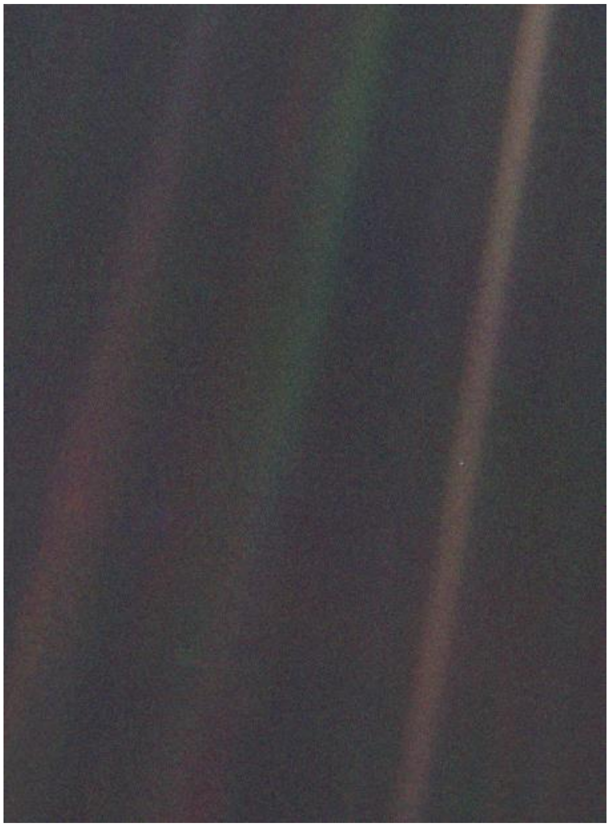
Global Engineering

Global Forum Presentation by Dr. Gang He, Department of Technology and Society

Thank you for inviting me, it's a great pleasure to join such a distinguished panel to discuss global engineering. As Wolf said, I have a background in geography, and geographers like to ask: what scale? Global seems like a big scale compared to our day to day lives, but if we look through the interstellar scale, then our globe is just a "Pale Blue Dot." This image of Earth was taken by the Voyager 1 spacecraft on February 14, 1990, from more than 6 billion kilometers. In the image the Earth is a mere point of light. You can hardly find the Pale Blue Dot. "Look again at that dot. That's here. That's home. That's us. On it everyone you love, everyone you know, everyone you ever heard of, every human being who ever was, lived out their lives" – as Carl Sagan put it nicely. Today, companies like SpaceX are talking about multi-planet species, however, it repeatedly shows the Earth is still the only planet that is livable.



Credit: NASA / JPL
Source: https://photojournal.jpl.nasa.gov/catalog/PIA00452

So, why global engineering? To me, two fundamental goals of human being on the "pale blue dot" – human happiness and earth sustainability – rely on global engineering. Let me talk about human happiness first. Humans need clean energy, clean water, and clean air to survive, this is especially true for the global poorest, and the two unborn billion population, most of who will be in Africa. Here are a few more examples, more inclusive economic development, health in an aging society, and social equity and safety. From an earth sustainability perspective, climate change, cross border pollution, and global biodiversity losses, are cross-border challenges at regional and global scale, and global engineering has a role to play.

Engineers solve problems, that's the strength and beauty of engineering. There are also two fundamental challenges for engineering. First, sometimes we solve a problem without knowing what is the problem. Or more specifically, the causes of the problem. Second, we solve a problem by creating what later turns out to be a bigger problem. The use of DDT is a great example. DDT is very effective to kill pests and mosquitos, but later turned out to be poisonous to our ecosystem as it accumulates through the food chain. Climate change is another. We address the energy shortage problem by burning fossil fuels which are the root of climate change. Electrification is listed as the greatest engineering achievement of 20th century by the National Academy of Engineering,[*] however, the electric power sector contributes about 40 percent of global carbon emissions.

Therefore, "global" in global engineering that we are discussing here shows both the scale and scope of the challenges and the new thinking and practices needed to address those challenges. We used to talk about think globally, but act locally, yes, we still need more of that, at the same time, we need to think and act globally. That's when global engineering really jumps in. Global engineering is engineering for humanity, which cycles back to the starting point of engineering: improve the living quality of human beings, and enable human capacity to continue doing so. Global engineering is also engineering for earth sustainability, which addresses the unintended consequences of human engineering systems.

How can we do global engineering? Here I listed four, no, five "I"s, interdisciplinary, internationalization, integration, innovation, and I, each of us, that is, we. I did not invent those "I"s. C. S. Kiang, Steven Chu, and many other thinkers are talking about those ideas. Global engineering integrating those thoughts is a way to survive and thrive in the grand challenges we face.

I'll give a few examples to share what "I" do? Thanks to my Dean's and Chair's mentoring policy, I'm lucky to have two mentors, and they advise me to promote research at all possible occasions. So, I'm proud to share what I do related to what I have talked about today, briefly.

The first is a class that I have been teaching with colleagues: Grand Challenges in Energy and Environmental Policy. Dr. Gerry Stokes, who is the graduate program director in the Department of Technology and Society, took the lead, and together with Dr. Elizabeth Hewitt, we created this class to give the students both the trees and the forest about the grand challenges we face: climate change, renewable energy, nuclear and proliferation, energy water nexus, urban development, national innovation systems, and so on. We have faculty, and guest speakers with student contributions and field trips, we really hope the students can think big while starting from ground up. This is a nice group picture when we led the class to visit Brookhaven National Laboratory's National Synchrotron Light Source (NSLS) facility in 2016.

---

[*] http://www.greatachievements.org/

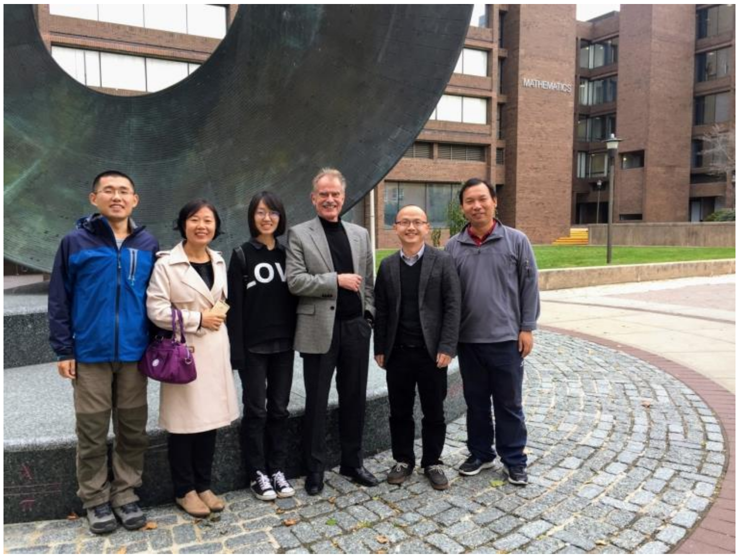
BNL Grand Challenges Class visit, 2016

The second is a project is on Sustainable Energy for All. In 2015, China achieved access to electricity for its entire population—the first of the large emerging and developing countries to achieve that landmark goal that most advanced industrialized countries met decades earlier. I work with Dr. David Victor, and Chinese stakeholders to investigate some key experiences and lessons to be learned from China's successful program to provide electricity for all and work with African and Southeast Asian organizations, to design and implement their programs. Yes, engineering solutions are very important, for example, cheap distributed off-grid technologies. However, there is also an emphasis on the political, economic, and institutional aspects to make the technologies work. I was invited to share this work in EIA Energy Conference 2017, DOE's flagship conference, and the IAEE International Energy Conference.

The third one is some work on the frontiers of energy, water, air, and human health. Global clean power transition faces two significant hurdles: increasing penetration of variable renewable energy resources (VERs) while achieving system flexibility and reliability; and the energy-X nexus challenge, X including the water stress, air pollution, and human health impacts of power generation. Current research often addresses the two challenges independently, and often focuses more specifically on carbon and climate in the energy-X nexus discussion. This project develops an integrative modeling tool to study the energy-X nexus and explore how we can make decisions under multiple resource and environmental constraints.

Another example is the visiting scholars program that I have initiated and hosted. By 2018, it has brought eight visiting scholars to our department. They are from interdisciplinary backgrounds, such as economics, environmental sciences, systems, and so on. In addition to their innovative work, they come to Stony Brook, which enriches the academic and cultural exchanges, creates networking opportunities and sparks international collaborations. This program would be impossible without the support of the Chair and the amazing staff both in my department and in Visa and Immigration Service (VIS).

Visiting Scholars 2016-2017. From left: Jingxuan Hui, Dr. Hongtao Bai, Dr. David Ferguson (DTS Chair), I, Junfeng Zhang, and Dr. Qian Sun



Visiting Scholars 2017-2018. From left: Yunfei Du, Dr. Yanmei Li, Dan Nie, Dr. Wolf Schafer (DTS Chair), I, and Dr. Tao Zhang

These are just some examples of my work related to global engineering. If you are interested, I'm very happy to talk more. I'm lucky to be surrounded by wonderful colleagues who are doing incredible work on energy transition, waste management, urban development, big data, AI, data for sustainability, leadership, human-computer interface, and engineering education. Those few examples illustrate the unique role of our department, the Department of Technology and Society, that bridges engineering and humanity, and enables engineering for social good.

With that, thank you and I’m happy to join the panel discussion.

Related publications:

Gang He, Anne-Perrine Avrin, James H. Nelson, Josiah Johnston, Ana Mileva, Jianwei Tian, and Daniel M. Kammen. 2016. SWITCH-China: A Systems Approach to Decarbonizing China’s Power System. *Environmental Science and Technology*. 50(11):5467-5473. doi: 10.1021/acs.est.6b01345.

Jianlin Hu, Lin Huang, Mindong Chen, Gang He, Hongliang Zhang. 2017. Impacts of Power Generation on Air Quality in China - Part II: Future Scenarios. *Resources, Conservation and Recycling*. 121:115-127. doi:10.1016/j.resconrec.2016.04.011

Gang He, Daniel M. Kammen. 2016. Where, when and how much solar is available? A provincial-scale solar resource assessment for China. *Renewable Energy*. 85:74-82. doi: 10.1016/j.renene.2015.06.027.

Gang He, Daniel M. Kammen. 2014. Where, when and how much wind is available? A provincial-scale wind resource assessment for China. *Energy Policy*. 74:116-122. doi: 10.1016/j.enpol.2014.07.003.

Gang He, David Victor. 2017. Experiences and lessons from China's success in providing electricity for all. *Resources, Conservation and Recycling*. 122:335-338. doi:10.1016/j.resconrec.2017.03.011