SCIENTIFIC CONTROVERSIES

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Controversies over the Impact of Science on Society

- Many of the controversies over science and society that dominate today

– such as **global warming, sustainable energy, environmental degradation, and biomedical interventions into life**

– have their roots in earlier debates in the 1960s.

- The Vietnam War protests, the emergence of the counterculture, and the civil rights movement, formed part of a wider backdrop against which science and technology increasingly came into question.

GLOBAL WARMING

- Global warming is the long-term warming of the planet's overall temperature.
- Though this warming trend has been going on for a long time, its pace has significantly increased in the last hundred years due to the burning of fossil fuels.
- As the human population has increased, so has the volume of fossil fuels burned.
- Fossil fuels include coal, oil, and natural gas, and burning them causes what is known as the "greenhouse effect" in Earth's atmosphere.

- The greenhouse effect is when the Sun’s rays penetrate the atmosphere, but when that heat is reflected off the surface cannot escape back into space.
- Gases produced by the burning of fossil fuels prevent the heat from leaving the atmosphere.
- These greenhouse gasses are carbon dioxide, chlorofluorocarbons, water vapor, methane, and nitrous oxide.
- The excess heat in the atmosphere has caused the average global temperature to rise overtime, otherwise known as global warming.

- Global warming has presented another issue called climate change. Sometimes these phrases are used interchangeably, however, they are different.
- Climate change refers to changes in weather patterns and growing seasons around the world.
- It also refers to sea level rise caused by the expansion of warmer seas and melting ice sheets and glaciers.
- Global warming causes climate change, which poses a serious threat to life on earth in the forms of widespread flooding and extreme weather.
- Scientists continue to study global warming and its impact on Earth.

RENEWABLE AND SUSTAINABLE ENERGY

- The words "sustainable" and "renewable" are often used to describe certain sources of primary energy, often interchangeably.
- However, these words have very different meanings. Not everything renewable is sustainable, and in turn not everything which is sustainable is necessarily renewable.
- Literally 'to make new again', a renewable resource is one that is naturally replenished with time, like the growth of new organisms or natural recycling of materials.
- Renewable energy is any energy production which uses one of these resources.
- Renewable resources do not have a fixed quantity

- more can always be generated.

- However, if the rate of use exceeds the rate of renewal

- that is, the source is used more than it's being recreated

- its continued use will become unsustainable.

- Generally, renewable energy is taken to mean any of the following:
- Solar power
- Wind power
- Hydropower
- Tidal power
- Geothermal power
- Resources are considered non-renewable if they take a very long time to be created (e.g. fossil fuels) or if their creation happened long ago and is not likely to happen again (e.g. uranium). Primary energy flows are almost always renewable. On the other hand, biofuels are renewable and definitely count as fuels.

SUSTAINABLE ENERGY

- Literally, that which can be maintained for a definable period of time, sustainable energy is energy production that can last for the foreseeable future.
- Sustainable energy practices must rely on resources which can continue to supply our needs.
- These sources must be used cautiously so that they will not be used up, run out, or otherwise become unusable.

- Even renewable resources can become unsustainable. If a resource is used up faster than it can regenerate, it will eventually be entirely depleted despite its renewability.
- Conversely, a non-renewable resource can be sustainable if it's used in moderation. Again, if used without caution, these too may become be depleted in a short time.
- For most people sustainable energy use means that the environment is not significantly damaged due to accumulated effects of an energy practice. This part of the definition of sustainable energy is quite politically charged with widely varying opinions.
- Often advocates for fossil fuels will claim that coal, oil and natural gas are sustainable because the reserves for these are so large, discounting the problems with climate change

MONEY METAPHOR

- A good way of understanding the difference between "sustainable" and "renewable" is to put it in context of monetary income.
- If energy were money, a renewable source of income is one that would recur, like a pay cheque, while a non-renewable source would be non-repeating, like receiving an inheritance.
- A sustainable source of money might be one that could fund a desired standard of living for an extended period of time, while a non-sustainable source of income would be small and quickly used up.

- Sustainability is not a black and white issue.
- Just as a source of income (renewable or not) may become less sustainable when supporting a larger family or for a higher standard of living, energy sources become less sustainable with increased energy use due to world growth in population and, in fact, standard of living.
- Differing values and perspectives lead people to having different views as to when a primary energy source is or is not sustainable.

ENVIRONMENTAL DEGRADATION

- Environmental degradation is the deterioration (causing degenerative harm) of the environment through exhaustion of natural assets such as water, soil, and air including the ecosystem, habitat intrusion, wildlife extermination, and environmental pollution.
- It is an apparent change in the environment deemed undesirable or pernicious.
- Environmental degradation has captured the attention of the globe and necessary actions and policies have been established to control the state of affairs.
- An increase in population over the years has led to rapid economic growth through utilization of resource-depleting activities and pollution technology.
- The general efforts applied to counteract this menace is environmental management and protection.

CAUSES OF ENVIRONMENTAL DEGRADATION

- There are multiple ways in which environmental degradation takes place.
- Pollution is unquestionably one of the primary reasons.
- There are four leading causes; **water, air, land, and noise**.
- Water pollution contaminates drinking water, air pollution pollutes the air we breathe and poses a health risk, while land pollution degrades the earth's surface.
- Noise pollution causes damage to the ears and impairs hearing.

- Overpopulation is most definitely a cause of environmental degradation.
- Improved healthcare systems have increased the lifespan of human beings hence resulting in overcrowding.
- An increase in population means a parallel rise in basic needs.
- That means more land for settlement and farming which results in deforestation, which is a factor leading to environmental degradation.
- Reduced forest cover results in an elevated level of carbon in the atmosphere and causes global warming.

- Land disturbance or damage is another cause since sprouting and spreading of weedy plant species eliminates the typical greenery.
- Landfills are disposal points for solid waste, especially in urban areas. They pollute the environment and deteriorate the surroundings.
- Other natural calamities such as earthquakes, storms, tidal waves, and wildfires also play a role in environmental degradation.

EFFECTS OF ENVIRONMENTAL DEGRADATION

- The deterioration of the environment has led to several adverse impacts.
- First, humans are at risk of suffering from dangerous health conditions like, for example, asthma and pneumonia due to air pollution.
- Another adverse effect is the loss of biodiversity. Environmental degradation might also lead to the depletion of the ozone layer which is responsible for protection against ultraviolet rays of the sun.
- Last but not least, a significant negative impact of environmental degradation is an economic downfall. For instance, a highly deteriorated environment attracts less or no tourists.

- In conclusion, the environment is the ultimate reason for the survival of humankind.
- Several interventions have to be put in place for use by members of the public to protect and sustain the natural environment.
- Environmental education and policy-making regarding environmental conservation and protection will be useful for natural environment.
- The world is making impressive strides in trying to minimize damage to the environment although a lot needs to be put into consideration (that is, population growth and urban development).

BIOMEDICAL INTERVENTIONS

- The term “biomedical” is a general term that combines the words “biological” and “medical”.
- The general interpretation of biomedical medicine is the branch of medicine that deals with genetics, biochemistry and how all the different body systems interact in both health and disease.
- Basically to help understand the underlying cause of a disease or disorder, and guide treatment and prevention.
- Biomedical interventions optimize the way the body functions, through nutrition, the complex chemical processes in the body, immune function, digestive function, detoxification, etc.

- As on the outside we all look different, on the inside we are also all different genetically and biochemically.
- Identifying those unique differences, and what has gone wrong, is the goal of biomedical interventions.
- To gain a clear picture of what may be causing an individuals underlying issues, requires a collection of data gathered from multiple sources, including:

- A persons genetic predisposition and possible gene - environment interactions.

- A comprehensive medical and symptom history is obtained so that one can see which body systems may be involved and need to be investigated further, or supported through nutritional or other interventions.
- Pathology testing, including routine pathology testing as well as more specific testing that may require more comprehensive tests to identify nutritional deficiencies, gastrointestinal dysfunction, immune deficiencies, neurotransmitter imbalances, etc.

- Biomedical intervention goals are:
- To identify and treat the full range of underlying medical conditions and deficiencies to achieve optimal health rather than just functional health.
- To maximize both safety and efficacy - this requires careful consideration of the risks and potential benefits associated with any treatment.

MISTAKES AND DISASTERS

- **The crash of NASA's Genesis probe**
- *The mistake:* A pair of parts were installed backwards
- *Estimated cost:* Over $260 million
- *What happened:* Genesis was a NASA probe meant to bring back space material from beyond Earth's moon. But its September 2004 landing, three years after takeoff, didn't go all that smoothly.
- The probe, carrying samples of solar wind to return to Earth for analysis, crashed in Utah; the resulting tumble to Earth contaminated many of the probe's precious samples, though some were recovered.
- A NASA report released in 2009 said that Lockheed Martin workers had inverted the position of the probe's accelerometers; the craft never knew it was decelerating into the Earth's atmosphere, and therefore never deployed its parachute.

THE EXPLOSION OF THE SPACE SHUTTLE CHALLENGER

- *The mistake:* An "O-ring" gasket failed in unexpectedly cold weather
- *Estimated cost:* $5.5 billion
- *What happened:* On January 28, 1986, NASA and the world watched in horror as the Space Shuttle Challenger exploded, just 73 seconds into its flight. The entire crew — Michael J. Smith, Dick Scobee, Ronald McNair, Ellison Onizuka, Christa McAuliffe, Gregory Jarvis, and Judith Resnik — perished.
- The problem, NASA eventually discovered, lay in Challenger's O-rings, components in the shuttle's solid rocket boosters that can normally withstand tens of thousands of pounds per square inch of pressure.
- However, these O-rings weren't designed to operate at low temperatures, and the morning of the Challenger launch was unusually cold.
- The O-ring seal failed at launch, was quickly resealed by aluminum oxides coming from the rocket, and was torn apart seconds later by strong winds, resulting in the explosion.

THE Y2K FIASCO

- *The mistake:* Programmers allotted just two digits to register years, failing to anticipate the turn of the century
- *Estimated cost:* $308 billion
- *What happened:* Also known as the Millennium Bug, the Y2K problem was the result of early computer programmers deciding to use two-digit years for data instead of four digits — making data systems unable to distinguish the year 1900 from 2000.
- As the year '00' approached, press reports hyped up the prospect of worldwide doom, forecasting ravaged computer systems around the world. Most companies were able to fix the problem before the deadline, except for a few places like the U.S. Naval Observatory, where the clock temporarily displayed the incorrect date.
- But these preventative fixes, across all the world's computer systems, was costly: In November 1999, the U.S. Department of Commerce reported that the total cost of remediation in the U.S. was around $100 billion; by 2006, that number had risen another $34 billion. Worldwide, the cost is believed to be around $308 billion.

THE MARS CLIMATE ORBITER-LOST

- *The mistake:* Some engineers used feet; others used meters
- *Estimated cost:* $125 million
- *What happened:* The Mars Climate Orbiter was a satellite meant to collect data on Mars for two Earth years (about one Martian year) and act as a relay station for data from the Mars Polar Lander.
- Launched in December 1998, the Orbiter was set to arrive at the Red Planet later the next year. But on September 23, 1999, NASA announced the orbiter was lost.
- An investigation revealed the loss was due to confusion in mathematical units: While one team working on the spacecraft had used standard U.S. measurements, like feet, the other team had used the metric system.
- "The problem here was not the error, it was the failure of NASA's systems engineering, and the checks and balances in our processes, to detect the error. That's why we lost the spacecraft," Dr. Edward Weiler, NASA's Associate Administrator for Space Science said in a statement at the time.

HUBBLE'S VISION ISSUE

- *The mistake:* The Hubble telescope's main mirror was ground down just 2 microns (one-fiftieth the thickness of a human hair) too far, resulting in blurry vision
- *Estimated cost:* $1.5 billion for a trip to space to repair it (estimated cost of one Space Shuttle launch)
- *What happened:* Soon after the Hubble Space Telescope settled into orbit in 1990, scientists were distressed to find that the images it was sending back were of much lower quality than expected.
- Turns out the telescope's primary mirror had been ground down just a little too far — towards its edge, the mirror was too flat by just 2 microns — causing light reflecting off the edge of Hubble's mirror to focus at a different point from light bouncing off closer to the center.
- In 1993, a repair crew took a shuttle flight up to install what basically amounted to eyeglasses for Hubble's unfocused gaze: two mirrors specially designed to correct the aberration caused by the flaw, as well as other correction devices for other components.

Ariane 5 Rocket self-destructs

- *The mistake:* An old piece of software code couldn't store an unexpectedly large integer, triggering a self-destruct
- *Estimated cost:* $370-500 million
- What happened: The European Space Agency's Ariane 5 rocket was designed to vault Europe to the head of space exploration and industry, though its guidance system was running some of the same computer code as its older and slower sibling, Ariane 4.
- At 36.7 seconds into the launch, the guidance computer routinely attempted to convert the sideways velocity of the rocket from a 64-bit "floating point" format to 16-bit "signed integer" format.
- But in this case — with Ariane 5's faster rocket — the velocity conversion generated a number that was too big to be represented by a 16-bit signed integer (which can only store values up to 32,767.)

- The nozzles of two solid rocket boosters and an engine suddenly swung out of position, nearly detaching the boosters from the body of the rocket, triggering a self-destruct mechanism, and the rocket disintegrated 39 seconds into its maiden flight, destroying several extremely expensive satellites.
- Ordinarily, "when a program converts data from one form to another, the conversions are protected by extra lines of code that watch for errors and recover gracefully," science historian James Gleick wrote in *The New York Times*.
- It was further said that-

"Indeed, many of the data conversions in the guidance system's programming included such protection. But in this case, the programmers had decided that this particular velocity figure would never be large enough to cause trouble. After all, it never had been before. Unluckily, Ariane 5 was a faster rocket than Ariane 4."

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