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Daniel B. Oerther, Ph.D., P.E., BCEE, BCES

Professor Daniel B. Oerther, PhD, PE, BCEE, BCES is the Executive Director of the American Academy of Environmental Engineers and Scientists and a Professor of Environmental Health Engineering at the Missouri University of Science and Technology. Dan earned his PhD from the University of Illinois, and he previously served as the Senior Science Advisor to the United States Secretary of State in the Office of Global Food Security. Dan is widely known for his discovery research in environmental biotechnology, his integrative research resulting in the nurse+engineer STEMpathy framework, his application research employing science diplomacy to support access to water and food security in developing communities globally, and his scholarship of teaching and learning including modified mastery learning. Dan is a three-time recipient of the Fulbright Award (India, Brazil, and the United Kingdom), and the only individual to be recognized as Board Certified by the American Academy of Environmental Engineers and Scientists, a Diplomate Laureate of the American Academy of Sanitarians, and a lifetime honorary Fellow of the American Academy of Nursing.

Leadership and Excellence in Environmental Engineering and Science

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Geosyntec consultants

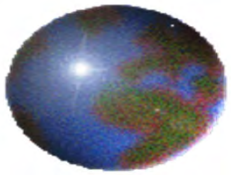
DSWA
DELAWARE SOLID WASTE AUTHORITY

CDM Smith®

LA DWP Los Angeles Department of Water & Power

We will begin our presentation in a few minutes…

Leadership and Excellence in Environmental Engineering and Science



Engineering for Peace and Diplomacy

Bernard Amadei
Dept. of Civil Engineering
The University of Colorado, Boulder, USA

February 7, 2024

A world divided by wealth and poverty, health and sickness, food and hunger, cannot long remain a stable [and peaceful] place for civilization to thrive [NAE Grand Challenges for Engineering].

A VUCA World

Volatile – Dynamic, fast-paced, perhaps unstable, but not necessarily hard to understand.

Uncertain – Cause and effect are known but key information is lacking; the outcome is uncertain.

Complex – Many interconnected processes and variables. Some information is available but the volume/nature of it can be overwhelming to process.

Ambiguous – Causal relationships are completely unclear. No precedents exist; "unknown unknowns."

Additive (and addictive) Forces

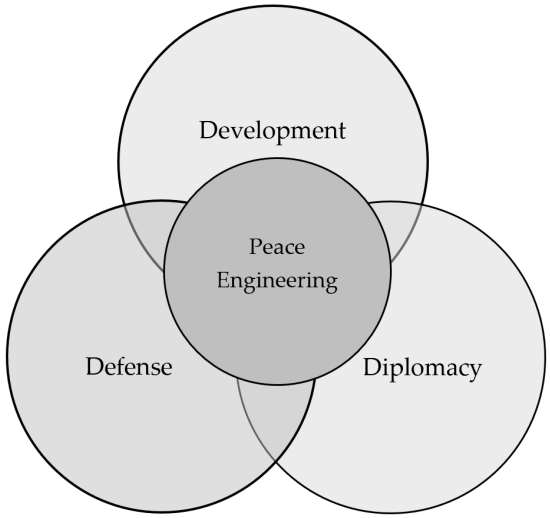
apathy, intolerance, fear
dogmatism, lack of compassion,
violence, power, ego, greed,
corruption, hatred, denial,
consumption, ignorance, denial,
exclusion, politics competition,
jealousy

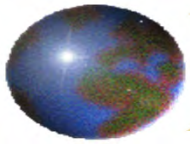
Human Characteristics

- Bounded rationality, limited certainty, limited predictability, indeterminate causality, and evolutionary change
- Heuristic approach to complexity and change
- Pathological forms of behavior

Peace Engineering

- The proactive use of engineering skills to promote a peaceful and just existence for all (A. Vesilin, 2006)
- The intentional application of STI principles for trans-disciplinary systemic-level thinking to build and support conditions for peace (Jordan, 2020)
- A relatively new and interdisciplinary field that aims to apply engineering principles and technology to promote peace, prevent conflicts, and address the root causes of violence and instability in various contexts. It involves collaboration between engineers, social scientists, policymakers, and other stakeholders to develop innovative solutions for peace and stability (OpenAI, 2023)





Greatest Engineering Achievements OF THE 20TH CENTURY

Welcome!
How many of the 20th century's greatest engineering achievements will you use today? A car? Computer? Telephone? Explore our list of the top 20 achievements and learn how engineering shaped a century and changed the world.

1. Electrification
2. Automobile
3. Airplane
4. Water Supply and Distribution
5. Electronics
6. Radio and Television
7. Agricultural Mechanization
8. Computers
9. Telephone
10. Air Conditioning and Refrigeration
11. Highways
12. Spacecraft
13. Internet
14. Imaging
15. Household Appliances
16. Health Technologies
17. Petroleum and Petrochemical Technologies
18. Laser and Fiber Optics
19. Nuclear Technologies
20. High-performance Materials

20

Greatest Achievements

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BHOPAL GAS TRAGEDY
DECEMBER, 1984





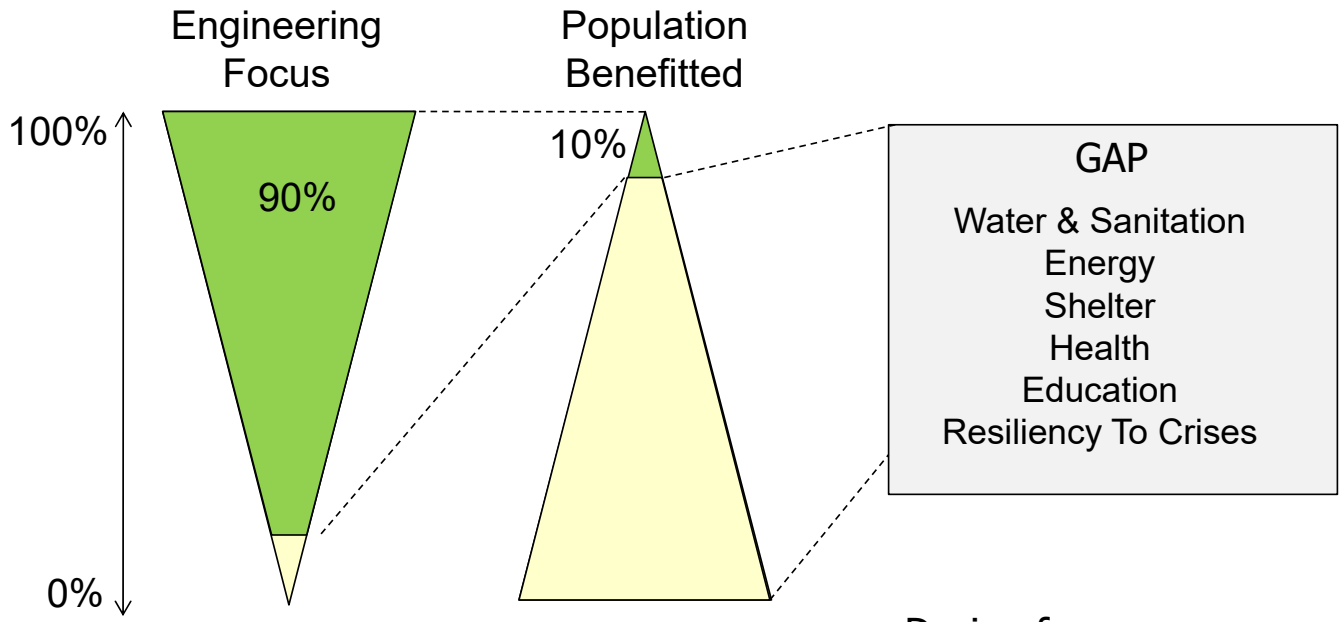




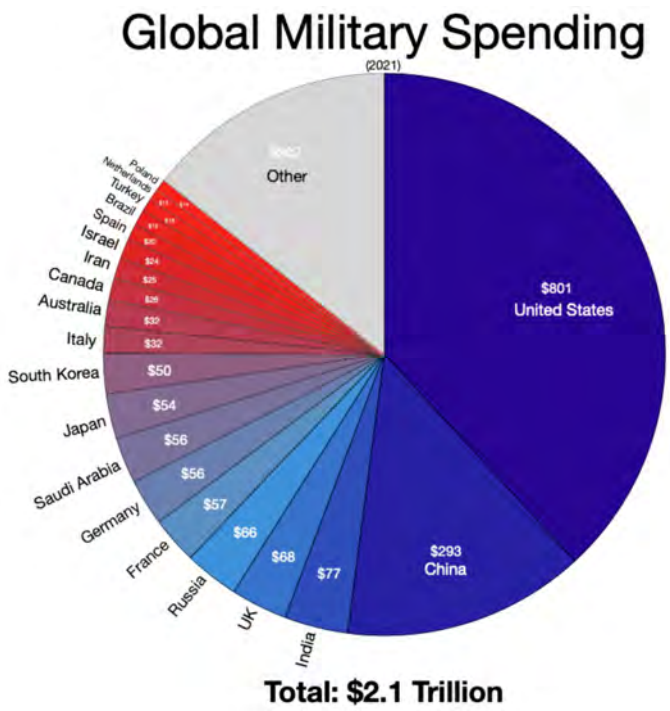





"Most of the world's designers focus on developing products and services exclusively for the richest 10% of the world's customers. Nothing less than a revolution in design is needed to reach the other 90%." *Dr. Paul Polak, International Development Enterprises*

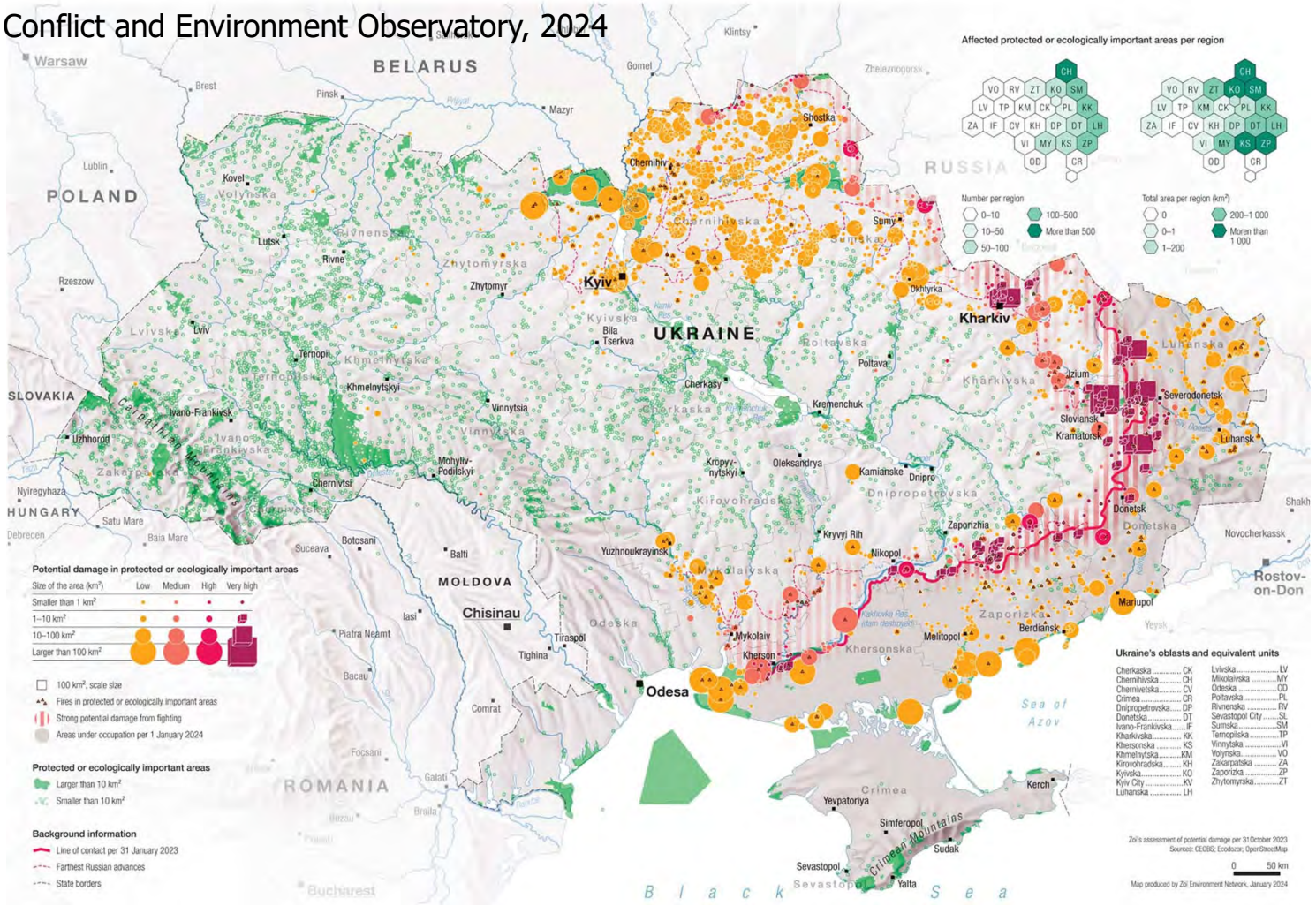


Design for peace

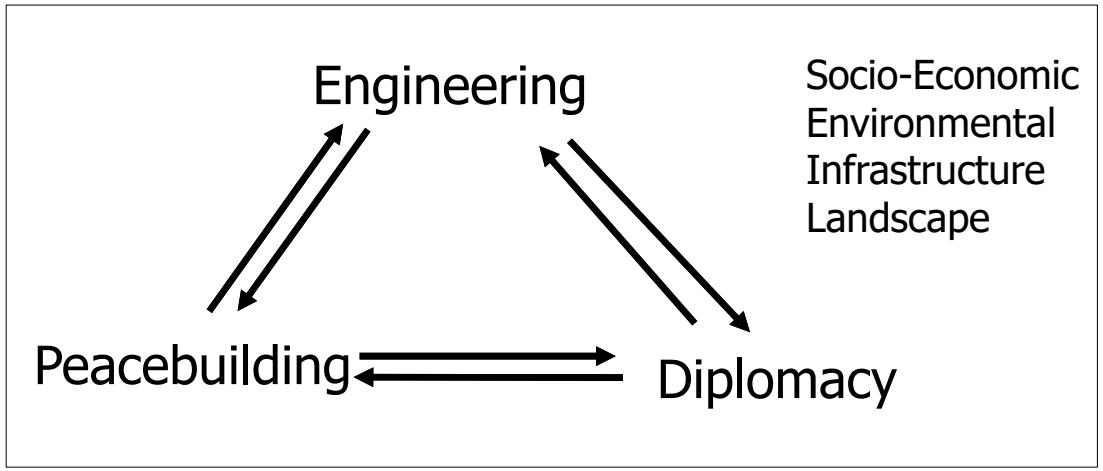


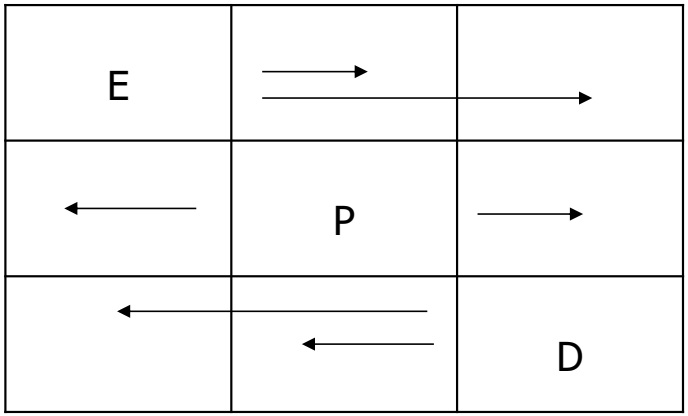
$2.1 x 10^{12} /365/24/60/60 = $66,589 per second!

Conflict and Environment Observatory, 2024



A Nexus


Engineering
Socio-Economic
Environmental
Infrastructure
Landscape
Peacebuilding
Diplomacy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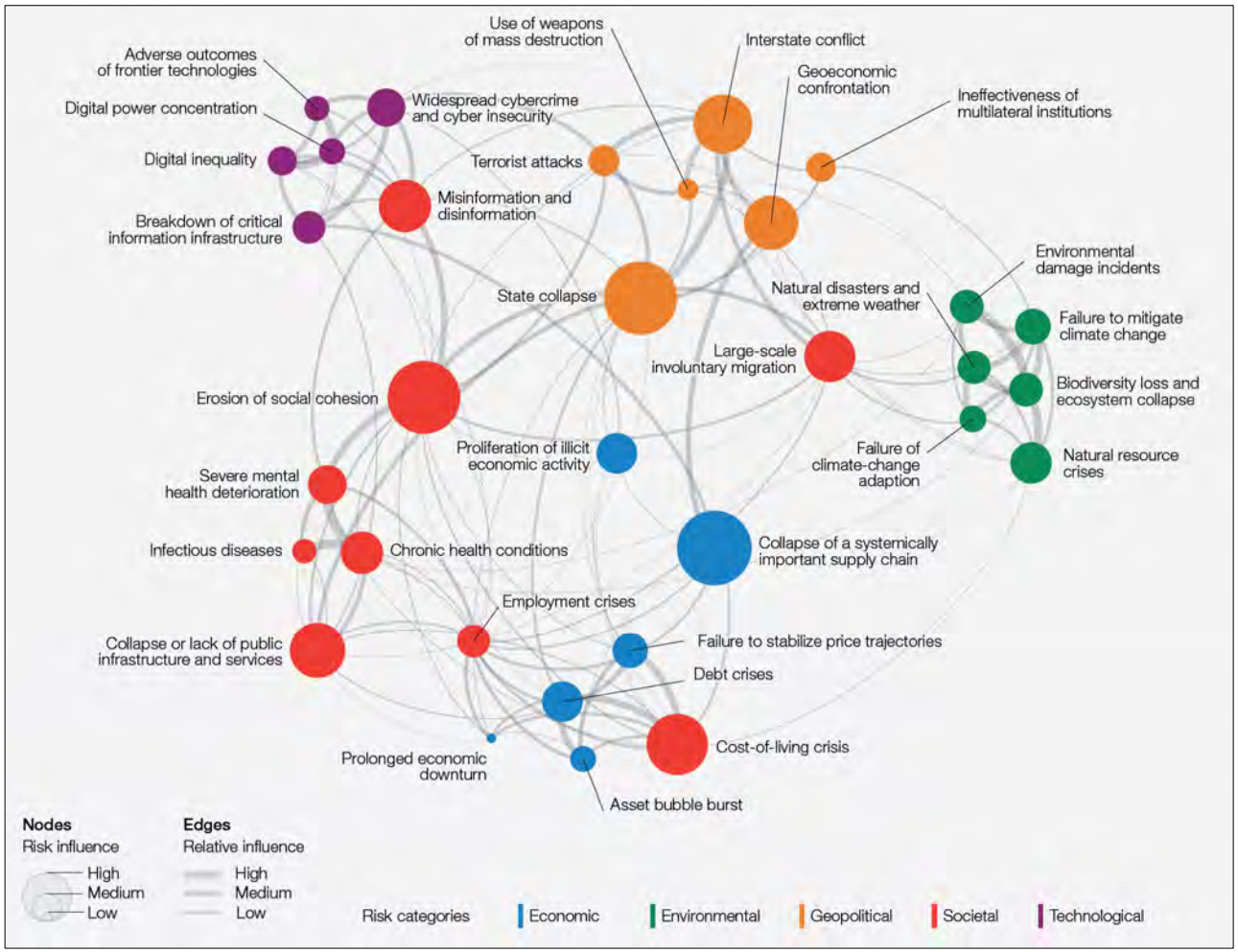
World Issues in the 21st Century

- Climate change and security risks
- Rapid urbanization
- Population growth, migration, and resettlement
- Water, energy, food, and land resources security
- Access to education, shelter, healthcare, etc.
- Environmental damage and biodiversity loss
- Natural and human-induced risks and emergencies
- Peacebuilding, violent conflict prevention, recovery
- Social equality and inclusive growth
- National and global security.


Use of weapons of mass destruction
Interstate conflict
Geoeconomic confrontation
Ineffectiveness of multilateral institutions
Adverse outcomes of frontier technologies
Digital power concentration
Widespread cybercrime and cyber insecurity
Digital inequality
Terrorist attacks
Misinformation and disinformation
Breakdown of critical information infrastructure
Environmental damage incidents
State collapse
Natural disasters and extreme weather
Failure to mitigate climate change
Large-scale involuntary migration
Biodiversity loss and ecosystem collapse
Erosion of social cohesion
Failure of climate-change adaption
Natural resource crises
Proliferation of illicit economic activity
Severe mental health deterioration
Infectious diseases
Chronic health conditions
Collapse of a systemically important supply chain
Employment crises
Collapse or lack of public infrastructure and services
Failure to stabilize price trajectories
Debt crises
Cost-of-living crisis
Prolonged economic downturn
Asset bubble burst
Nodes
Risk influence
High
Medium
Low
Edges
Relative influence
High
Medium
Low
Risk categories
Economic
Environmental
Geopolitical
Societal
Technological


WORLD ECONOMIC FORUM
The Global Risks Report 2024
19th Edition
INSIGHT REPORT

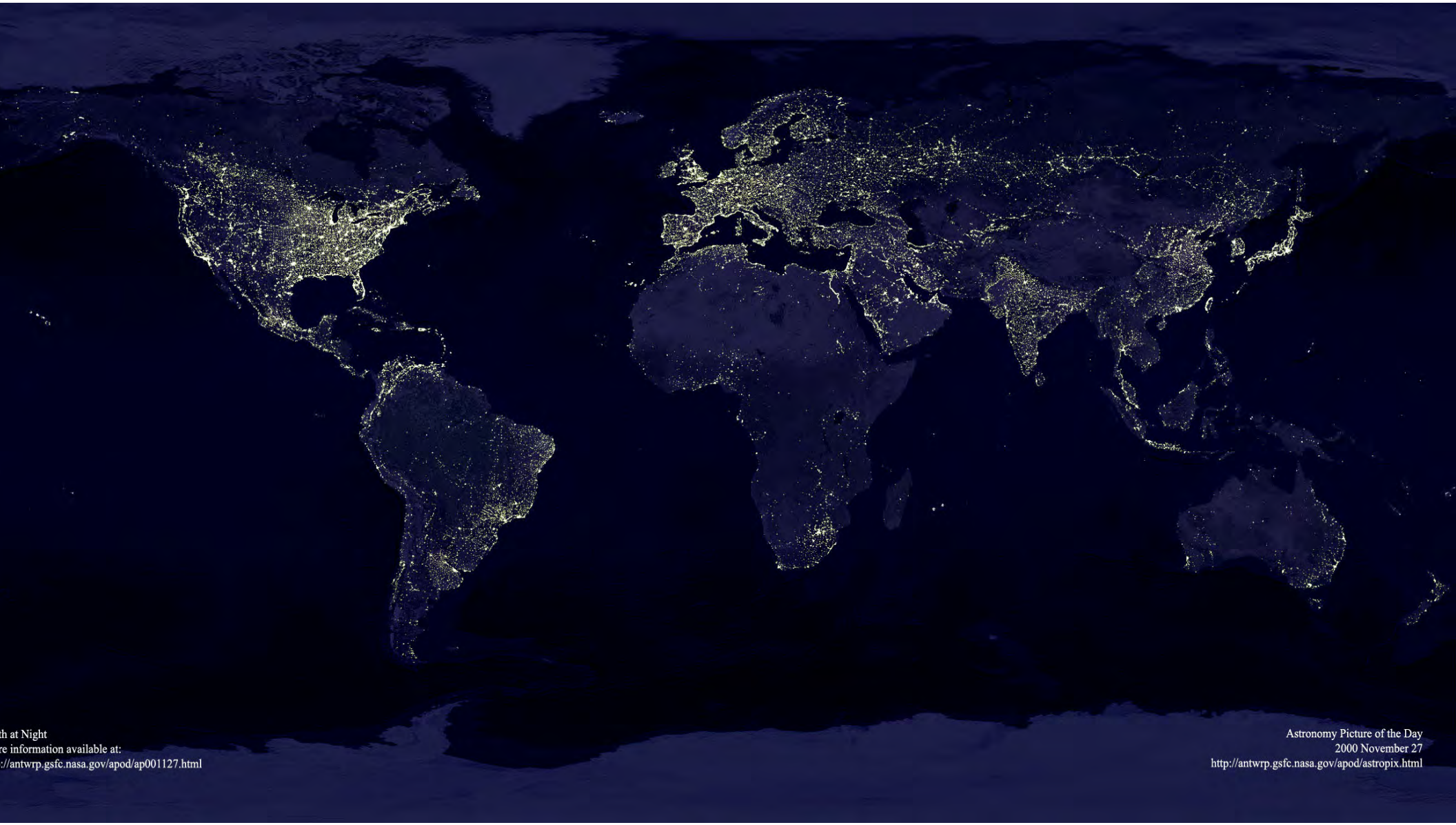
LIFE LONG LEARNING

K-GRAY EDUCATION

The [person] who graduates today and stops learning tomorrow is uneducated the day after (Newton D. Baker)

Do today's engineering and science graduates, educators, and practitioners have the skills and tools to address the global problems that our planet and humans face today or will be facing within the next 20 years and beyond?

To contribute to building a more sustainable, stable, equitable, and peaceful world and promote a culture of peace that benefits the global economy and the world's population more than the current culture of war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re information available at:
://antwrp.gsfc.nasa.gov/apod/ap001127.html
Astronomy Picture of the Day
2000 November 27
http://antwrp.gsfc.nasa.gov/apod/astropix.html

Developing a New Generation of Engineers for the 21st Century

Demystifying engineering education and practice as usual, which is to provide value-neutral technical solutions to well-defined problems.

Engineers are called to be CHANGE-MAKERS, peace-makers, social entrepreneurs, and facilitators of sustainable human development

Attributes of the Engineer of 2020/30 and Beyond

- ❑ Strong analytical skills
- ❑ Practical ingenuity
- ❑ Creativity
- ❑ Good communication
- ❑ Business & management skills
- ❑ Leadership
- ❑ High ethical standards
- ❑ Resilience & flexibility
- ❑ Lifelong learners

- Global Awareness
- Personal Awareness
- Teamwork
- Experience & Application

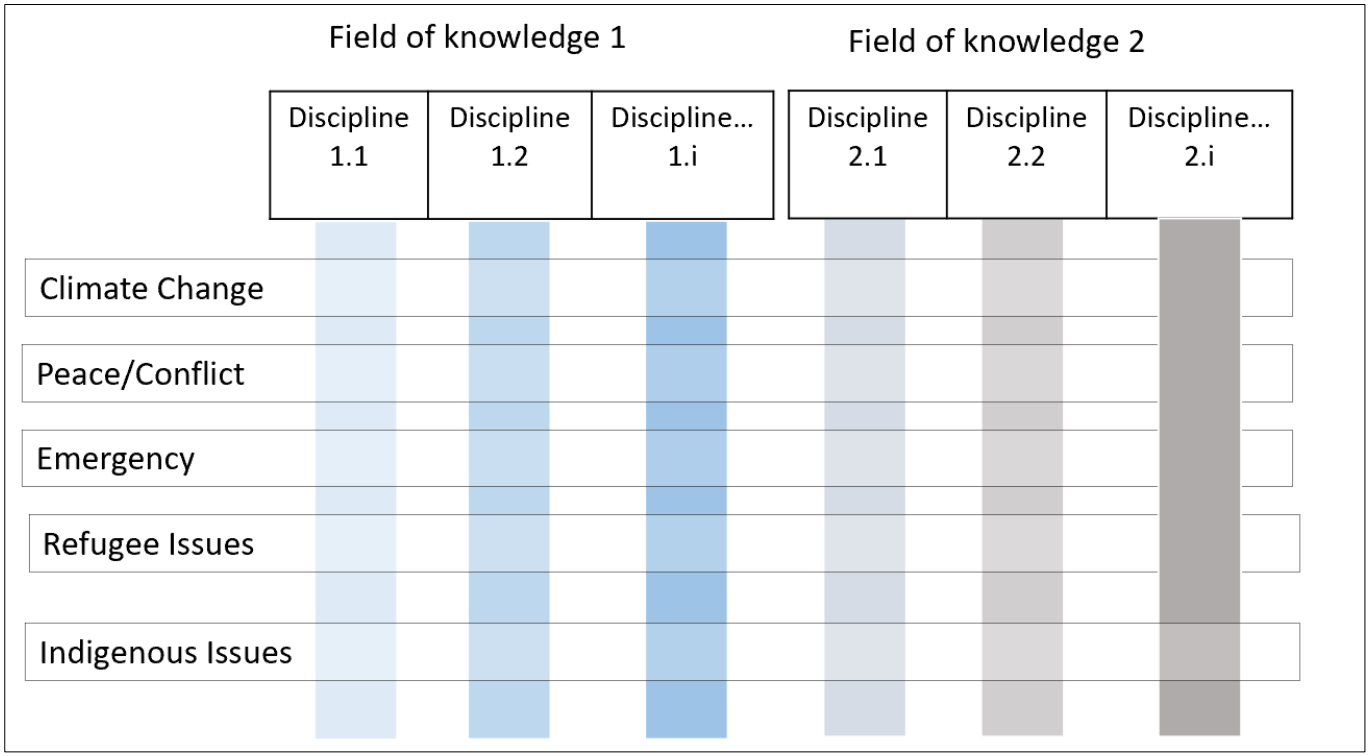
Solutions:
- With a Human Face
- Appropriate
- Done right and rightly done

The Engineering for One Planet Framework (2022)

Four learning outcomes:

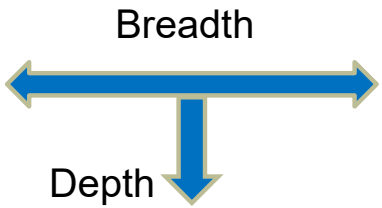
- Systems thinking as foundation
- Knowledge and Understanding (environmental literacy, responsible business and economy, social responsibility)
- Skills, Experiences, and Behaviors (design, material selection, environmental impact assessment)
- Leadership skills (critical thinking, communication, and teamwork).

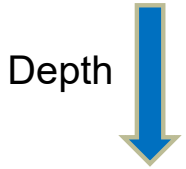
Transdisciplinary education

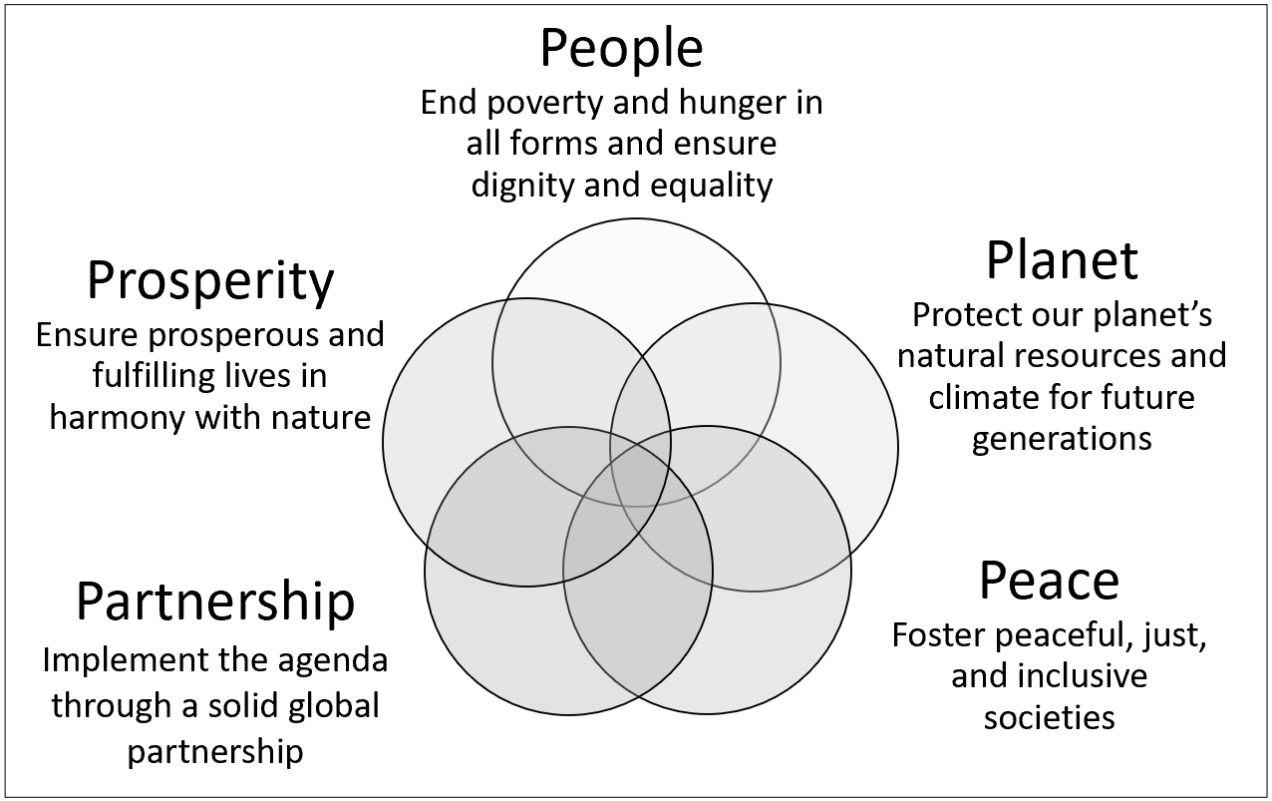


An action-based blueprint for the education of engineers who

- Have appropriate skills and tools to address critical world issues
- Interact with others and are whole brain thinkers.
- Can manage projects in different contexts and scales.
- Are flexible and resourceful enough to deal with unfamiliarity
- Are committed to lifelong learning.
- Are system thinkers and consider the unintended consequences of their decisions.
- Have access to technology and have the humility to understand that the Western world does not always have all the solutions.



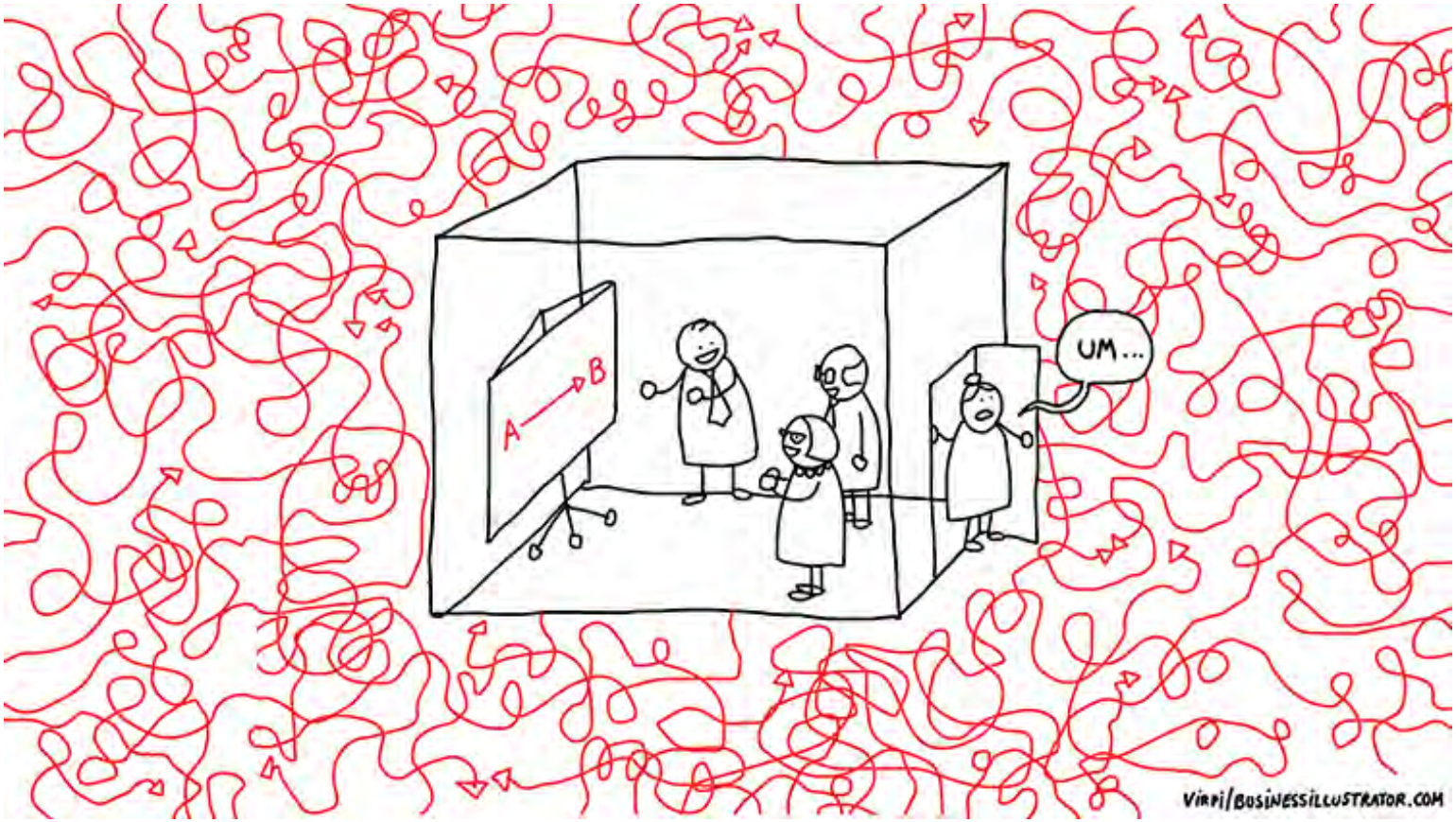



People
End poverty and hunger in all forms and ensure dignity and equality
Prosperity
Ensure prosperous and fulfilling lives in harmony with nature
Planet
Protect our planet's natural resources and climate for future generations
Partnership
Implement the agenda through a solid global partnership
Peace
Foster peaceful, just, and inclusive societies

Right solutions	- Suitable for the people (social justice). - Good for the environment (ecological stewardship). - Create partnerships and prosperity and not division. - Develop solutions that are contextual and scale-appropriate. - Undertake initiatives and create solutions advocating for promoting and supporting underlying principles.
Rightly done solutions	- Sound from a traditional design, planning, and intervention point of view - Sound engineering. - Reliable and encouraging participation, O&M. - Instrumentation included and M&E. - Innovative and adaptive technologies that support humanitarian aid, disaster recovery, and peacekeeping and peacebuilding operations. - Enhance communications collaboration and trust among stakeholders.
Right reasons solutions	- Does the problem require an engineering intervention? - Is there a need to improve solutions continuously technically? - Big or small solutions? - Appropriateness, affordability, longevity, scalability - Must improve living standards. - Must reduce conflict.

Local and Global Engagement

A new epistemology of engineering practice and education based on the idea of reflective and adaptive practice, system thinking, and a holistic approach to global problems.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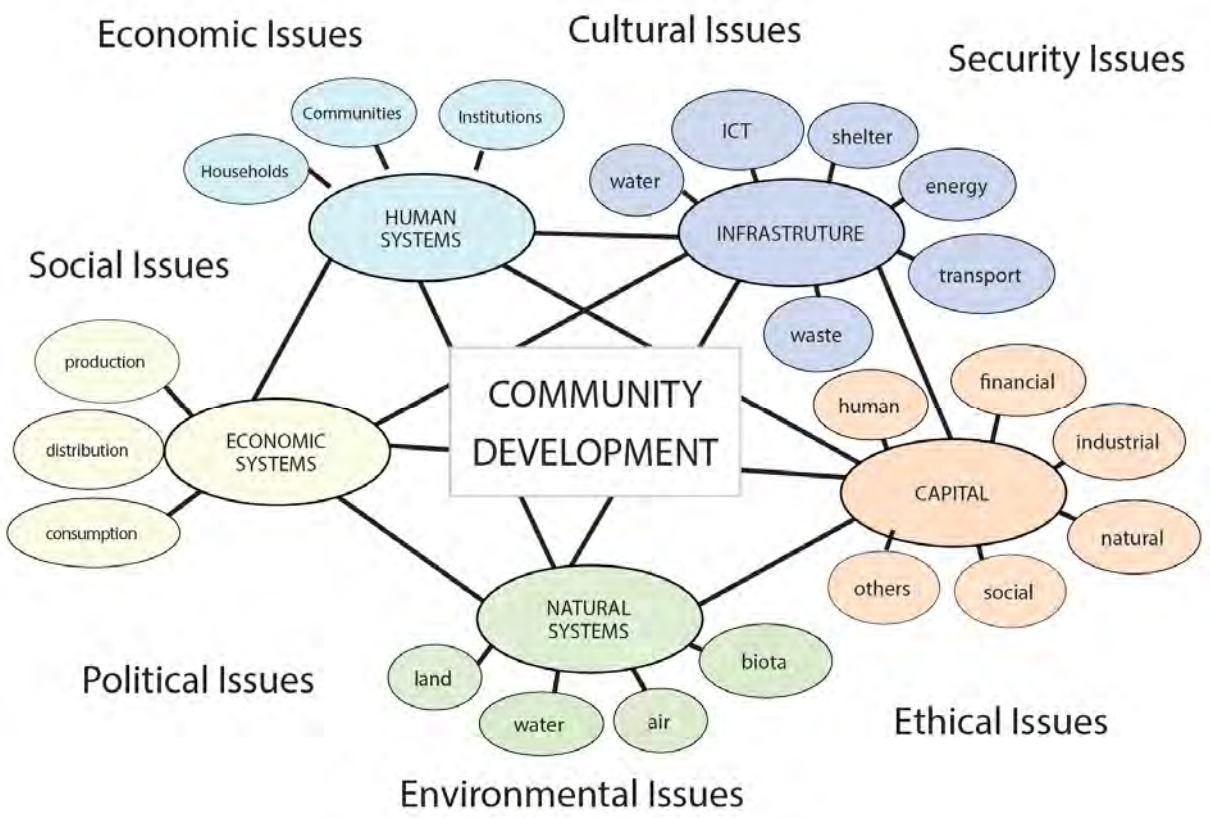
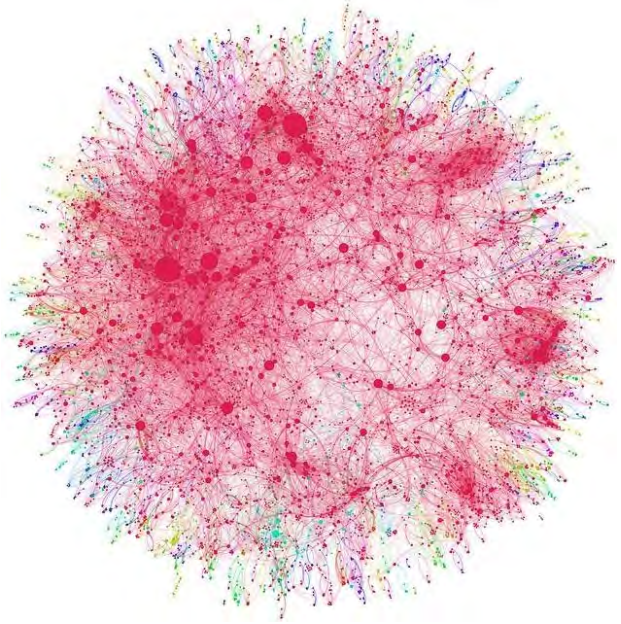
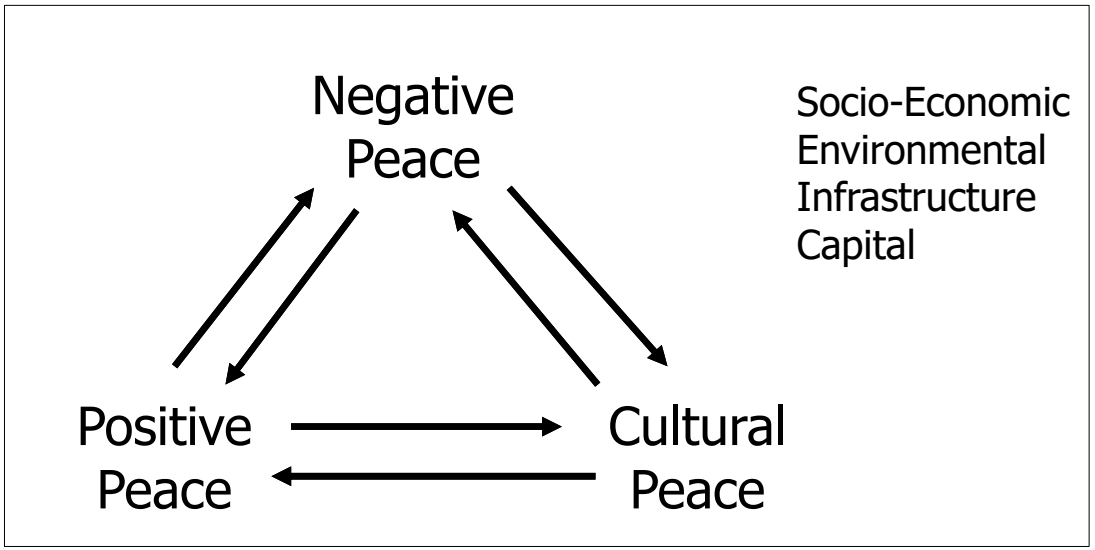

Economic Issues
Cultural Issues
Security Issues
Communities
Institutions
Households
HUMAN SYSTEMS
ICT
shelter
water
energy
INFRASTRUTURE
transport
Social Issues
waste
production
distribution
consumption
ECONOMIC SYSTEMS
COMMUNITY DEVELOPMENT
financial
human
industrial
CAPITAL
natural
others
social
NATURAL SYSTEMS
biota
land
water
air
Political Issues
Ethical Issues
Environmental Issues

Conflict-affected Environments as Multiple Complex Adaptive Systems

- Ill-defined, messy and wicked
- Complexity and uncertainty are the norm
- Constantly evolve, cope, and adapt to change (resilience)
- Self-organize, self-correct, and adapt by changing structure, behavior, rules of interaction through evolutionary and co-evolutionary change
- No unique and best solutions to complex problems exist, only satisficing (i.e., good enough) solutions



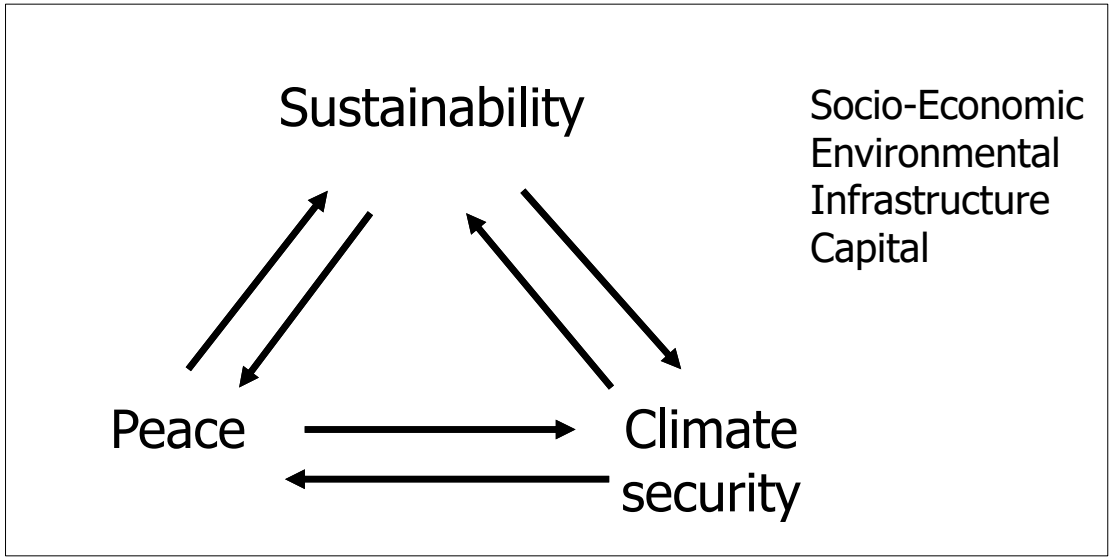
Peace

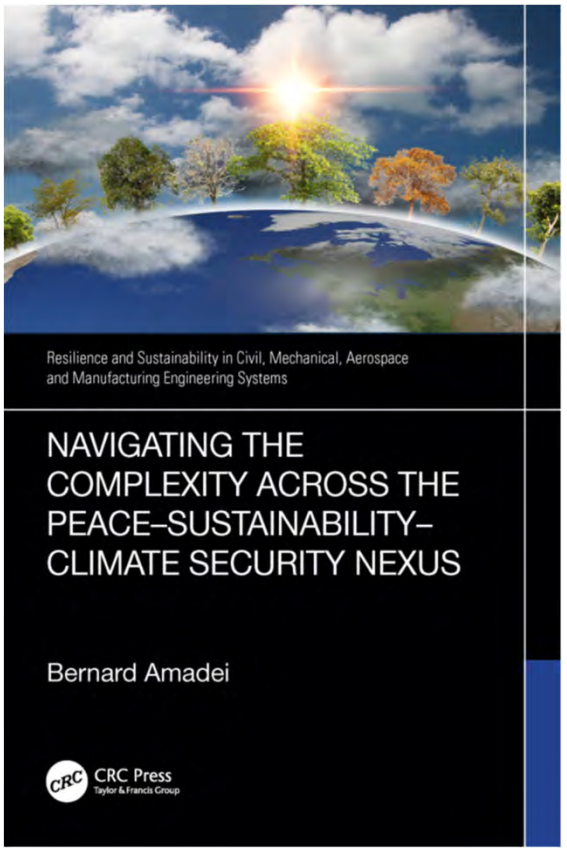


J. Galtung

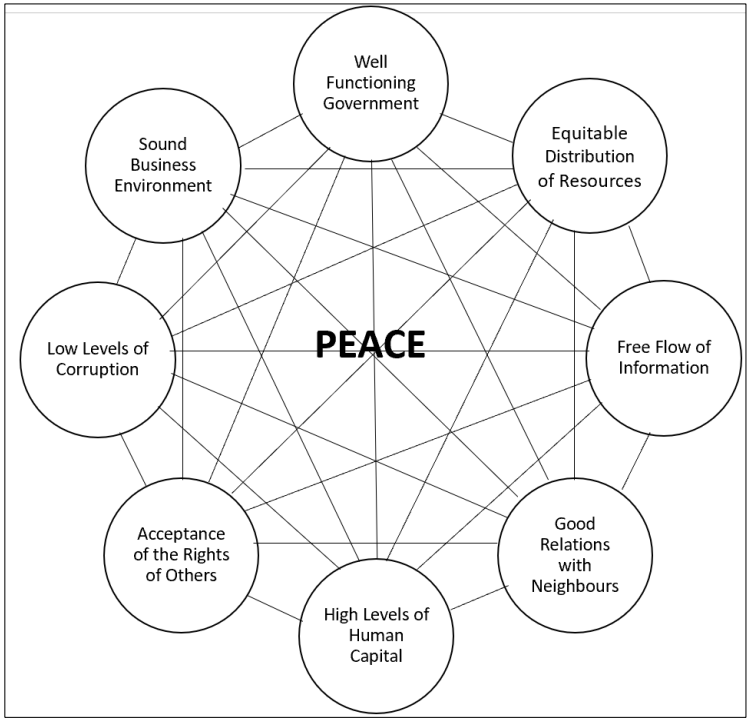
An enabling violent-free state of **dynamic equilibrium** emerging from the right relationships among different populations and their interaction with the various systems in the landscape upon which they depend.

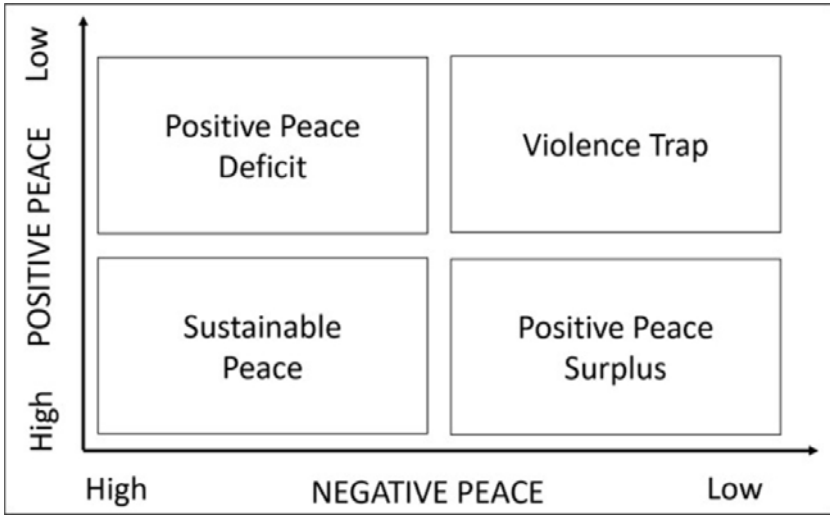
Peace-Sustainability-Climate Security Nexus

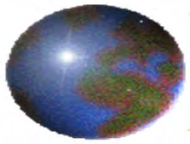




Institute for Economy and Peace







Systems thinking for peacebuilding projects in conflict-affected environments

- Improves our capacity to see systems as wholes and anticipate the consequences of interventions
- Improves impact of our intervention by allowing us to focus on high-leverage points
- Improves our ability to anticipate and manage unpredictability and dynamism
- Requires a local, multi-perspective, participatory, and iterative approach to be effective
- Provides a suitable environment for good policy/decision-making.

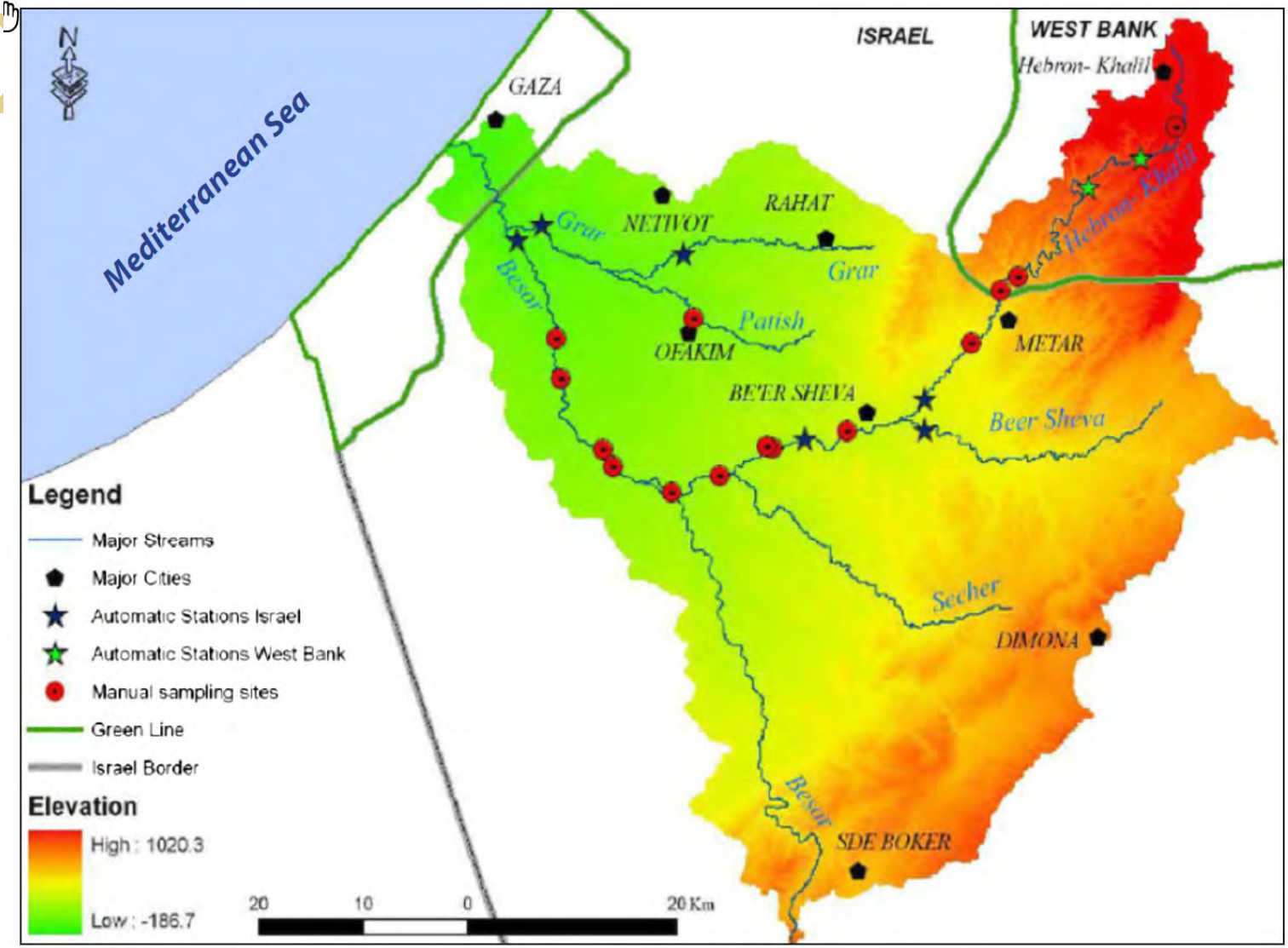
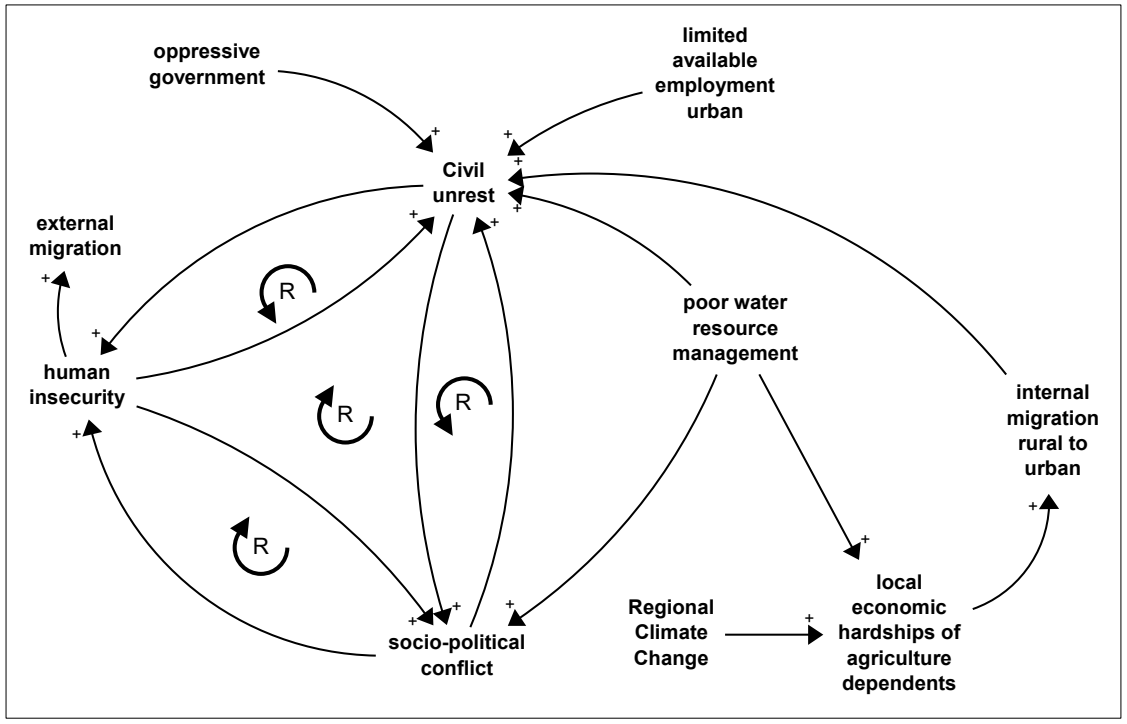
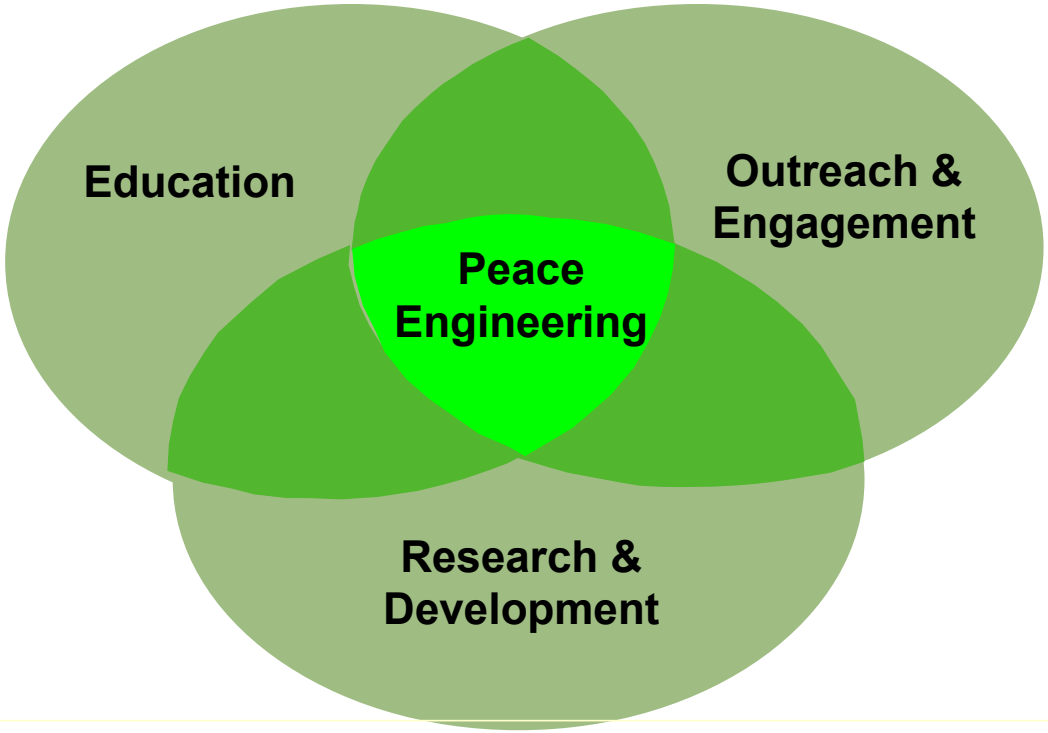
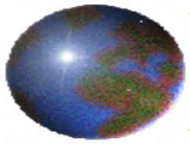


Figure 1. Hebron–Besor-Wadi Gaza Basin Source: Tal et al. 2010

Syrian Conflict 2010-Present




Education
Outreach &
Engagement
Peace
Engineering
Research &
Development



- Engineers contribute to *peacebuilding* by addressing fundamental root causes and drivers of potentially violent social conflicts, reducing barriers to peaceful outcomes, ensuring human security, addressing development issues, and building resilient infrastructure and capacity so that conflicts related to adverse events are less likely to unfold or relapse.

- Engineers contribute to *peacemaking* by collaborating with negotiating and mediating units on stabilization, bringing together different parties to agree and collaborate on joint solutions (technical and non-technical), especially in transboundary or conflict-prone areas.

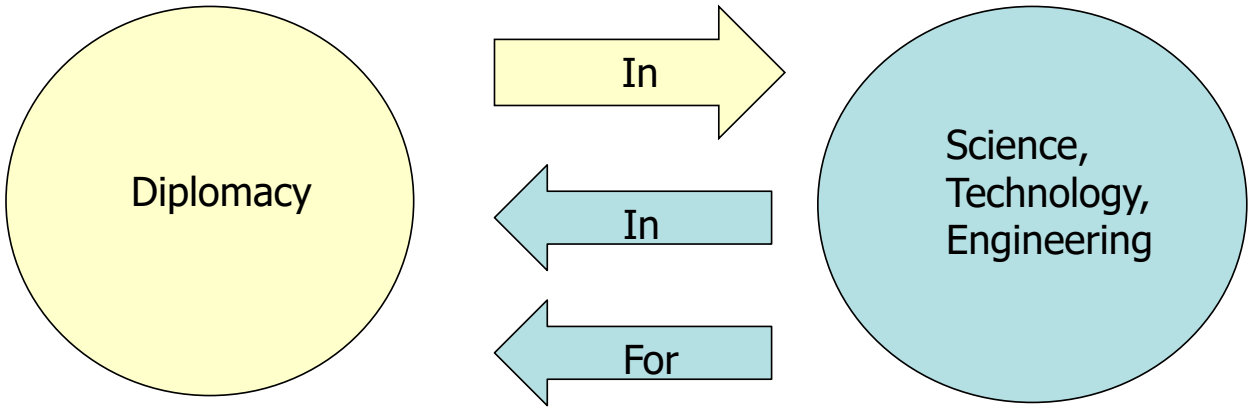
- Engineers contribute to *peacekeeping* by restoring essential community services and capacity, contributing to reconstruction efforts, and being responsible for the sustainable functioning of infrastructure as communities recover from conflict while benefitting from peacekeeping operations over a defined period.

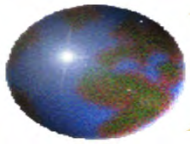
BOK of Peace Engineering

Engineers who are aware of:

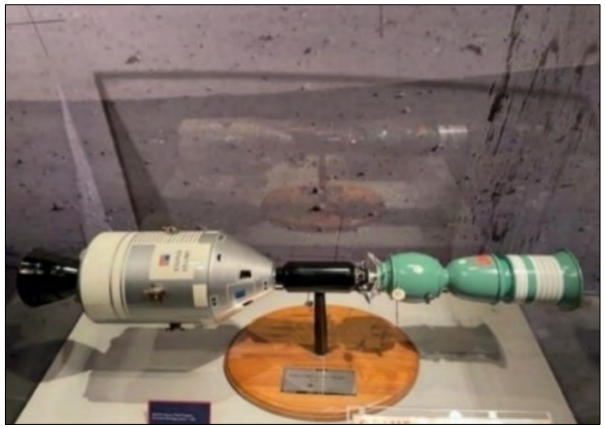
- Different parts of the peacebuilding, peacemaking, and peacekeeping continuum.
- Conflict resolution strategies and technologies
- Peacebuilding technology platforms for conflict detection and prevention.
- Projects and technologies to improve the capacity, resilience, and standard of living in conflict-affected environments
- Measures to foster communication, unity, and confidence among disputing entities.
- Integrated solutions intersecting humanitarian aid, development, and peace.
- Training of communities and local decision-makers in conflict-prone regions to resolve conflicts and promote sustainable development.

Engineering and Diplomacy





Engineering in/for Diplomacy	BOK	Diplomacy in Engineering
• Technical advising • Infrastructure development • Environmental diplomacy • Technical assistance and capacity building for crisis response • Science and technology diplomacy • Peacekeeping missions • International Standards and Regulations • Economic diplomacy • Cybersecurity	• International relations and diplomacy • Policy and governance • Cross-cultural communication • Ethics • International law and regulations • Innovation and technology transfer • Conflict resolution and mediation • International project management	• Negotiations and collaboration • International projects • Cross-cultural negotiations • Environmental and regulatory compliances • Project stakeholder engagements • Conflict resolution • Policy and advocacy • International relations • Ethical issues • International project management



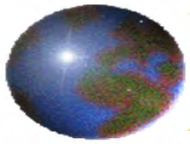
Apollo-Soyuz Moment, June 17, 1975

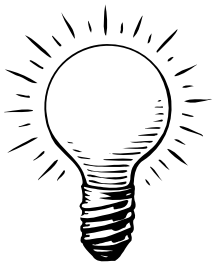
ICIMOD International Centre for Integrated Mountain Development

FOR MOUNTAINS AND PEOPLE

Engineers are responsible not only for the safety, technical, and economic performance of their activities but also have responsibilities to (i) use resources sustainably, (ii) minimize the environmental impact of projects, wastes, and emissions, and (iii) use their influence to ensure that their work brings social benefits which are equitably distributed.

Martin et al. (2005)

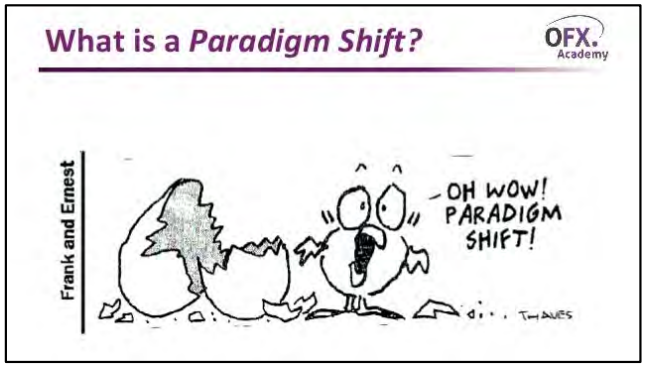


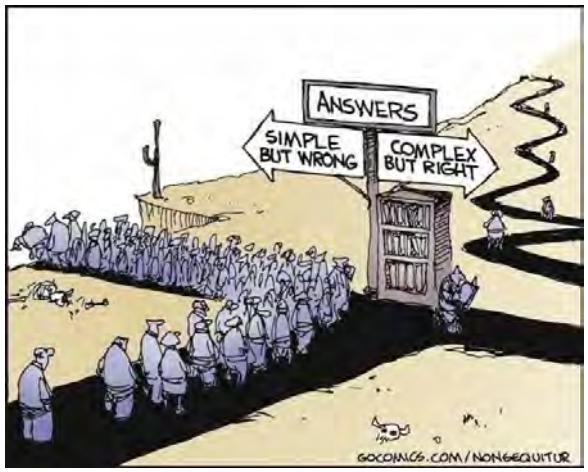


"The significant problems we face today cannot be solved at the same level of thinking we were at when we created them."

Albert Einstein

Contact: amadei@colorado.edu





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