



Teaching Tomorrow's Engineers

Designing University Engineering Curriculum to
Address Pakistan's Future Needs and Challenges

Kevin Shi & S. Sohail H. Naqvi

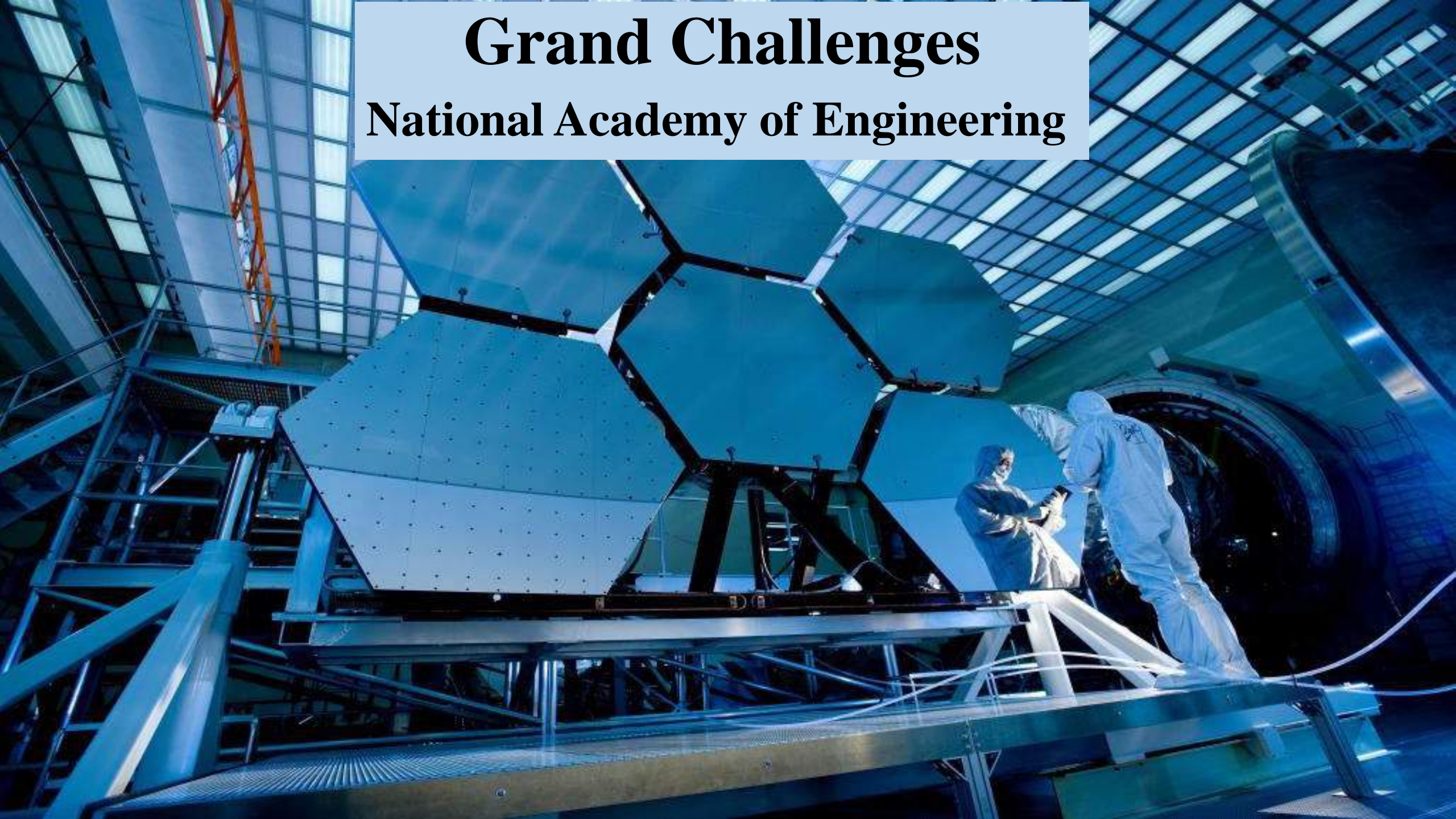
Engineering Miracles

- Steam Engine
- Automobile
- Radio and Television
- Telephones
- Airplane
- Internet
- Spacecraft
- Nuclear technology



Grand Challenges

National Academy of Engineering



How can we make **solar energy** economically viable?



How can we advance **personalized learning**?



How can we reverse engineer the brain?






How can engineering lead to
advancements in **medicine**?



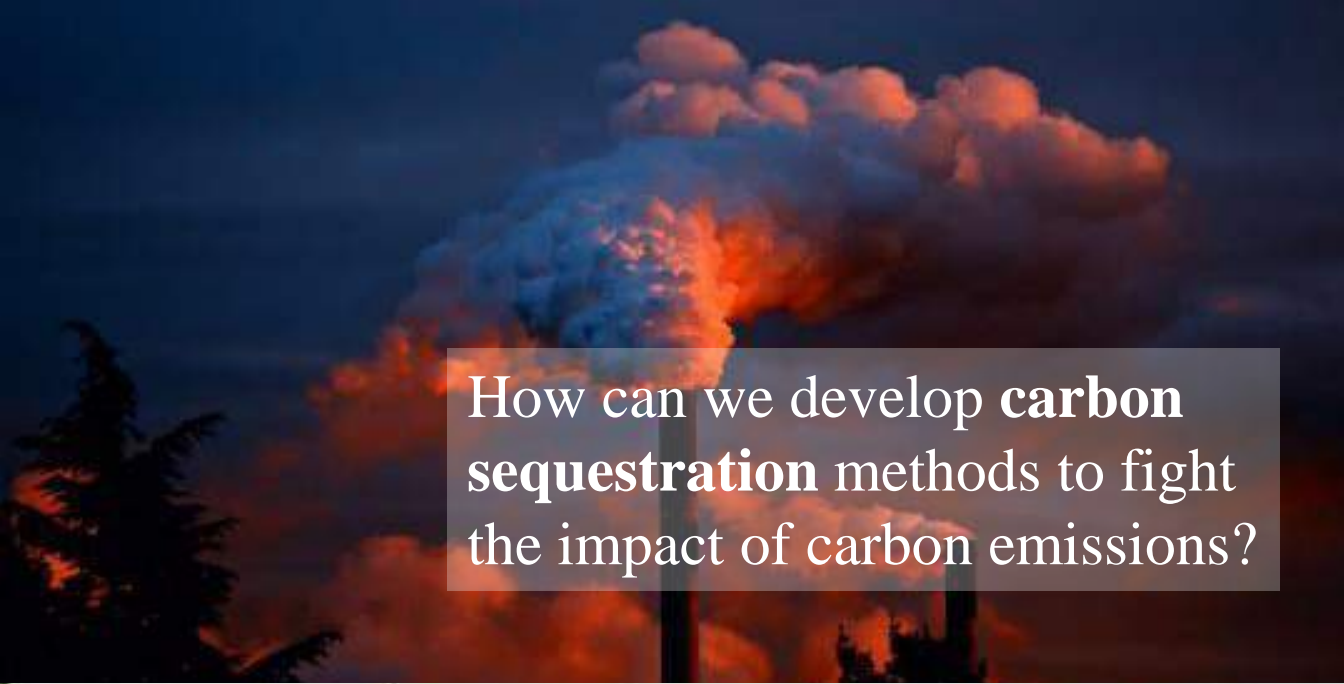
How can we advance
health informatics?



How can we better
secure **cyberspace**?



How can we improve
access to **clean water**?



How can we develop **carbon sequestration** methods to fight the impact of carbon emissions?



How can we better harness energy from **fusion**?



How can we manage the **nitrogen cycle**?



How can we prevent **nuclear terror**?


The image is a vertical composition. The top half features a city skyline at sunset or twilight, with numerous skyscrapers illuminated and their lights reflecting on a body of water in the foreground. A curved, multi-lane bridge or highway is visible in the lower right of this section. The bottom half of the image is a deep blue night sky filled with many stars, with a dark silhouette of trees and land along the horizon.

How can we restore and improve
urban infrastructure?

How can we engineer the tools for
further **scientific discovery?**



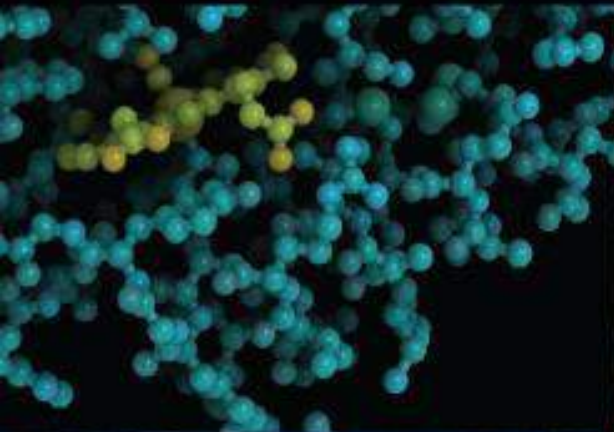
These challenges blend and blur lines between disciplines. It is clear that the engineer's of tomorrow needs to have a **comprehensive and broad-based education.**

An overhead view of three people (two men and one woman) sitting around a large wooden conference table in an office. They are looking at and pointing to large architectural blueprints spread across the table. The man on the left is wearing a light blue shirt and holding a yellow highlighter. The man in the center is wearing a light blue patterned shirt and using a calculator. The woman on the right is wearing a blue top. On the table, there is a blue hard hat, a smartphone, a laptop, a calculator, and several rolled-up documents. The floor is covered with a patterned carpet. A text box is overlaid on the bottom left of the image.

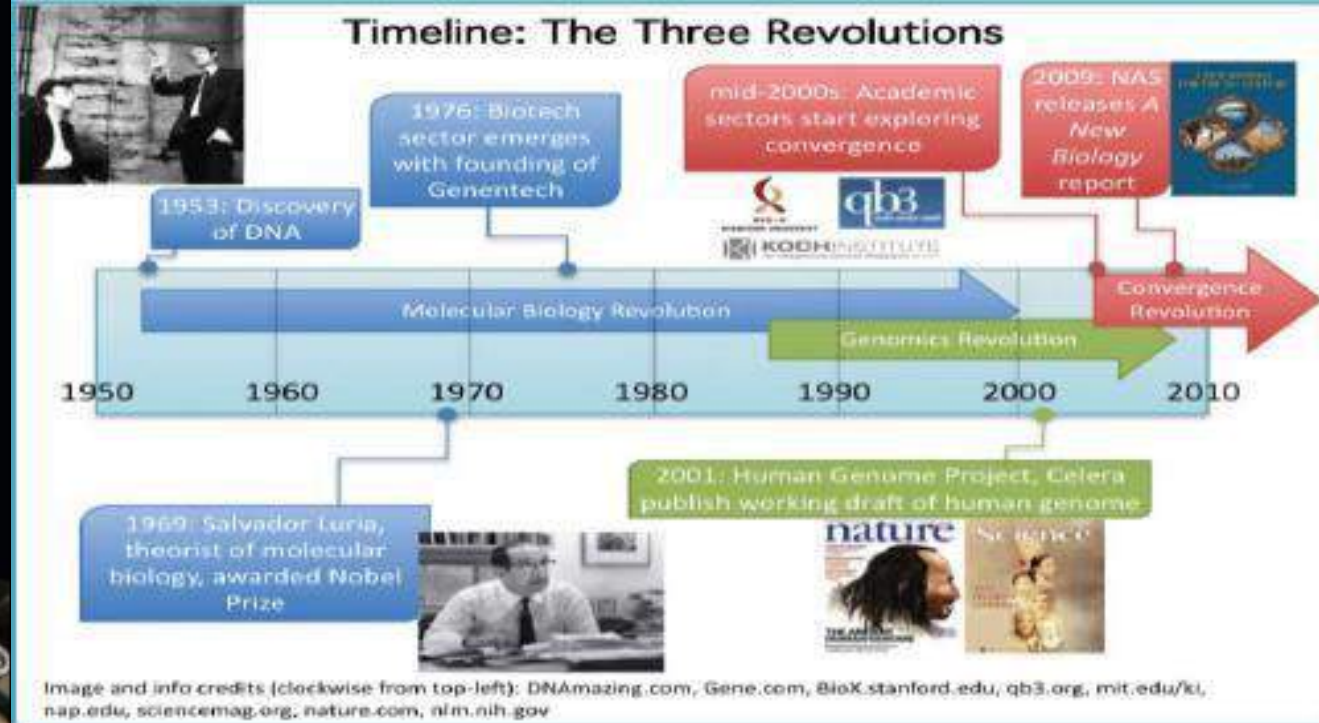
People are now talking of **convergence**, the merging of technologies and disciplines to create an array of new techniques and opportunities.

The Third Revolution:

The Convergence of the Life Sciences, Physical Sciences, and Engineering



Timeline: The Three Revolutions



This report is presented to the health science research community to help delineate an important new research model—convergence—which draws on an ongoing merger of life, physical and engineering sciences.

This new model is being adopted at many institutions in different forms. The past decade has seen the evolution of new interdisciplinary research areas—bioinformatics, synthetic biology, nanobiology, computational biology, tissue engineering, biomaterials, and systems biology are examples. These new fields share a comparable, underlying research model, convergence, and there is a need to see them as a unity in order to ensure their continued progress. The successful application of this model will require not simply collaboration between disciplines, but true disciplinary integration.



Does Pakistan's Engineering Curriculum Rise to the Challenge?

The world's cadre of engineers will seek ways to put knowledge into practice to meet these grand challenges.

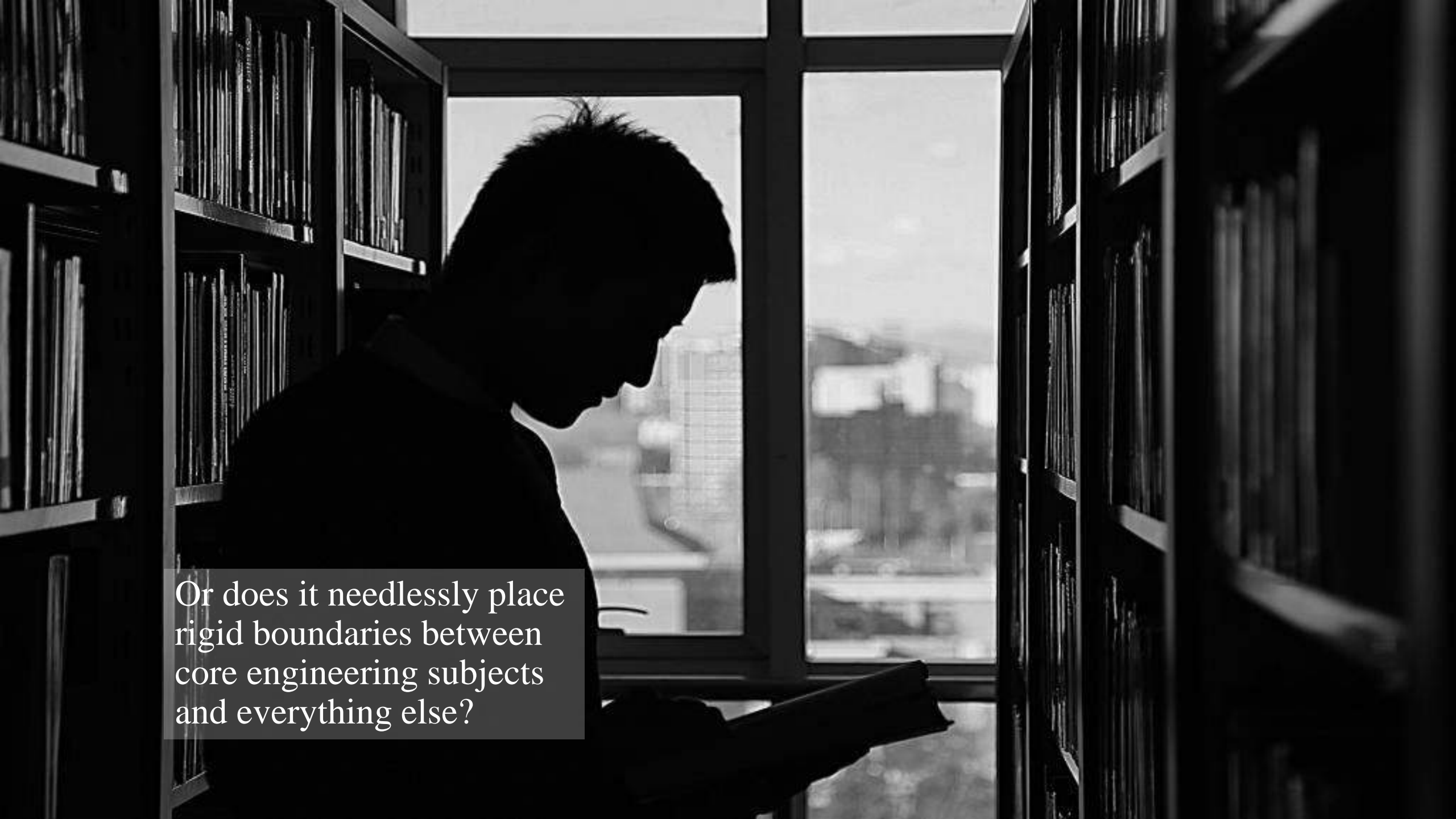
Applying the:

- Rules of reason,
- Findings of science
- Aesthetics of art
- Spark of creative imagination

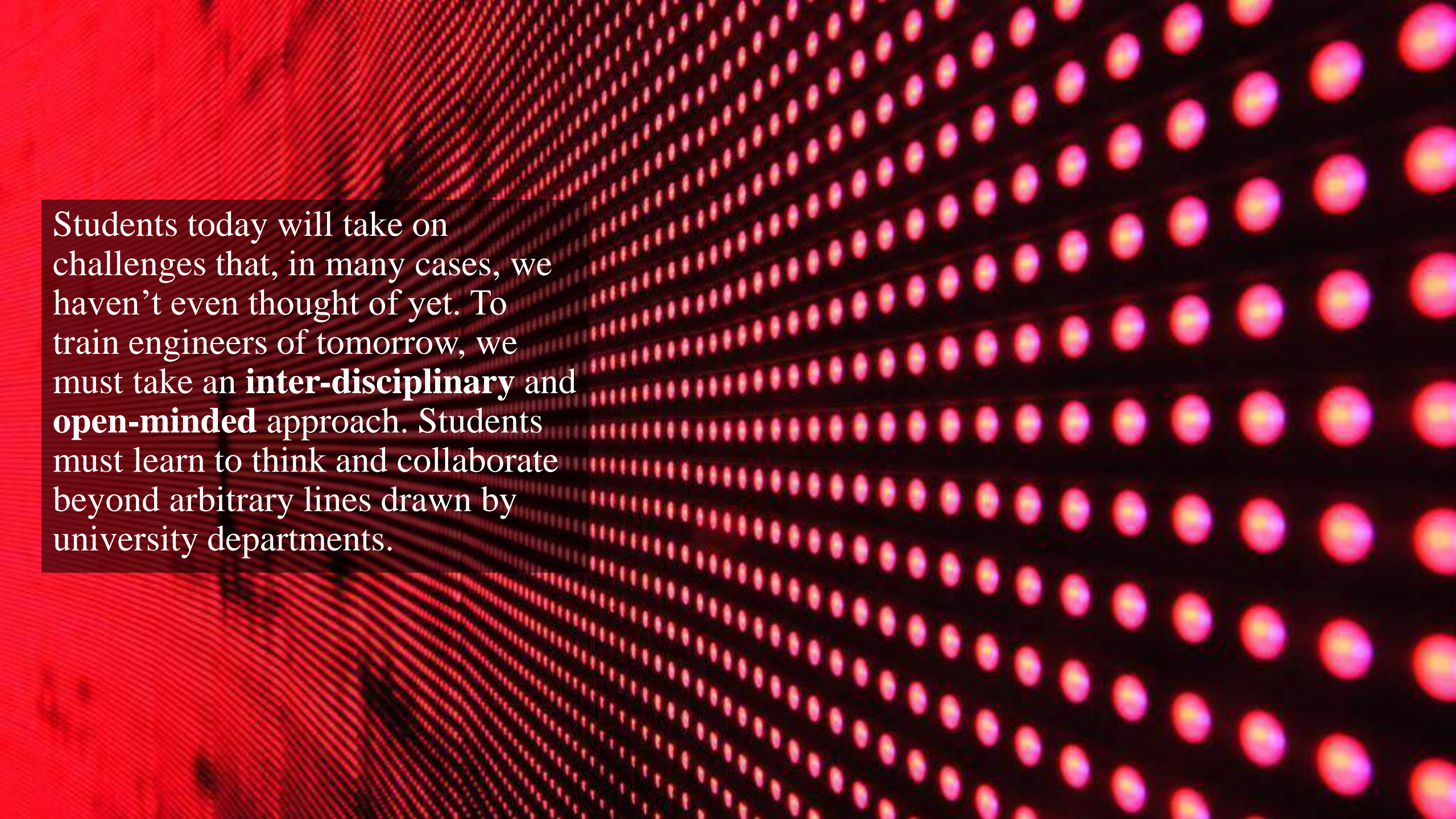
Engineers will continue the tradition of forging a better future.

Knowledge Area	PEC/HEC	Purdue	Georgia Tech
Humanities	19-21	24	32
Management Sciences (encouraged but elective in case of LUMS)	6	-	-
Natural Sciences	19-20	33-35	34

Knowledge Area	PEC/HEC	Purdue	Georgia Tech
Computing	9	-	3
Engineering Foundation	29	25	30
Major Based Core (Breadth)	19-20	9-11	-
Major Based Core (Depth)	17-18	7-10	23

A black and white photograph of a person in silhouette, sitting in a library and reading a book. The person is positioned in front of a large window that looks out onto a cityscape. Bookshelves filled with books are visible on both sides of the person. The lighting is dramatic, with the person's face and the book they are holding being the primary light sources, while the rest of the scene is in deep shadow.

Or does it needlessly place
rigid boundaries between
core engineering subjects
and everything else?



Students today will take on challenges that, in many cases, we haven't even thought of yet. To train engineers of tomorrow, we must take an **inter-disciplinary** and **open-minded** approach. Students must learn to think and collaborate beyond arbitrary lines drawn by university departments.

2013

The seven top characteristics of success at Google are all soft skills: being a good coach; communicating and listening well; possessing insights into others (including others different values and points of view); having empathy toward and being supportive of one's colleagues; being a good critical thinker and problem solver; and being able to make connections across complex ideas.

2017

Project Aristotle shows that the best teams at Google exhibit a range of soft skills: equality, generosity, curiosity toward the ideas of your teammates, empathy, and emotional intelligence. And topping the list: emotional safety. No bullying. To succeed, each and every team member must feel confident speaking up and making mistakes. They must know they are being heard.



Evidence from the Top

Companies at the forefront of technology, such as Google, are increasingly realizing the importance of learning and skills outside hard engineering subjects.

Source: Strauss, Valerie. "The surprising thing Google learned about its employees – and what it means for today's students." *Washington Post*. December 20, 2017

Conclusion

- The challenges that Pakistan and the world face currently and in the future are complex, and require outside-the-box thinking and expertise across disciplines.
- Employers, researchers, and universities are increasingly prioritizing a broad-based and inter-disciplinary education.
- The focus of our Curriculum needs to be the “Spirit” not the “Form”
- We must not isolate engineering students from the other hard sciences, the humanities, and social sciences.