Empowering Global Citizens

Through Science and Technology for a Sustainable Future

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Northeastern University

July 2025

Dialogue of Civilization

Evolution of Scientific Thought and Technology Abroad

Summer 1, 2025

GREECE

A Long History of Innovation and Creativity

Why Greece?

Throughout its history, Greek culture has been a source of innovation and creativity, stretching back to the ancient Greeks who left indelible marks in mathematics, astronomy, engineering, philosophy, literature, and art. Presently, this ethos endures, manifesting in Greece's dedicated attention to innovation and entrepreneurial endeavors. The moral and social responsibilities, deeply rooted in Greek culture, are also evident in their engineering approaches. Greek engineers exhibit an unwavering dedication to crafting technologies that prioritize sustainability, eco-friendliness, and holistic societal welfare.

When?

May 8 – June 11, 2025

Who is eligible?

For students across the entire University who wish to learn about Scientific Evolutions, Engineering, and Technical Innovations abroad, and who want to bring advancement and a better future to their communities.

Outcome:

Experimental and Interactive Global Learning Experience on Scientific Evolution and Technical Innovation.

Courses:

GE1210: Scientific Revolutions – Abroad

GE2310: Engineering and Technical Innovation – Aboard

Multiple Site Visits

Interactive and Experiential learning

The Acropolis

Delphi

Epidaurus

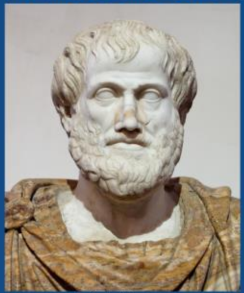
Micenae

Mieza

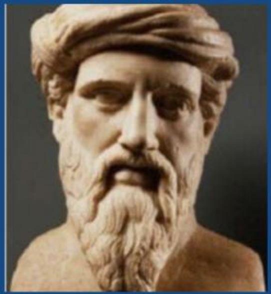
Palace of Knosos

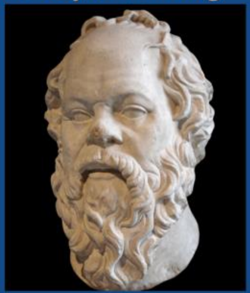
Evolution of Scientific Ideas

Foundational contributions to Science, the Scientific Way of Thinking



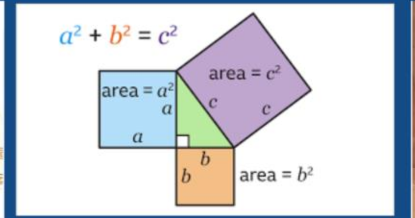
Aristotle





Socrates

Eureka



Pythagoras Theorem

Ctesibius Clock

Technological Achievements in Ancient Greece

First continuous clock, the first analog computer (The Antikythera Mechanism), the first steam engine (Hero's Machine), the first-hand water pump (Archimedes Screw), first mechanical robot, etc.

First Mechanical Robot, Ancient Greek Technology Museum

The Antikythera Mechanism

Social and Cultural Activities

Participate in an incredible Greek cultural immersion

Greek Classical Music

Greek Dance

Meteora

Thessalloniki

Olympia

The program aspires for students to experience the Scientific Revolutions and the Engineering and Technical Innovations initiated in Ancient Greece. It will make the connections between the history of science and scientific sites. Also, it will explore the engineering and technological principles behind major events and advances throughout history in an international context. It will investigate the significant technical innovations and their impact on the local culture. Students will study the evolution of scientific thought, and engineering and technological advances through visits to museums, archaeological sites, and observatories. These courses will benefit students of all disciplines. They will explore people's understanding of the natural world around them (natural phenomena, stars & and planets, motion, elements, magnetism, light, time, etc.) and the connections between science, technology, history, philosophy, and culture in Ancient Greece and the unique conditions that gave birth to the scientific way of thinking and technology and follow the evolution of some of these ideas to the present. Through guided visits to archeological sites and museums, students will learn how the people lived and the effect science and technology had had on their lives (medicine, architecture - public buildings, houses, and temples – education, arts, food, and energy use.

Led by

Prof. Christos Zahopoulos

Prof. Bala Maheswaran

College of Engineering, Northeastern University

Potential Archeological Site and Museum Visits

- Guided tour to the Archaeological Museum of Heraklion.
- Guided tour of the Archaeological site of Knossos, including the Minoan Palace.
- Guided tour to the Archaeological Museum in Santorini and the Ancient Housing site in Akrotiri.
- Guided tour of Mycenae & Epidaurus, including the Ancient Theater of Epidaurus.
- Guided tour of Ancient Olympia.
- Guided tour of the Archimedes' Museum in Olympia.
- Guided tour of the Archaeological Museum of Athens.
- Guided tour of the Acropolis.
- Guided visit to the Acropolis Museum.
- Guided tour of Aristotle's Lyceum & and Plato's Academy.
- Guided Tour of the Ancient Agora.
- Guided tour of the Museum of Ancient Greek Technology in Athens.
- Guided tour of Delphi and the Archaeological Museum at Delphi.
- Guided tour of the Archaeological Museum of Thessaloniki.
- Guided tour of Ancient Pella, the Capital of Ancient Macedonia.
- Guided tour of the archaeological site and the Archaeological Museum in Vergina.
- Guided excursion to Stagira, Aristotle's Birthplace

Dialogue of Civilization

Technical Innovation and Product Prototyping

Summer 1, 2022

Silicon valley

A Pride City of USA – Securing our Future

Why Silicon Valley?

Silicon Valley is the Innovators' and Entrepreneurs' dream world!
Silicon Valley is ground zero for customer driven technology evaluation, innovation, invention and prototyping.
Silicon Valley is an ideal location for Inspiring interactive and non-traditional college learning experience.

When?

May 15 – June 17, 2022

Who is eligible?

Students across the entire University, who are highly motivated and naturally curious about how things work, mainly, for rising sophomores and juniors, who are interested in technical innovation, technology transfer, startup companies, product prototyping and the culture of entrepreneurship in the region.

Outcome!

Experimental and Interactive Learning Experience on Innovation, Prototyping, and Entrepreneurship.

Courses:

GE2010: Introduction to Customer-Driven Technical Innovation – Silicon Valley
GE2030: Introduction to Product Prototyping – Silicon Valley

Institutional Experience

Multiple Company and Institutional visits

Interactive Experience

Interactions with Leaders, Innovators and Entrepreneurs

Innovation Experience

New Ideas, New Products, New Business Plan via Innovation

Skin Tester: Inexpensive method to diagnose the pore sizes, acidity, hydration, and oil levels of an individual's skin.

NaviCAP: How can we improve the daily life of the blind in terms of: Navigation, Social Interactions, Safety, and Daily Living Costs?

Seat Tracker: To minimize the amount time that students spend looking for a seat.

Regalo Project: Highly portable modular furniture that can be customized, assembled and disassembled with the structural integrity of LEGO

FreshMesh: Giving users the information to use food before it expires in order to save money on food and help the environment.

Quick Spot: Looking for parking space.

TeamUP: To locate nearby players and find a local venue to play sports

Team Work Experience

Alone we can do so little; together we can do so much. - Helen Keller

The program is looking to have students experience the technology-driven world of Silicon Valley. They will spend time understanding new technologies, what drives them, how to be prepared to be entrepreneurial, and use technology and the internet in creative ways. Students will look beyond the design of devices and problem solving, to see market forces, customer-driven needs and rapid design and prototyping in a new light via company visits, guest lectures, interviews, activities and teamwork.

Silicon Valley itself is the highlight of the program - it is the Innovators' and Entrepreneurs' dream world! We'll look in depth at 6-8 trending and growing technologies represented by start-ups and other companies in the Bay Area (e.g., Intel, self-driving cars). For each technology, students will visit a company to hear from a guest speaker. Students will also enjoy day trips and cultural activities, including visiting San Francisco.

Led by

Prof. Bala Maheswaran
College of Engineering
Northeastern University

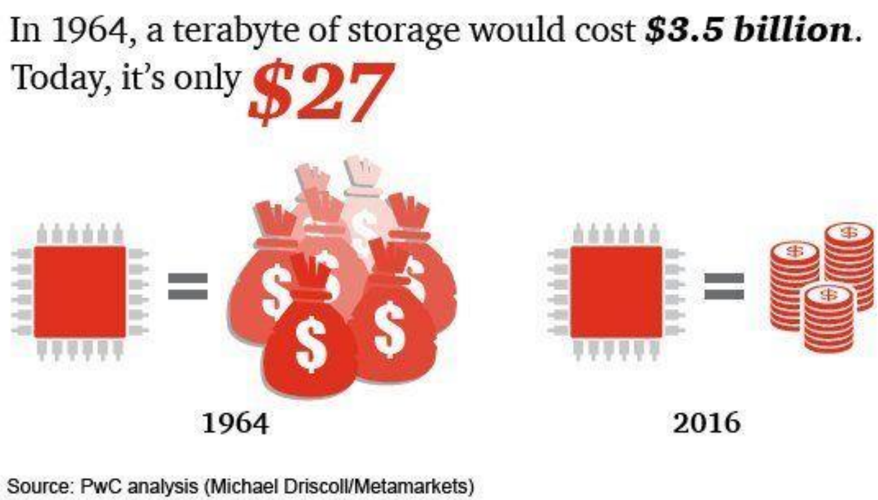
Social

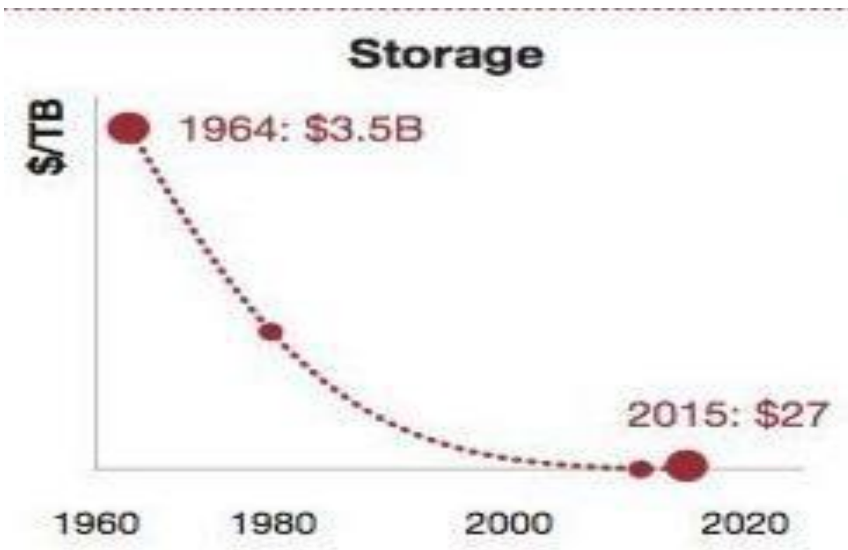

TESLA


ROBERT
intel

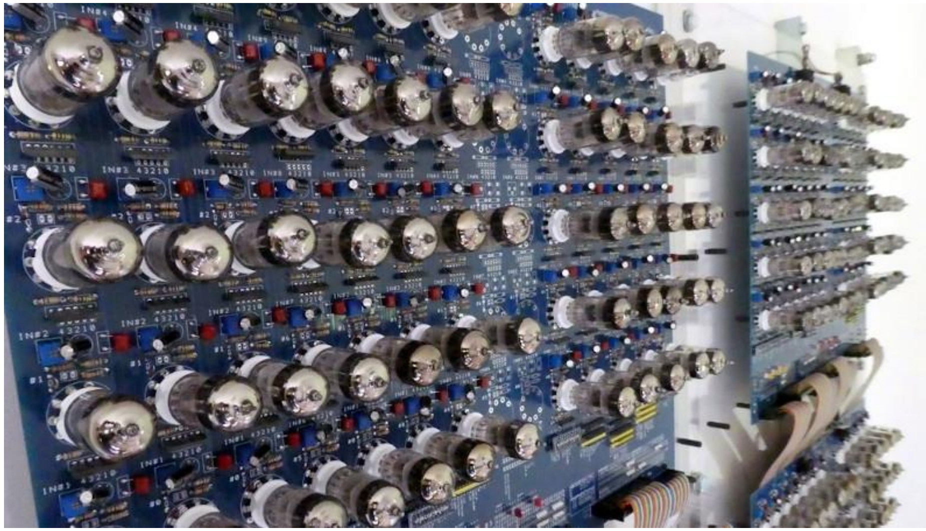
What is the cost of a Terabyte storage (1TB = 1000 Gigabytes) in 1964?

- **Today, it is less that $35.**
- **In 1964, a terabyte of storage cost $3500000000. ($3.5 billion).**

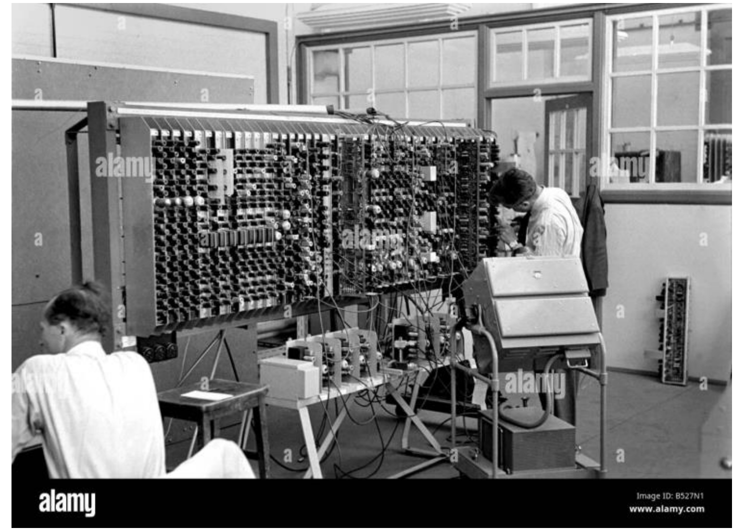




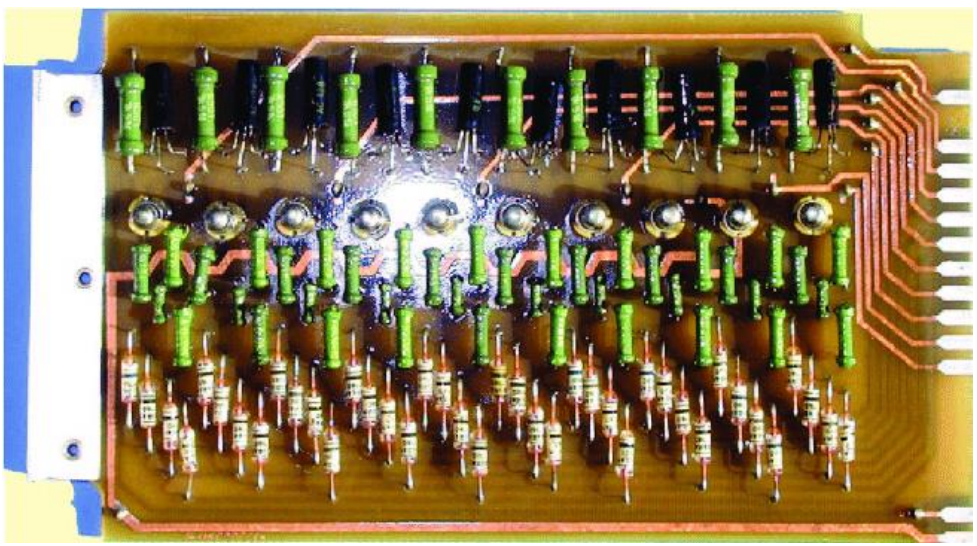
http://www.huffingtonpost.com/entry/pwc-five-global-shifts-reshaping-the-world_us_587a5c6ee4b077a19d180e1e

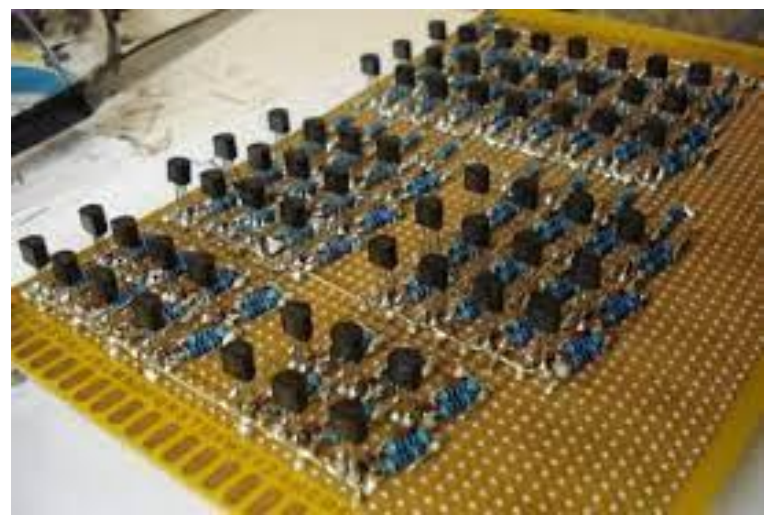


The First New Vacuum Tube Computer Design For Well Over Half A Century



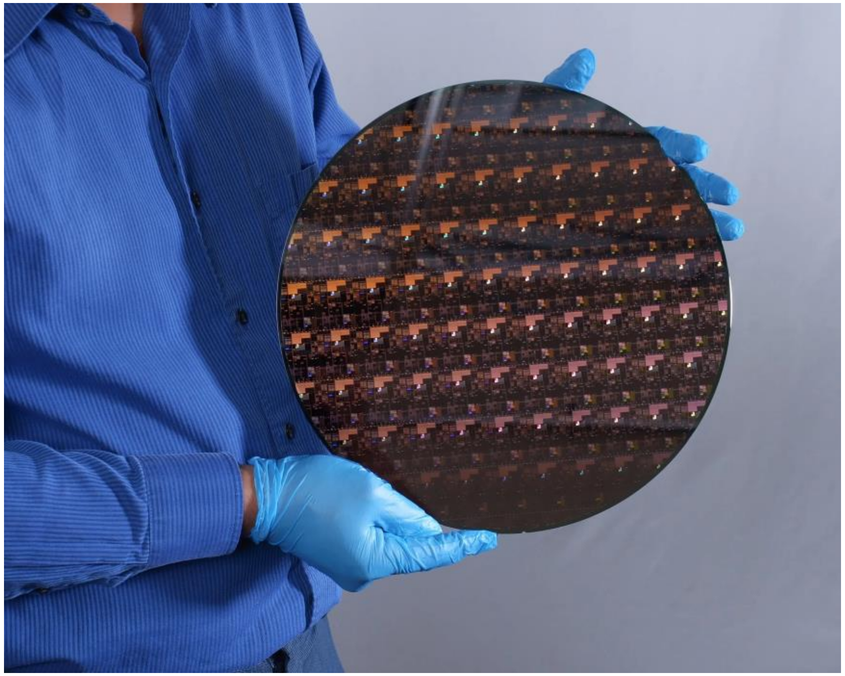
Computers 1950s hi-res stock photography and images - Alamy



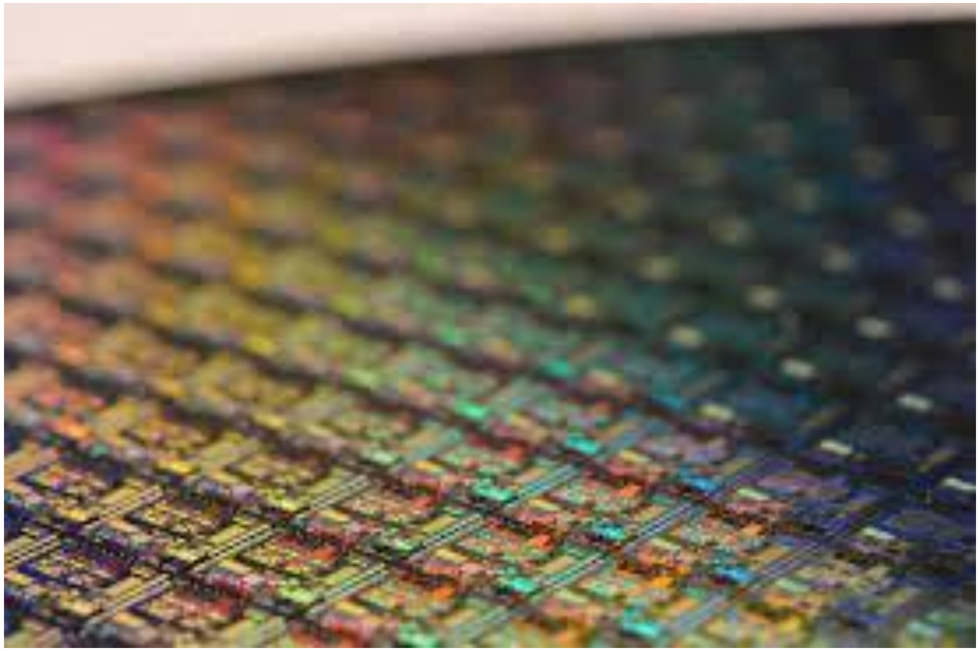


Old computer card based on diode transistor logic with no bypass... |

computer chip ...



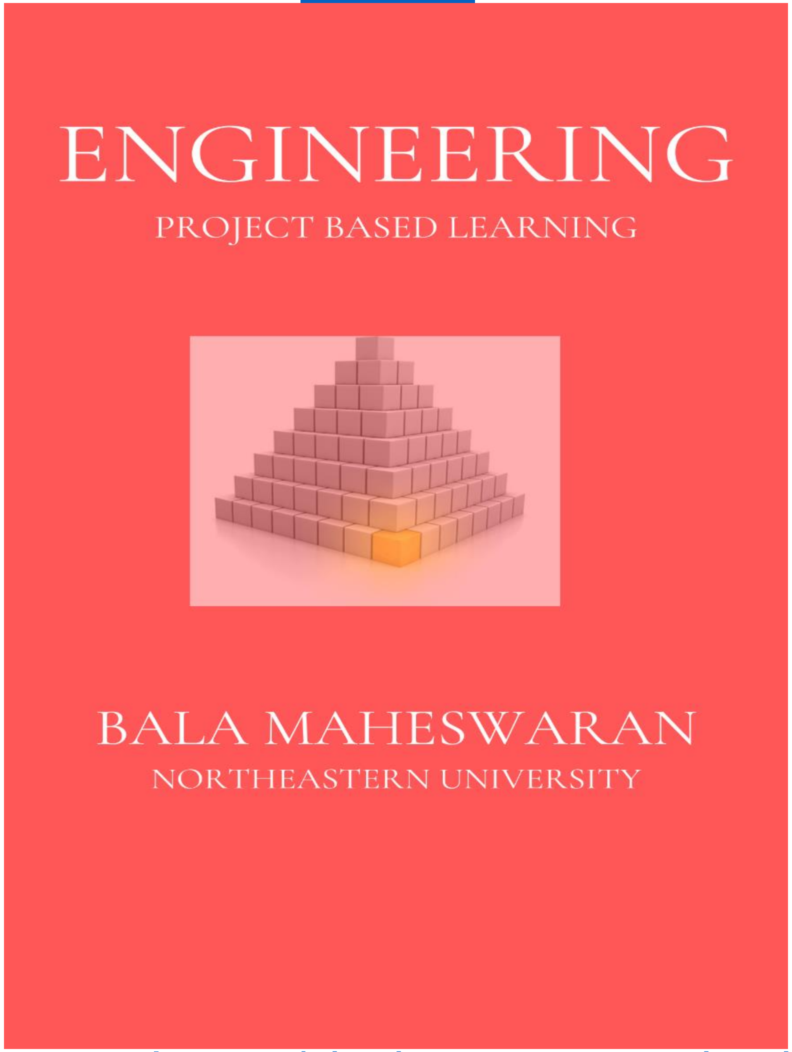
IBM's new 2-nm chips



If transistors can't get smaller, then coders have to get smarter | MIT News

Potential Reference Book

Papers



https://scholar.google.com/citations?user=mrda9d4AAAAJ&hl=en
https://peer.asee.org/?q=Bala+Maheswaran

My Proposed Global Engineering Education Course

UN Sustainable Development Goals (SDG)

They were adopted by all United Nations Member States in September 2015 as part of the 2030 Agenda for Sustainable Development.

UN Sustainable Development Goals (SDGs)

Comprehensive roadmap for addressing global challenges, adopted in September 2015:

1. No Poverty	2. Zero Hunger	3. Good Health
4. Quality Education	5. Gender Equality	6. Clean Water
7. Clean Energy	8. Decent Work	9. Innovation
10. Reduced Inequalities	11. Sustainable Cities	12. Responsible Consumption
13. Climate Action	14. Life Below Water	15. Life on Land
16. Peace & Justice	17. Partnerships	

National Academy of Engineering (NAE) Grand Challenges for Engineers

1. Make solar energy economical
2. Provide energy from fusion
3. Develop carbon sequestration methods
4. Manage the nitrogen cycle
5. Provide access to clean water
6. Restore and improve urban infrastructure
7. Advance health informatics
8. Engineer better medicines
9. Reverse-engineer the brain
10. Prevent nuclear terror
11. Secure cyberspace
12. Enhance virtual reality
13. Advance personalized learning
14. Engineer the tools of scientific discovery

Global Challenges Technology Could Solve

1. Carbon sequestration
2. Grid-scale energy storage
3. Universal flu vaccine
4. Dementia treatment
5. Ocean clean-up
6. Energy-efficient desalination
7. Safe driverless car
8. Embodied AI
9. Earthquake prediction
10. Brain decoding

Group of Seven (G7) Vs. Emerging Markets (E7)

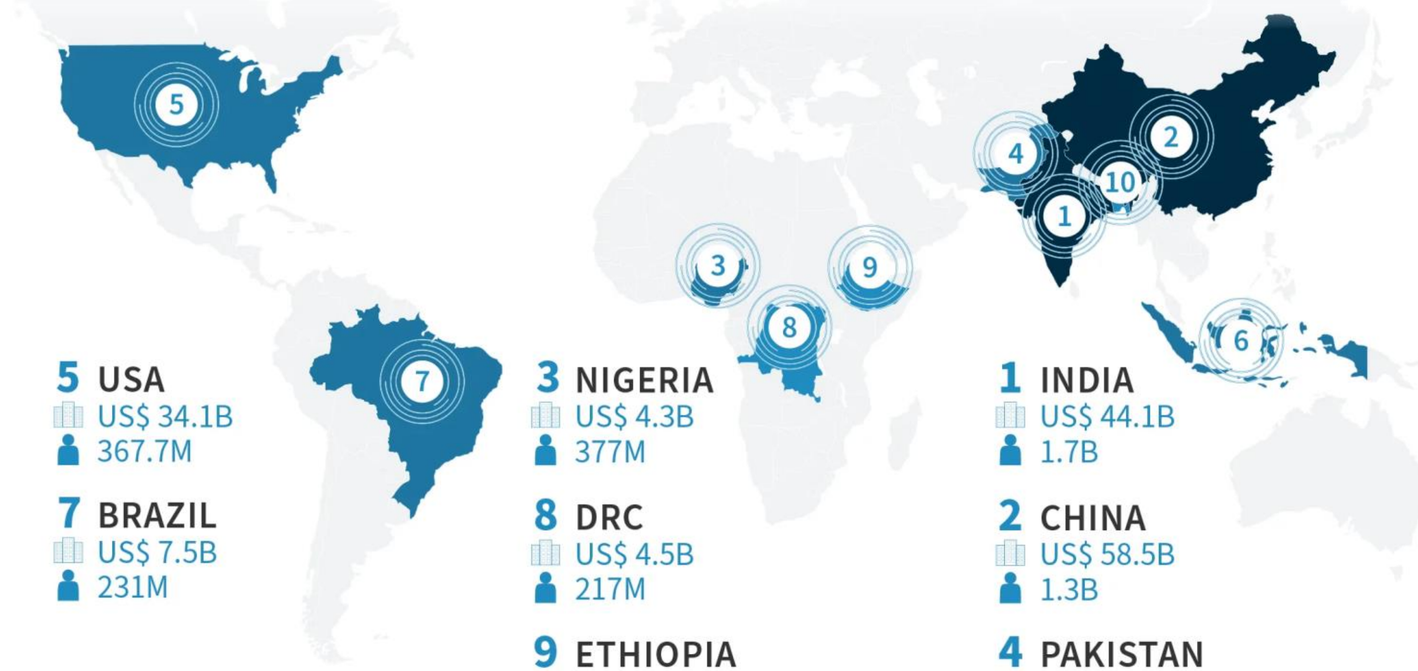
Leading Emerging Markets Set to Overtake G7 Economies by 2050

Figure 2: GDP of G7 and E7 countries (US$)

Source: *PwC analysis*

ECONOMY & POPULATION SIZE

Top 10 Countries by 2050



5 USA
US$ 34.1B
367.7M

7 BRAZIL
US$ 7.5B
231M

3 NIGERIA
US$ 4.3B
377M

8 DRC
US$ 4.5B
217M

9 ETHIOPIA
US$ 1.5B
215M

1 INDIA
US$ 44.1B
1.7B

2 CHINA
US$ 58.5B
1.3B

4 PAKISTAN
US$ 4.2B
367.8M

6 INDONESIA
US$ 10.5B
317M

10 BANGLADESH
US$ 3B
204M

Ranking GPD Population Size

0 - 250 M | 250 - 500 M | 500 - 750 M | 750 - 1000 M | 1000 - 1250+ M

Source: PwC, World in 2050, 2017

Delphos

Fastest growing and declining jobs by 2030

Rank	Top fastest growing jobs	Rank	Top fastest declining jobs
1	Big data specialists	1	Postal service clerks
2	FinTech engineers	2	Bank tellers and related clerks
3	AI and machine learning specialists	3	Data entry clerks
4	Software and applications developers	4	Cashiers and ticket clerks
5	Security management specialists	5	Administrative assistants and executive secretaries
6	Data warehousing specialists	6	Printing and related trades workers
7	Autonomous and electric vehicle specialists	7	Accounting, bookkeeping and payroll clerks
8	UI and UX designers	8	Material-recording and stock-keeping clerks
9	Light truck or delivery services drivers	9	Transportation attendants and conductors
10	Internet of things specialists	10	Door-to-door sales workers, news and street vendors, and related workers
11	Data analysts and scientists	11	Graphic designers
12	Environmental engineers	12	Claims adjusters, examiners and investigators
13	Information security analysts	13	Legal officials
14	DevOps engineers	14	Legal secretaries
15	Renewable energy engineers	15	Telemarketeters

Note: The jobs that survey respondents report the highest and lowest net growth (%) by 2030.

Source: World Economic Forum. (2025). *Future of Jobs Report 2025*.

Global Education

What Constitutes Global Citizens in the Realm of Global Education?

- Individuals not limited by single national or cultural identity.
- See themselves as part of broader global community.
- Care about others, environment, and global challenges like poverty and fairness.
- Global education teaches values and skills for good global citizenship.

The Global Citizenship Education definition

Provided by the United Nations Educational, Scientific and Cultural Organization (UNESCO). Their objectives include:

> *By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development.* Ref: *UNESCO, 2018*

They have embraced Global Citizenship Education as a pivotal component to support the achievement of the United Nations' sustainable development goal for education (SDG).

Global Citizens Education			
Education for Diversity and Inclusion	**Education for Civic Participation**	**Education for Economic Participation**	**Education for Managing Resources**
Gender Equality Education	Civic Education	Entrepreneurial Education	Education for Sustainable Development
Anti-Racist Education	Development Education	21st Century Skills	Environmental Sciences Education
Multicultural Education	Social Justice Education	Intercultural Education	Conservation Education / Nature Studies

.Ref: https://gcedsolutions.com/2021/03/23/what-is-global-citizenship-education/

Proposed Global Engineering Education Course Goals:

- Provide knowledge, skills, perspectives for interconnected world.
- Explore cultural diversity and ethical considerations.
- Understand globalization's impact on engineering practices.
- Enhance communication abilities and intercultural teamwork.
- Refine problem-solving skills within global challenges framework.

Proposed New Course: Global Education for Engineers

Course Objectives

Provide engineering students with necessary knowledge, skills, and perspectives to thrive in a globalized world, covering cultural diversity, ethical considerations, and globalization impacts.

Seven-Module Structure

Module 1-2: Exploring Globalization and Engineering

Module 3-4: Fostering Cultural Competence in Engineering

Module 5-6: Ethical Dimensions of Global Engineering

Module 7-8: International Standards and Regulations

Module 9-10: Sustainable Development & Global Challenges

Module 11-12: Global Project Management

Module 13-15: Communication & Final Projects

How can we effectively integrate the proposed 7-module Global Engineering Education course structure into existing engineering curricula without overwhelming students?

Engineering Educators Bringing the World Together
2025 ASEE Annual Conference & Exposition
Palais des congrès de Montréal, Montréal, QC • June 22–25, 2025 ASEE
Paper ID #45504

Cultivating Global Citizens Through Engineering Education: A Framework for Sustainable Development

Prof. Bala Maheswaran, Northeastern University

Bala Maheswaran, PhD COE Distinguished Professor Northeastern University 367 Snell Engineering Center Boston, MA 02115

Discussion Questions

- What does it mean to be a "global engineer citizen" in your specific engineering discipline?
- What are the top 3 actionable steps your institution could take immediately to advance global citizenship in engineering education?
- What is one commitment you're willing to make to advance global citizenship in engineering education?
- How will you continue this conversation within your own institution and professional networks?

Academic Integration:

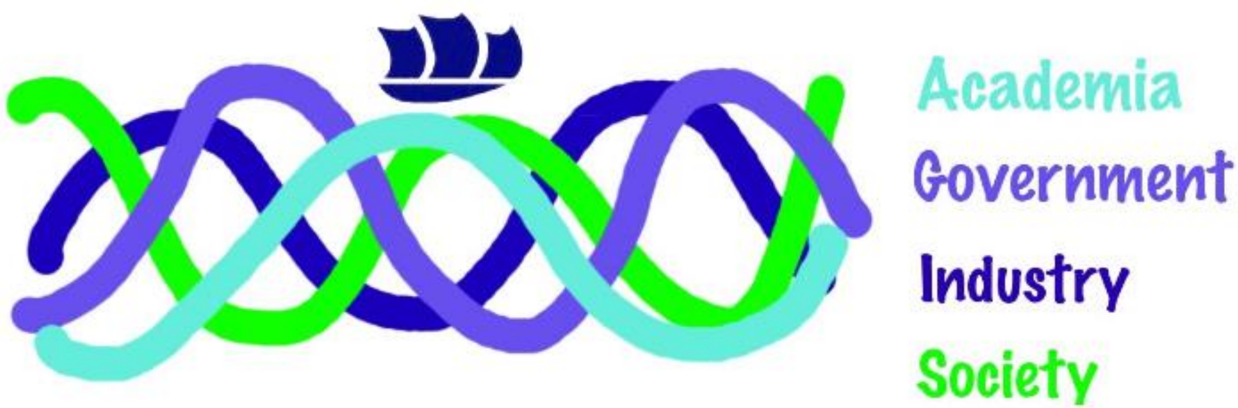
- Target: Any academic year (freshman through senior).
- Timing: After major selection for relevant case studies.
- Assessment: Class participation, assignments, final projects.

Teaching Enhancement:

- Guest lectures for specific modules.
- Real-world perspective seminars.
- Interactive approach implementation.

Global Necessities

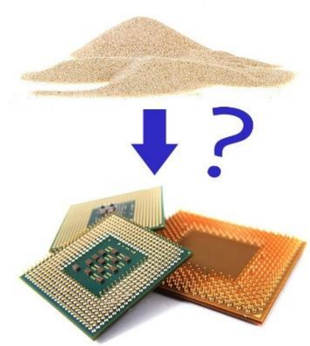
- These are world's most pressing challenges. They provide a framework for academia, governments, organizations, and individuals to work together towards a more sustainable and equitable future.
- Uniting Academia, Government, Industries and Society for Sustainability and Equity.



Potential Resources

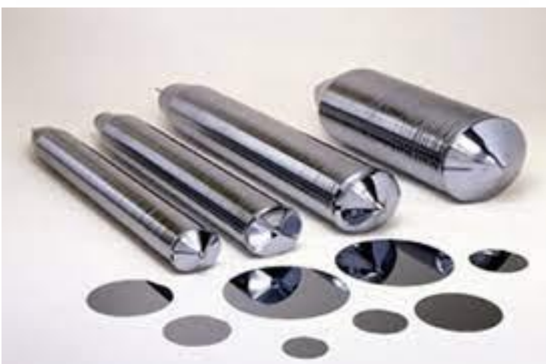
- We currently have a diverse student body from various countries, and we're actively engaged in multiple collaborative initiatives worldwide. What we require is a strategic approach to transform our education into a truly global endeavor.

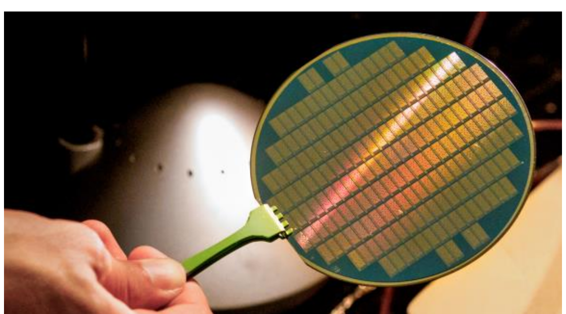
    - Much like how we extract gold from the Earth because it's already there,
    - harness oil from the ground,
    - produce microchips from sand using our knowledge and skills.



- We can establish a global education environment without necessitating additional resources. Instead, what we need is an injection of creativity.

Sand to Chips





Making computer chips

1. Sand
2. Purification
3. Melting and Growing Silicon Ingots
4. Slicing into Wafers
5. Oxidation to grow a layer of silicon dioxide (SiO2) on their surface.
6. Photolithography: This step defines the transistors and interconnections of the integrated circuit.
7. Etching: Leaving behind the desired patterns.
8. Doping: To create semiconductor devices (transistors),
9. Deposition:
10. Annealing:
11. Chemical Mechanical Polishing (CMP):
12. Back-End Processes:
13. Testing:
14. Packaging:
15. Quality Control:
16. Final Testing:
17. Distribution:

LEADING PLACES OF ORIGIN OF INTERNATIONAL STUDENTS, 2022/23

Total International students:	1,057,188
China:	289,526
India:	268,923
Sub-Saharan Africa:	18 percent

Ref:
https://www.insidehighered.com/news/global/international-students-us

How can engineering programs leverage their international student population (1,057,188 students from diverse countries) as a resource for global education?

Why is sustainability in engineering education so crucial?

- It is about preparing the **next generation of engineers** to be leaders in sustainable practices.
- By educating students with the knowledge and skills to address **environmental, social, and economic** challenges.
- We empower them to create a positive impact on the world.
- **Integrating sustainability into the engineering curriculum** allows us to foster awareness and understanding of sustainable practices from the very beginning.
- We can no longer afford to teach engineering in isolation from its environmental and societal implications.
- By incorporating **sustainability-focused courses and modules**, we ensure that every engineer has a solid foundation in sustainable principles.

Preparing Engineering Students for the Future

- We must prepare future engineers to appreciate, include, and better understand the perspectives and needs of people.
- Our empathy enables human-centered design, understanding stakeholder needs, and co-designing with the community.
- By taking steps to position people at the center of innovation, we build an inclusive environment and better future engineers.
- The future engineers must be prepared to lead their immediate engineering communities across other disciplines and in their greater communities.

What steps do we need to make this happen?

Summery

- Sustainability in engineering education is not an option; it is a necessity.
- We owe it to future generations to prepare engineers who are equipped with the knowledge, skills, and mindset to create sustainable solutions for a better tomorrow.
- By integrating **sustainability principles via Science and Technology** into our curriculum, fostering project based experiential learning, engaging with industry, empowering students, and assessing our progress, we can truly make a difference.
- Let us embrace the challenge and grab this opportunity to transform engineering education.
- Together, we can build a sustainable future, i.e., *Engineering for One Planet*.