



東京工業大学
Tokyo Institute of Technology

Ethics in Engineering

Week 1: Why Is Engineering Ethics a Current Focus of Attention?

Hypothetical Case Study

- You are an engineer for a company that has received a contract regarding a structural design for a high-rise building. This building will be constructed in the central part of the capital of Country A. According to the construction standards of Country A, you need only consider the influence of the wind as it blows directly on the front side of the building. Your team has created a design that would fully satisfy the requisite standards, and the owner is pleased with such design.

Hypothetical Case Study

- When the construction is about to commence, you, who returned to your home country, discover that an enormous typhoon is slated to occur in areas surrounding Country A of a magnitude that only takes place once every 1000 years. Therefore, you calculate the maximum wind speed of this large typhoon that could potentially hit the building. As a result, you noticed that there would be no problem in the case of the wind aimed at the front of the structure, however, it is possible that the building would collapse if the wind were to impact the building at an oblique angle.

Hypothetical Case Study

- You report your findings to your boss and attempt to convince him to change the structural design of the building. However, your boss does not listen to you based on the assertion that “our design has satisfied the laws and regulations of Country A, and there is no need to change the design to prepare for the probability of something that might occur only once every 1000 years.”
- What would you do if you were the engineer?

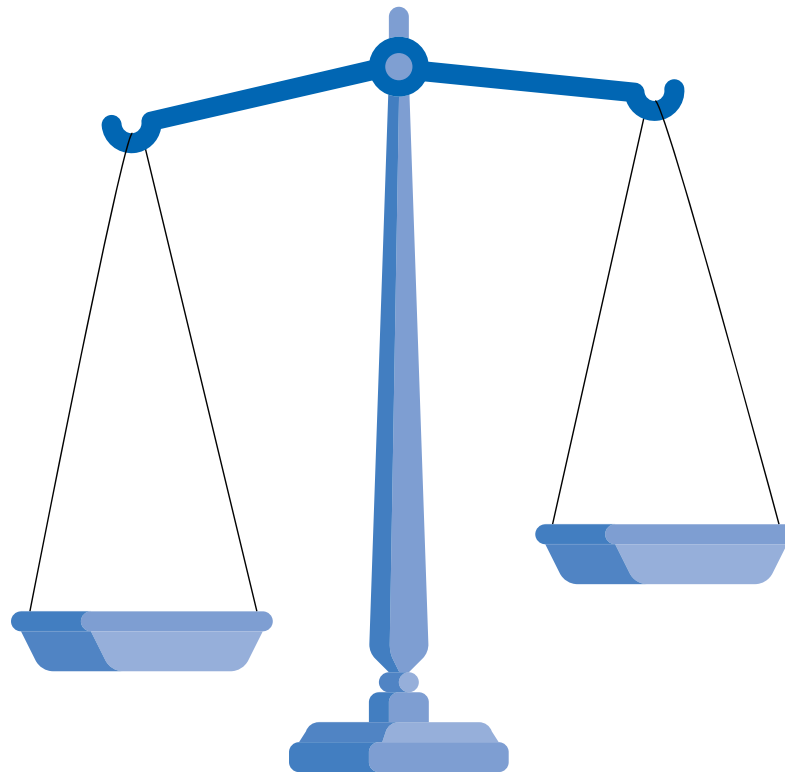


Yanosuke Hirai
(1902-1986)

"Matsunaga Yasuzaemon (migi) to tomoni" by [Zsefvgyi](#) is licensed under [CC BY-SA 3.0](#)
[https://commons.wikimedia.org/wiki/File:Matsunaga_Yasuzaemon_\(migi\)_to_tomoni.jpg](https://commons.wikimedia.org/wiki/File:Matsunaga_Yasuzaemon_(migi)_to_tomoni.jpg)

Important Balance of Values

- Social Contribution
- Advancement of expertise
- Organizational development
- Loyalty
- Facts
- Environment



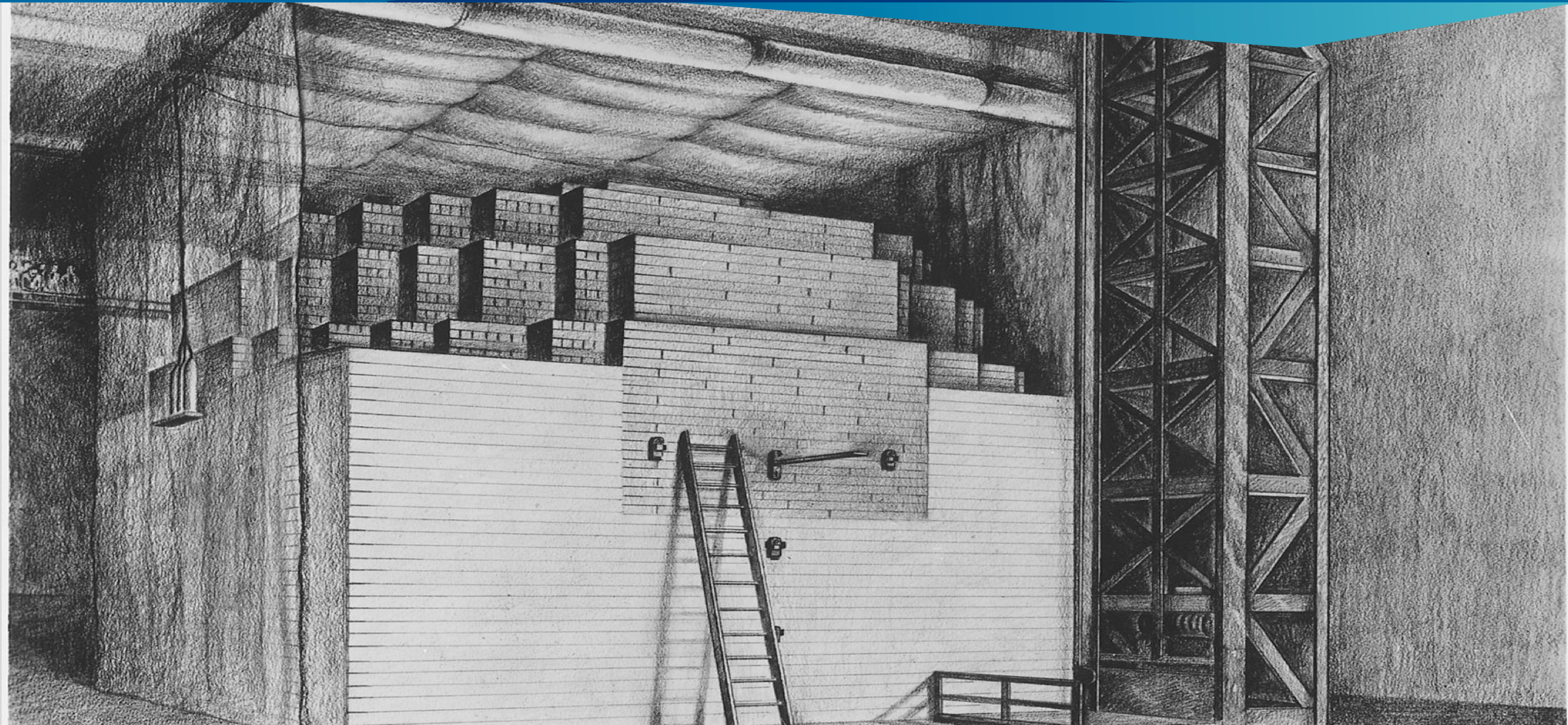
- Safety
- Information transparency
- Compliance
- Faithfulness
- Cost
- Technological innovation

Four Levels of Engineering Ethics

Levels	Targets
Meta	Substance of science/technology
Macro	Relationship between science/technology and society
Meso	Organizations and systems relating to science/technology and the relationship between same and individuals
Micro	Individuals (i.e., scientists and engineers) and their behaviors

Dates of Drastic Changes in Science and Technology in Relation to Society

- December 2, 1942
- September 11, 2001
- June 13, 2010
- March 11, 2011



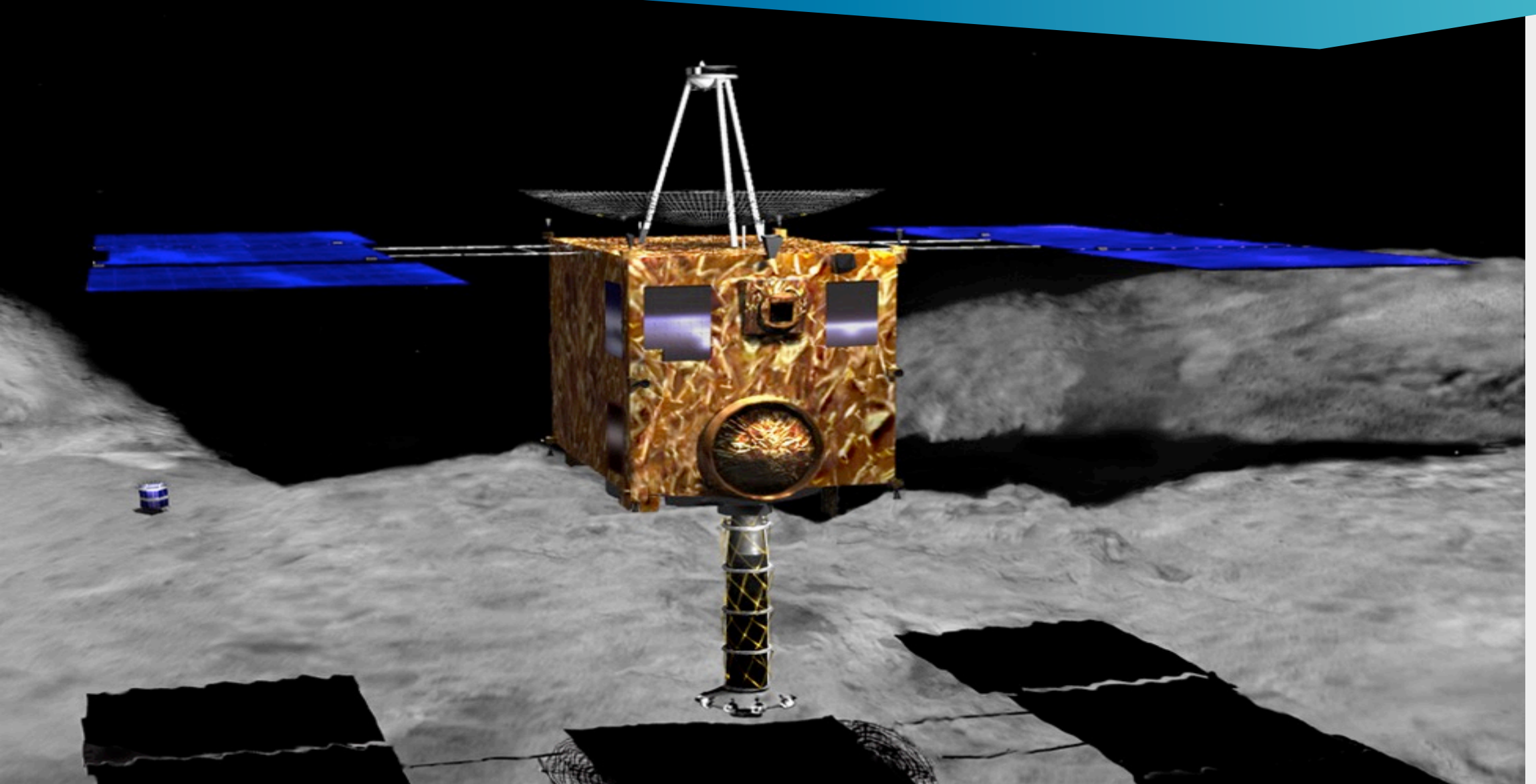
December 2, 1942
Control of nuclear fission, chain reaction

"Stagg Field reactor" by Melvin A. Miller of the Argonne National Laboratory https://commons.wikimedia.org/wiki/File:Stagg_Field_reactor.jpg



September 11, 2001 terrorist attacks in the United States

"WTC smoking on 9-11" by [Michael Foran](#) is licensed under [CC BY 2.0](#)
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June 13, 2010
Japan's Hayabusa Asteroid Probe comes back to Earth

"Hayabusa hover" is by [JGarry at English Wikipedia](https://commons.wikimedia.org/wiki/File:Hayabusa_hover.jpg)
https://commons.wikimedia.org/wiki/File:Hayabusa_hover.jpg



March 11, 2011
Great East Japan Earthquake and Fukushima Daiichi
Nuclear Power Plant accident

"US Navy 110318-M-HU778-007 An aerial view of Minato, Japan, a week after a 9.0 magnitude earthquake and subsequent tsunami devastated the area"
by U.S. Marine Corps photo by Lance Cpl. Ethan Johnson.

https://commons.wikimedia.org/wiki/File:US_Navy_110318-M-HU778-007_An_aerial_view_of_Minato,_Japan,_a_week_after_a_9.0_magnitude_earthquake_and_subsequent_tsunami_devastated_the_area.jpg

Impacts of Science and Technology on Society

This era of science and technology is having a broad and profound influence on human society.

This is an era in which decisions made by specialists and organizations involved in science and technology can have enormous influence on **society and the environment**.

The **responsibilities and ethics** of engineers are being questioned.

Fudano's Principles for Ethical Issues

When you face ethical issues, consider the following concepts:



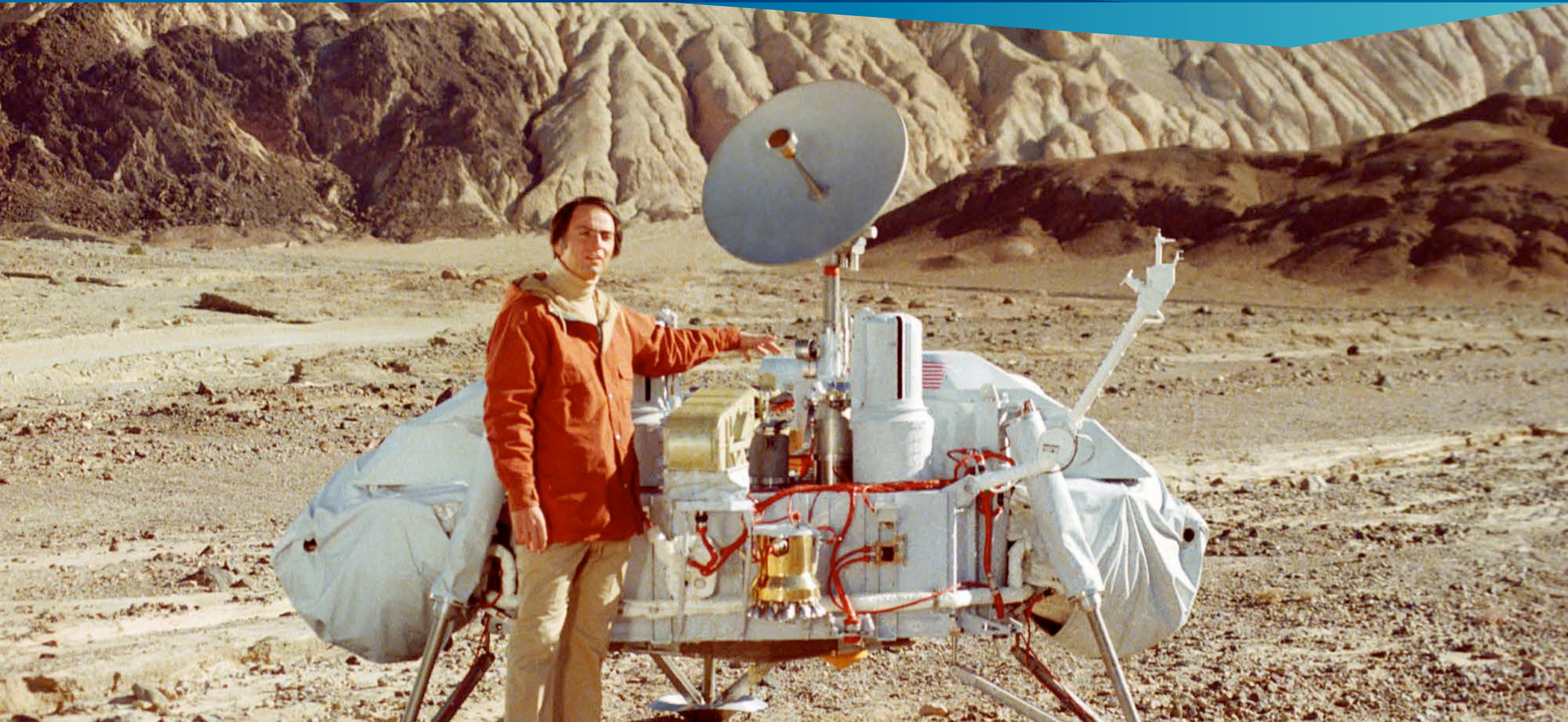
Timeframe



Space



Social Relationship

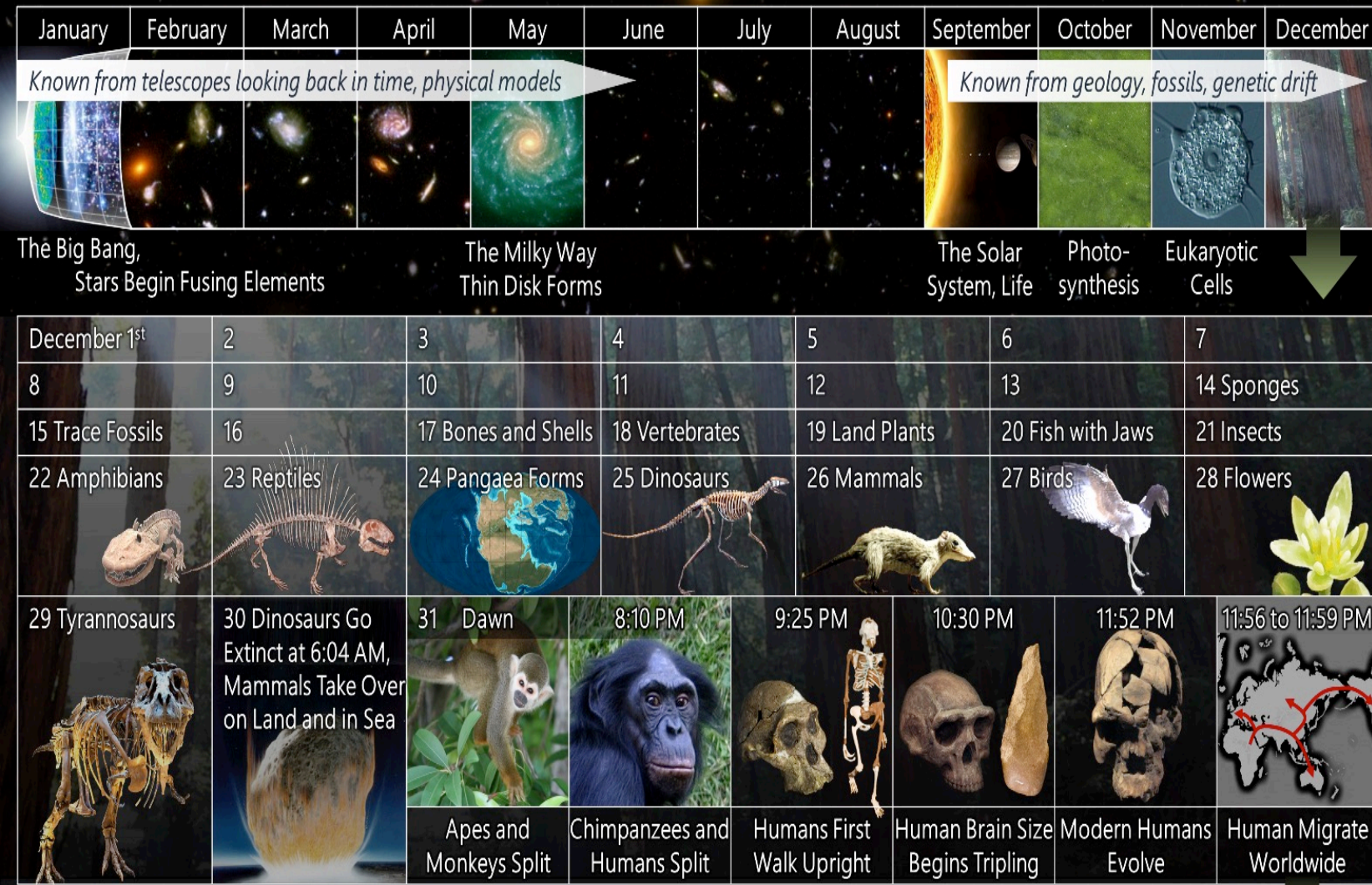


Carl Edward Sagan

"Sagan Viking" by JPL
https://commons.wikimedia.org/wiki/File:Sagan_Viking.jpg

The Cosmic Calendar

The 13.8 billion year history of the universe scaled down to a single year, where the Big Bang is January 1st at midnight, and right now is midnight 1 year later

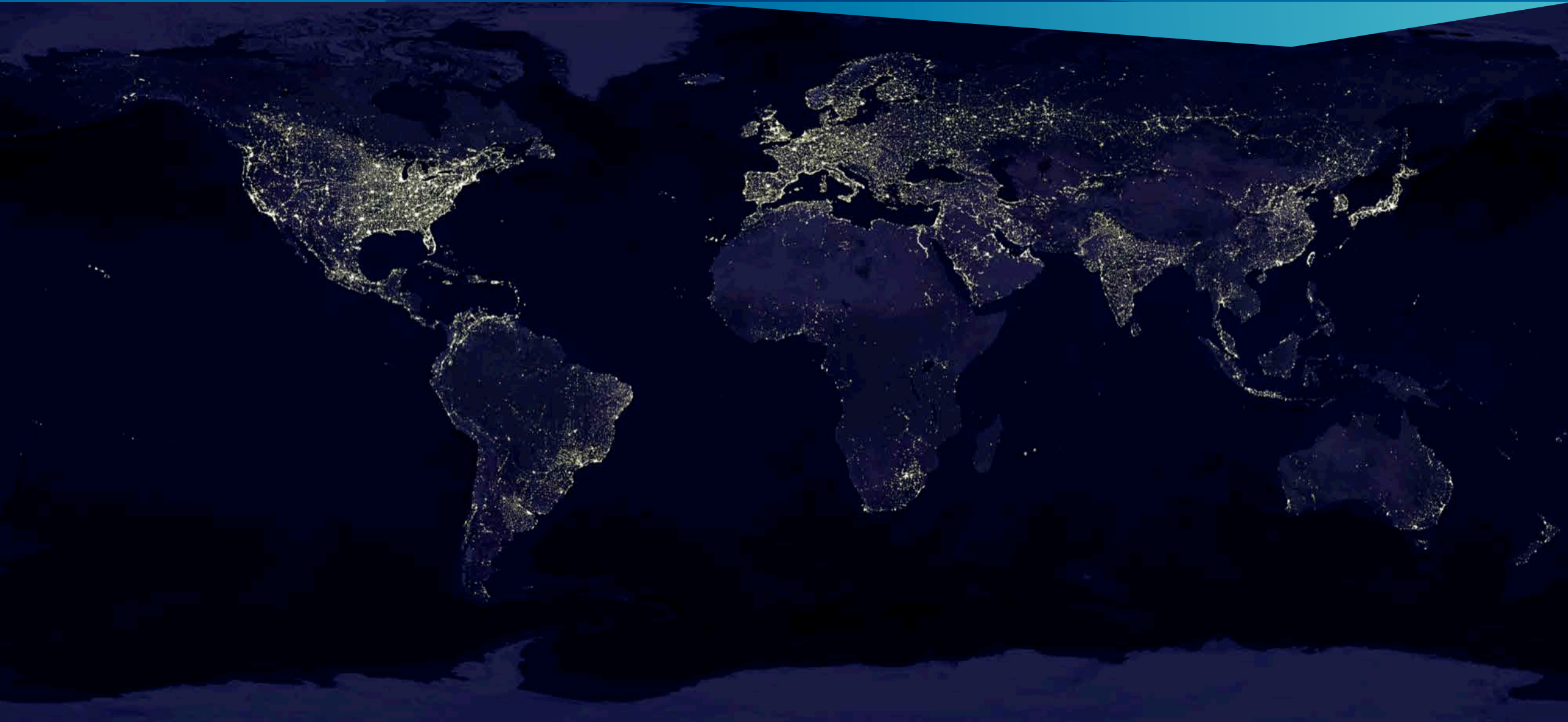


- January 1: Big Bang
- September 9: Birth of the solar system
- September 14: Formation of the Earth
- September 25: Birth of life
- December 31 at 10:30 p.m.: Emergence of humanity
- December 31 at 11:59:56 p.m.: Greek philosophy
- December 31 at 11:59:59 p.m.: Birth of modern science

Cosmic Calendar - Carl Edward Sagan
13.5 billion years compressed into a single calendar year

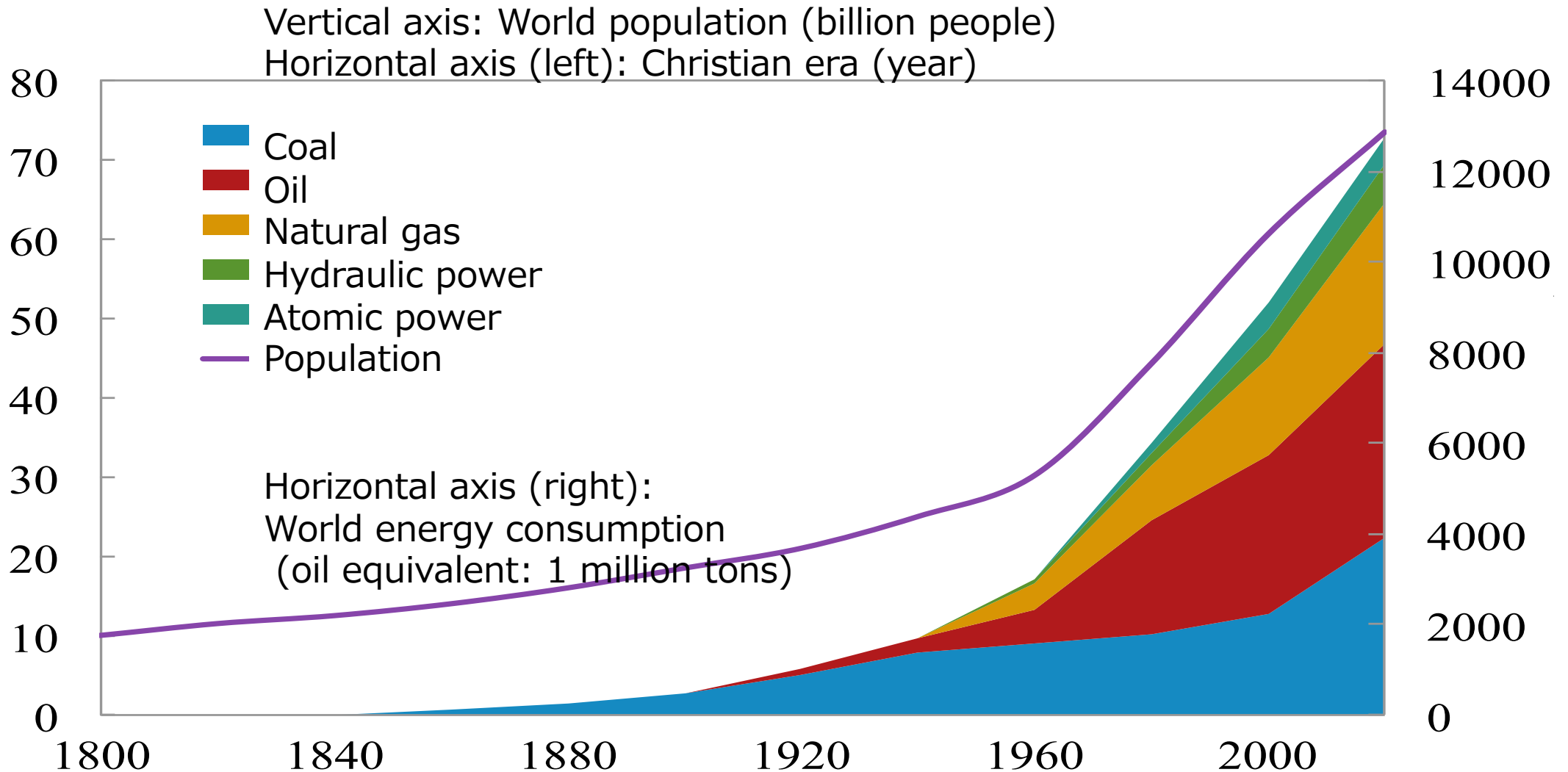
20 Great Achievements by Engineers during the 20th Century

1. Electrification
2. Automobiles
3. Airplanes
4. Water supply and distribution
5. Electronics
6. Radio and television
7. Agricultural mechanization
8. Computers
9. Telephones
10. Air-conditioning and refrigeration
11. Highways
12. Spacecraft
13. The Internet
14. Imaging technology
15. Household appliances
16. Medical and health technologies
17. Petroleum and petrochemical technologies
18. Laser and fiber optics
19. Nuclear technology
20. High-performance materials



Earth's city lights as viewed from space

http://eoimages.gsfc.nasa.gov/images/imagerecords/55000/55167/earth_lights_lrg.jpg



Human Achievements Represented as a Quarter of a Second

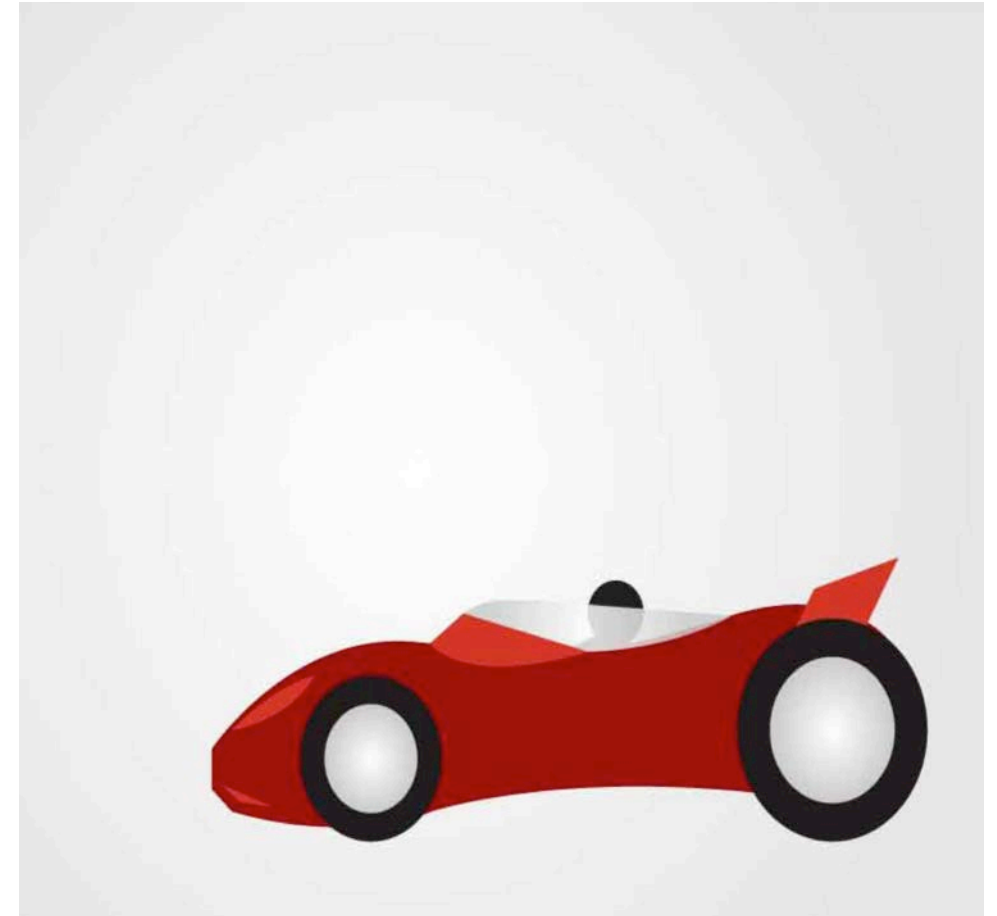
Source: State of World Population, data from the Ministry of Economy, Trade and Industry (Ministry of International Trade and Industry) and others.

Can humanity fully utilize the advancements of science and technology?

There have been many important human achievements over the last 100 years (a blip of only 0.25 seconds on the compressed cosmic calendar).



What will the future bring?



Four Levels of Engineering Ethics

Levels	Targets
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21st Century Engineers: Ethics

Engineering competencies

Internationally available engineers

Local training and global practice

- International mutual approval of engineering education equivalent
Washington Accord (1989)
- International mutual approval of engineering qualification
CPD (Continuing Professional Development: training for continuing professional development for specialists)

Engineering in a Fast-changing World

Engineering responsibilities will be expanded, the quantity of information will sharply increase, and opportunities for engineers will spread throughout the world.



A new image of engineering is emerging.



There is a need to reform engineering education.

Necessity of Internationally Available Engineers

International mutual approval of a substantial equivalent for engineering education

- Washington Accord (with a central focus on English-speaking countries, 1989)
- The “Eug Ing” European Federation of National Engineering Associations (1993)
- Quality assurance for trade in services (WTO) (1995)
- APEC Engineer (creation of system for 1995 through 1997)
- International strategies of ABET (evaluation of engineer education programs outside the US)

IEA: Required Qualifications and Abilities for Graduates of Engineering Departments

1. Knowledge of engineering
2. Problem analysis
3. Designing and developing of solutions
4. Investigation
5. Use of the newest tools
6. Engineers and society
7. Environment and sustainability
8. Ethics
9. Individual activities and teamwork
10. Communication
11. Project management and finance
12. Continuing education and lifelong learning

6. Engineers and society

7. Environment and sustainability

8. Ethics

- Evaluate problems regarding society, health and safety, law, and culture arising from engineering activities and responsibilities for the best results using inferences based on associated knowledge.
- Apply fundamental ethical principles, observe ethical developments as a specialist, carry out relevant responsibilities, and comply with the proper codes of behavior for engineers.
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Micro Level: Recent Incidents in Japan (Individuals and Organizations Involved in Science and Technology)

- **Tokyo Subway Sarin attack**
- **Sodium leak at the Monju fast-breeder reactor**
- **JCO Tokaimura criticality accident (1999)**
- Concealed knowledge of recalls at Mitsubishi Motors
- Yukijirushi food label replacement scandal
- TEPCO (Hitachi) issue
- Scandal of concealment of recalls by Mitsubishi Fuso Truck and Bus Corporation
- Pipe rupture accident in the secondary system of Unit 3 of the Mihama Power Station
- Falsification of data by Kansai Electric Power Co.
- Falsification of drainage data by JFE Steel Corporation
- JR Fukuchiyama line train derailment accident
- Falsified quake-resistance data for condominium designs
- Paloma gas water heater accident
- Electric power company concealment scandal
- Fukushima Daiichi Nuclear Power Station accident
- Asahi Kasei Construction Materials Corporation piling data fabrication scandal

Two Aspects of Ethics

What should be done	What should not be done
Aspirational Ethics	Preventive Ethics
Positive ethics	Negative ethics
“Extroversion-oriented” ethics	“Introversion-oriented” ethics
Emotionally positive ethics	Emotionally negative ethics

NAE Grand Challenges for Engineering



Advance Personalized Learning



Make Solar Energy Economical



Enhance Virtual Reality



Reverse-Engineer the Brain



Engineer Better Medicines



Advance Health Informatics



Restore and Improve Urban Infrastructure

NAE Grand Challenges for Engineering



Secure Cyberspace



Provide Access to Clean Water



Provide Energy from Fusion



Prevent Nuclear Terror



Manage the Nitrogen Cycle



Develop Carbon Sequestration Methods



Engineer the Tools of Scientific Discovery