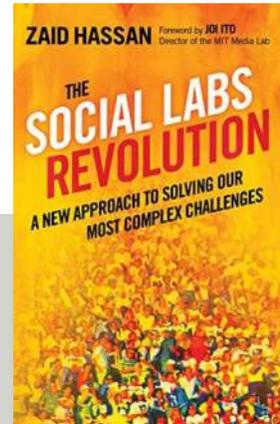
- » Take a living systems perspective.

- » Build social capital within the systems we are part of.

- » Emergence.



- **Building capacity for change and growth in leaders.**



## Social Change Lab Model

➤➤➤ **Our domain: The Engineering Community**

➤➤➤ **Convene people/stakeholders within & surrounding domain**

- Seek out diverse participants

➤➤➤ **Co-create**

- Cross-pollinate across groups
- Catalyze collaborative enterprise

➤➤➤ **Experiment & prototype**

### Change Labs (or Social Labs)

multi-stakeholder platform through which a diverse team of people work together to solve complex system level problems in a way that is:

- Systemic
- Collaborative
- Experimental

# ECL-USA: The First Five Years, Envisioning the Future

Institute participants' hopes for the next five years of ECL are summarized below.



- **Seek diversity of all types.**



- **Expand our outreach.**

- » Capture success stories from ECL participants at their organizations.
- » Become a recognized entity in the engineering community and beyond with the value that we provide well known.
- » Provide value that justifies participation.



- **Engage more young people in ECL.**

- » Influence decision-makers who enable young people to take part.
- » Focus more on young professionals rather than students.



- **Achieve growth.**

- » Bring in more people from outside the engineering community.
- » Build bridges, e.g., academia.
- » Consider regional hubs.



- **Enhance our programming.**

- » Offer the outcomes of our summits as educational materials / tools.
- » Maintain the strength of the small-group format.
- » Maximize the use of in-person provocateurs.
- » Provide more pre-summit support for potential attendees.
- » Provide post-summit materials for use by others.
- » Take advantage of the expertise in the Boulder area.

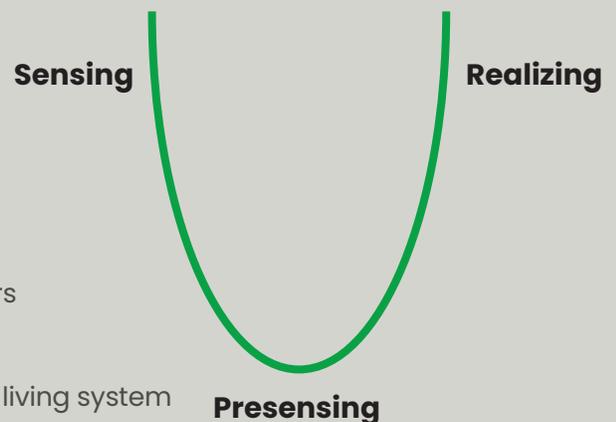


- **Take action outside of our summits.**

- » Prioritize one of our initiatives that can reach the 20% adoption threshold.

## Deep "U" Process

- ➤ ➤ **Sensing, Sense-Making, and Realizing**
- ➤ ➤ **Systems Thinking**
  - As a core learning discipline
- ➤ ➤ **Inquiry and emergence**
  - Surface and examine assumptions, values, and behaviors
    - ◊ Dialogue as fundamental mode
  - Provocations to shift mindsets
  - Ask big questions about the engineering community as a living system
- ➤ ➤ **Enabling agency**
  - The ability and willingness to act



The purpose of the work of ECL is to **inspire leaders of change** within the engineering community to elevate their contributions in addressing the challenges that we face in the 21st century. The discussions at the 2022 Engineering Ideas Institute demonstrated that this change leadership can come from all sectors of the engineering community – academia, private sector practice, public sector practice, and industry. The provocations and discussions also highlighted the practices that can be utilized and the skills that are needed in change leadership – systems thinking, regenerative thinking, scenario planning, re-thinking engineering education, stakeholder convening and collaboration, and, even, whistleblowing.

To contribute at the highest levels, the engineering community must have the commitment and courage to go beyond our traditional technical role as problem solvers and engage in the hard work of leading change to benefit society.

Complete provocateur presentations from the 2022 Engineering Ideas Institute are available at the link below.

### [2022 Engineering Ideas Institute Provocateur Presentations](#)

