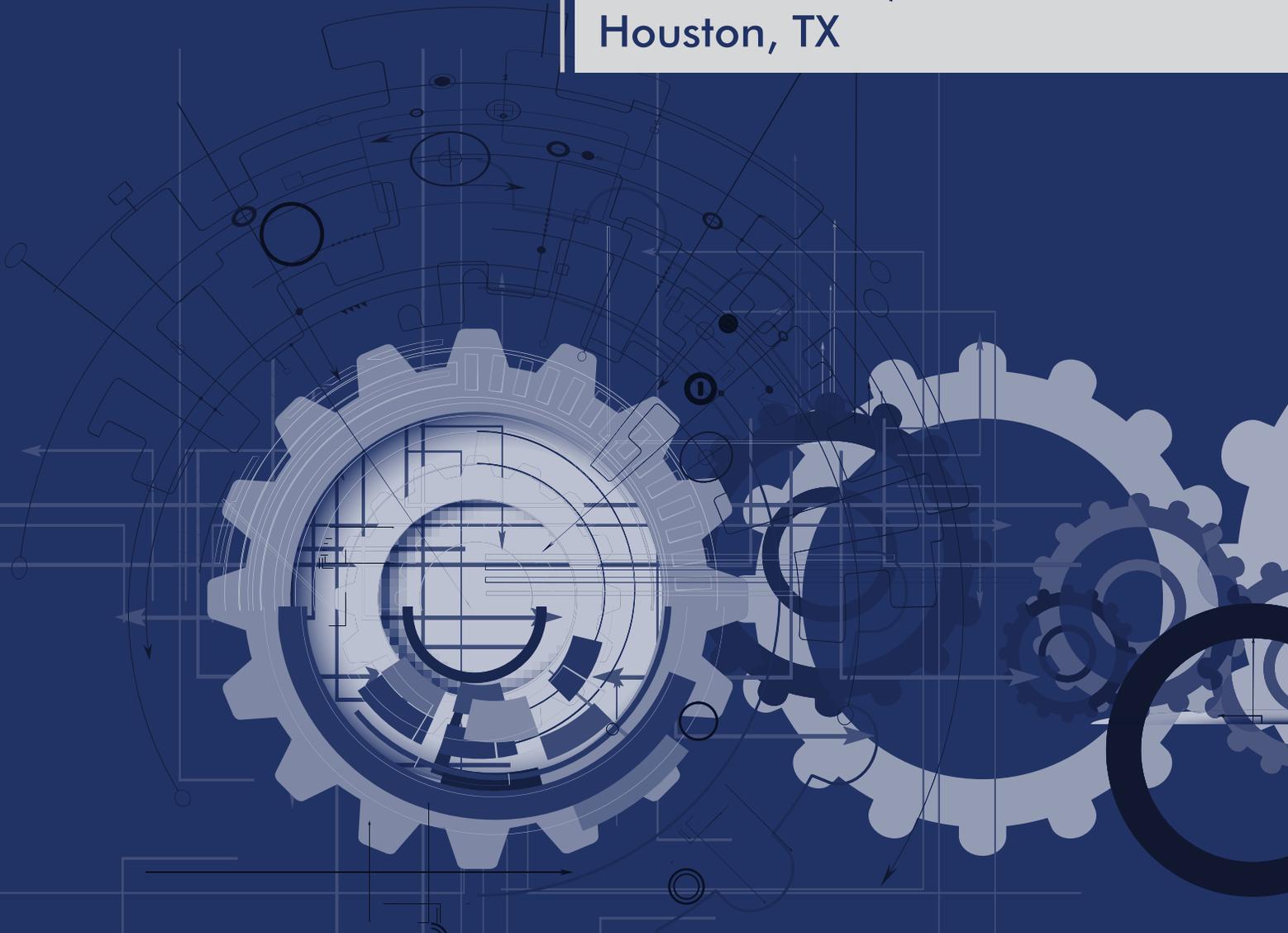




For more information on Engineering Change Lab-USA, contact Executive Director Mike McMeekin at [mike.mcmeekin@lamprynearson.com](mailto:mike.mcmeekin@lamprynearson.com) and visit our website [www.ecl-usa.org](http://www.ecl-usa.org)

# EXPLORING BIO-MEDICAL ENGINEERING

Summit 8 Report  
March 10 - 11, 2020  
Houston, TX



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Engineering Change Lab – USA (ECL-USA) Summit 8 was held on March 10 and 11, 2020, at the Texas Medical Center Innovation facility in Houston, Texas. As part of the world’s largest medical center, TMC Innovation provided an ideal setting for exploration of the future of engineering through the lens of biomedical engineering. Located in a renovated Nabisco cookie factory, TMC Innovation is home to 85 health care start-ups, including numerous examples of innovation in bio-medical engineering.



Summit 8 was held just as the full impacts of the COVID-19 coronavirus pandemic began to emerge in the United States. ECL-USA appreciates the commitment of the 45 stakeholders and provocateurs who were able to take part in Summit 8 at a time of concern and distraction.

## Synopsis of Provocations

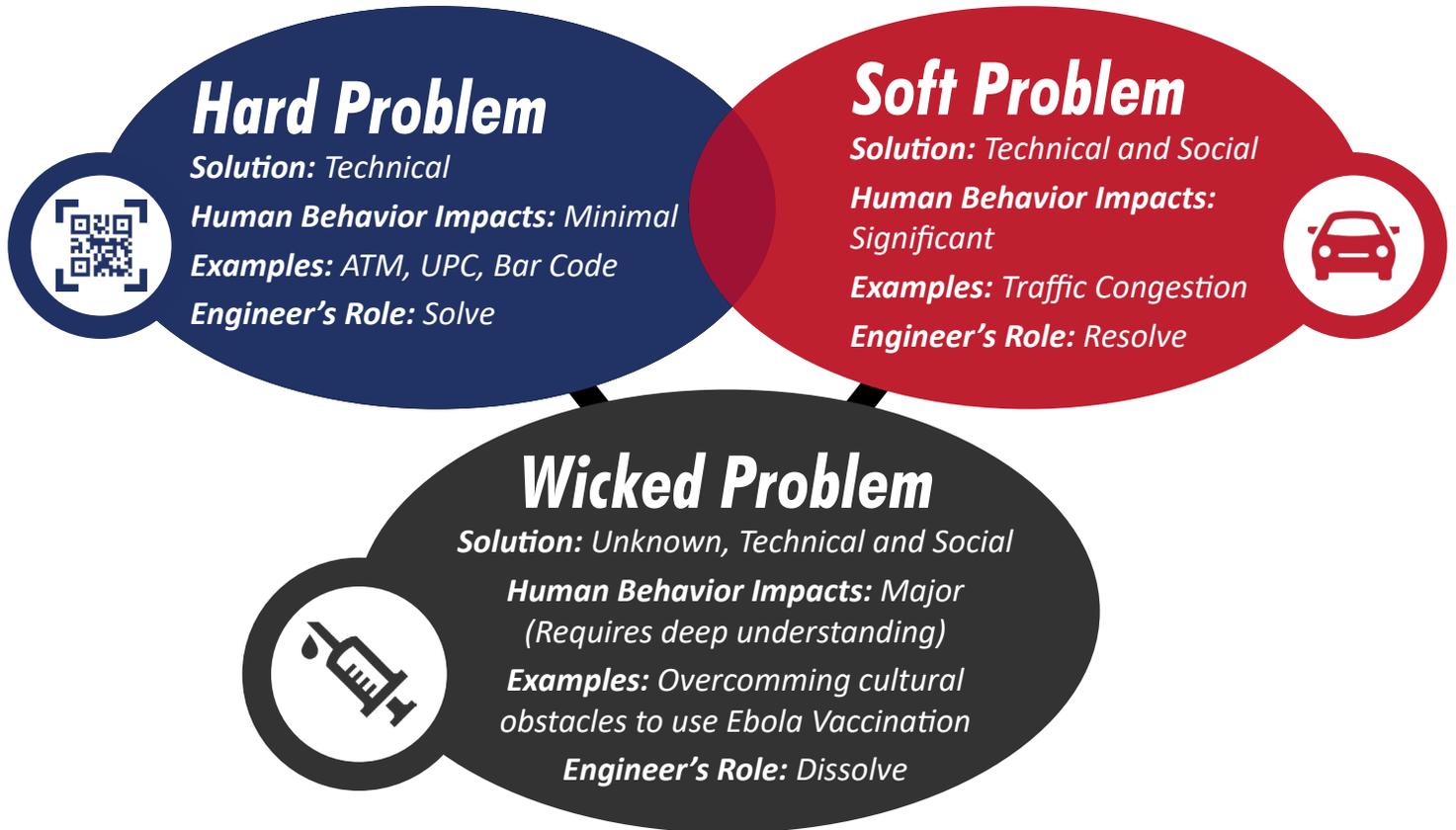
### **ENGINEERING FOR BETTER POPULATION HEALTH**



The unique intersection of engineering and advancements in public health is a major focus of the work of Guru Madhavan, Augustine Senior Scholar & Director of Programs at the National Academy of Engineering. Madhavan’s provocation at Summit 8 continued the partnership between NAE and ECL-USA.

*Guru Madhavan has served as a technical advisor to the U.S. Department of Health and Human Services and has worked in the medical device industry as a research scientist developing cardiac surgical catheters and neuromuscular stimulators. His publications include “Applied Minds: How Engineers Think.” He is an elected fellow of AAAS, AIMBE, and former president of IEEE- USA.*

Guru framed his provocation by outlining the different types of problems faced by engineers – Hard Problems, Soft Problems, and Messy (Wicked) Problems.



Engineers are excellent at solving “Hard” problems and getting good at resolving “Soft” problems according to Madhavan. Unfortunately, they are often “utterly clueless about how to tackle Wicked problems when human behavior and human value systems are deeply involved.”

Wicked problems with major human and political impacts require new approaches to decision-making that go beyond the traditional technical problem solving and cost-benefit analyses that engineers are so good at. From their experience in contributing to the Ebola crisis, NAE has developed a new approach to the evaluation of new vaccines. In addition to looking at the cost / benefit ratio, this approach also considers...

- › Degree of psychological impacts caused by the public fear and stigma created by the disease.
- › Pandemic potential.
- › Potential for eradication of the disease.

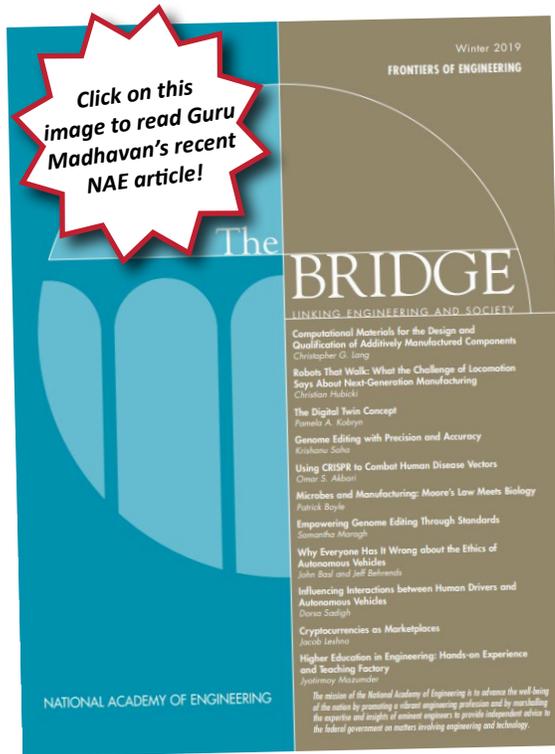
According to Madhavan, these factors will change the metrics and alter decision-making on future vaccines including an eventual vaccine for the COVID-19 coronavirus.



## KEY RECOMMENDATION FOR ENGINEERING IN THE FUTURE

Madhavan’s recommendation for engineering in the future is to transform the approach to problems, developing the capacity to sense and dissolve wicked problems. Through this approach, engineers can transform their role in society.

This philosophy is captured in the thinking of Ove Arup, the founder of the global design firm Arup. Guru Madhavan writes about Arup’s approach and philosophy in a recent article in NAE’s “The Bridge.”



In this article Madhavan cites several important points from Arup’s 1970 “Key Speech.” This speech was delivered to the firm’s partners at a time when Arup was approaching retirement and was concerned about the future of the firm. In the speech, he described the reasons for the firm’s expansion from its structural engineering roots into related fields such as architecture, environmental engineering, and computer programming. He stated that this was not just for expansion of the firm, but central to “the quest for quality... for we have realized that only intimate

integration of the various parts or the various disciplines will produce the desired result.” In an earlier speech, he described this as the need for consideration that “all the facts and possibilities bearing on a design must be thoroughly understood and digested before the design is frozen.” In the Key Speech he stated that “what we decide to do is much more important than how we do it.” The Key Speech is now required reading for all Arup staff. You can see the entire speech on Arup’s website.

## MEDICAL DEVICE INNOVATION AT JOHNSON & JOHNSON

Another perspective on biomedical engineering was provided by Matthew Kuhn, Project Leader and Senior Design Engineer at the Johnson & Johnson Center for Device Innovation located at the Texas Medical Center. In this role, Matt is responsible for leading all aspects of accelerated medical device development for new innovative technologies.

Matt described CDI’s mission to significantly impact healthcare by accelerating the development of

## Resources



### LINK TO THE “KEY SPEECH”

[HTTPS://WWW.ARUP.COM/PERSPECTIVES/PUBLICATIONS/SPEECHES-AND-LECTURES/SECTION/OVE-ARUP-KEY-SPEECH](https://www.arup.com/perspectives/publications/speeches-and-lectures/section/ove-arup-key-speech)



### LINK TO THE GURU MADHAVAN’S SUMMIT 8 PRESENTATION

[HTTPS://ECL-USA.ORG/WP-CONTENT/UPLOADS/2020/03/SUMMIT-8-MADHAVAN.PDF](https://ecl-usa.org/wp-content/uploads/2020/03/summit-8-madhavan.pdf)



### LINK TO AUDIO INTERVIEW WITH GURU MADHAVAN

[HTTPS://ECL-USA.ORG/WP-CONTENT/UPLOADS/2020/04/SUMMIT-8-INTERVIEW-MADHAVAN.MP3](https://ecl-usa.org/wp-content/uploads/2020/04/summit-8-interview-madhavan.mp3)

breakthrough medical technologies. As a collaboration between Johnson & Johnson Medical Devices Companies, Johnson & Johnson Innovation, and the Texas Medical Center, CDI @ TMC is a unique hybrid model for innovation that leverages the great resources of these larger enterprises, but with the speed and agility of an entrepreneurial start-up environment. Technologies that have been successfully de-risked can move into a commercialization pathway within Johnson & Johnson or spin out into a new company. CDI's innovation model focuses on proving feasibility of early-stage, high-risk medical device technologies through rapid, hands-on prototyping and fabrication, preclinical testing, and multi-disciplinary team collaboration.

CDI's **IDEA** process for evaluating new medical device technologies includes several factors:

- › **I**mpact- technologies demonstrate a significant value proposition for patients, clinicians, and healthcare institutions and represent an attractive market opportunity
- › **D**ifferentiation- technologies offer potential advantages over competitive devices and differentiated IP
- › **E**ngagement- the resources, team expertise, and development capabilities at CDI are well-suited for the development of a potential new medical device technology
- › **A**lignment- technologies align with Johnson & Johnson's areas of clinical interest and longer-term strategy

A unique aspect of biomedical engineering made apparent by Matt's provocation is that medical device research and development involves a considerable degree of complexity that may not similarly affect other engineering disciplines. He also highlighted an important attribute of the education of biomedical engineers (in contrast to many other engineering disciplines): incorporating an educational diversity of hard and soft engineering principles, medicine, biology, chemistry, and physiology is fundamental to develop well-rounded biomedical engineers. The "jack of all trades" educational foundation for biomedical engineers becomes a major strength that can be leveraged to drive innovation in healthcare."



# Group Discussion Takeaways

Summit 8 participants engaged in small group and large group discussion of learning about the future of engineering sparked by the provocations on bio-medical engineering and about lessons learned from bio-medical engineering applicable to other disciplines. Key take-aways are summarized below. These take-aways revealed significant overlaps with previous ECL learning that is highlighted.

## Summit 8 Takeaways

- › Commoditization has resulted in the role of engineers becoming that of a problem-solver for problems identified by others as opposed to an advisory role in dissolving messy problems.
- › The interdependence of engineering, technology, and social systems (including culture) needs more focus.
- › Research & Development budgets in the health care industry are massive compared to other industries. This level of commitment allows for tolerance of risk and failure in R&D.
- › Collaborations of engineers with other health care professionals yield better solutions.
- › Increased public policy involvement, involving higher level skills in advocacy and persuasion, is key to influencing problem definition.
- › In an approach like that being undertaken by ECL-Canada, ECL-USA can assist in influencing the adjacent communities of the U.S. engineering eco-system. Impacting 20% of the engineering community to adopt new approaches and develop new skills would mean 1 million engineers working to create change and would serve to drive change in the remainder of the engineering community.

## Previous ECL-USA Learning

Macro-ethics perspective  
Systems thinking

Human-centered engineering

Entrepreneurship and the need for increased  
R&D investments in engineering organizations.

Inter-disciplinary collaboration.

Public policy involvement, including in  
addressing codes and licensure requirements  
that can conflict with innovative approaches.

If you are interested in learning more about Engineering Change Lab – USA, contact Mike McMeekin, Executive Director ([mike.mcmeekin@lamprynearson.com](mailto:mike.mcmeekin@lamprynearson.com)).