Technology and Governance
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Introduction

This essay provides an overview of the broad topic of technology and governance and some of the compelling issues we face today. Accordingly, this piece will survey some crucial technological issues which require careful governance in order to manage them well, including information technology, biotechnology, climate change, and nuclear proliferation. Definitions are appropriate to clarify what exactly is at stake.

First, what exactly is "technology"? At its most simple, technology is just a complicated word for "tools." According to Robert E. Snow (1987), "science embodies the desire to understand whereas technology is a product of the impulse to control."[1] Orlikowski (citing Barley 1986 and Blau 1976) considers two different definitions. Technology can be considered as "hardware," that is, the equipment, machines, and instruments that humans use in productive activities, whether industrial or informational devices. Alternatively, the "technology" concept has been extended to "social technologies," including the generic tasks, techniques, and knowledge utilized when humans engage in any productive activities (Eveland 1986; Perrow 1967; Thompson 1967). Wiebe E. Bijker defines technology as having three layers of meaning: physical artifacts (such as hammers, dikes, or computers), human activities (such as hammering in a nail, making the dikes which maintain a dam, or laying fiber optic cable), and knowledge, such (as the know-how to build a cabinet, construct a dike, or design an Internet infrastructure plan).[2]

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[1]Robert E. Snow, Core Concepts for Science and Technology Literacy, Bulletin of Science, Technology & Society, Vol. 7, No. 3-4, 720-729 (1987)

[2]Wiebe E. Bijker, Socio-historical Technology Studies, pp: 229-256, in Handbook of Science and Technology Studies, Sheila Jasanoff et al eds., (Sage: Thousand Oaks, 1995).

Second, what does governance mean? Governance comprises the mechanisms, processes and institutions through which citizens and groups articulate their interests, exercise their legal rights, meet their obligations and mediate their differences. Governance is a broader notion than government, although it is meant to include actions by governments. Governance involves interaction between formal institutions and those of civil society (Weiss 2000).[3] Because technologies often have profound global impacts that transcend the local, we must also be attuned to the meaning of "global governance." According to Lawrence Finklestein (1995), global governance comprehends actions that do internationally, or across borders, what national governments to at home. Global governance comprises both decisions as well as their consequences.[4]

That politics often harnesses, controls, governs and utilizes technology is well established. Compelling examples of the politicization of technology include the positive: the United States effort to put a man on the moon, the establishment of the Tennessee Valley Authority, the creation and worldwide distribution of a polio vaccine, and efforts to bring electricity and telephony to rural America in the 1930s. Negative examples can be found as well, including Stalin's often brutal efforts to build the Soviet Union into an industrial superpower in the 1920s and 1930s, and the race towards nuclear dominance between the United States and the USSR during the cold war. More recently, contested debates have taken place regarding the placement and function of large dams in the developing world and what role developing nations and developed nations should play in reducing climate change respectively.[5] In both the developing and the developed world, politics affects what technology is chosen, how it is

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[4]Lawrence S. Finkelstein, "What is Global Governance?", Global Governance 1, (1995) 367-372.

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implemented, and how it influences other development objectives.[6] Social and political choices about how to manage a new set of technologies fundamentally determine the usefulness of that technology to society, how redistributive and equitable the impact of the technology will be, and how well a society will be able to utilize the promise of a new technology. Governance of science and technology is crucial to ensure that humankind has a real chance to tackle such global threats as climate change, the proliferation of weapons of mass destruction, hunger, and disease, while maintaining values, morality, ethics, and social welfare.

Theory

Different academic schools of thought have engaged and elaborated on the theme of governance and technology, including the fields of science, technology and society (or social studies of science) as well as science, technology and innovation. Science and technology studies (STS) is the study of how social, political, and cultural values affect scientific research and technological innovation, and how these in turn affect society, politics, and culture. The idiom of "co-production" developed by science and technology studies scholar Sheila Jasanoff (2004) observes that both scientific programs and the design of technological systems incorporate and give effect to normative ideals in society, so that the world as "it is" incorporates ideas about the world as it ought to be.[7] Thomas P. Hughes (1987) points out that technology often appears in technological systems, which contain messy, complex problem solving components: they comprise both physical artifacts as well as organizations. Legislative artifacts,

[6]According to Robert Wade government leadership in Japan, Taiwan and South Korea in promoting certain industries, particularly those in manufacturing of car parts machine tools and personal computers, was crucial to economic success. Peter Evans provides a groundbreaking analysis of what makes some states more effective than others in promoting industrial growth, particularly in the field of local information technology (IT) industries, focusing on the newly industrializing countries of Brazil, India, and Korea.
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such as regulatory laws and policies, can also be part of technological systems.[8] Science and Technology Studies is an academic field, which can provide important insights to policymakers regarding managing the social impacts of science.

A more practically oriented field is that of science, technology and innovation. Stated simply, "innovation is about doing new things, or doing old things in new ways."[9] The World Bank--a sincere promoter of STI--believes that science and technology can stimulate economic growth and help combat poverty. This field emphasizes the need for strong industry-science linkages. Science, technology and innovation scholars believe that innovation and science will help countries to reap the economic and social benefits from public and private investments in research, ensure the vitality and quality of the science system, and improve public understanding and acceptance of science and technology and the importance of innovation.[10] This field is extremely popular with national governments which have a focus on development.

Applications of Technology and Governance

Biotechnology has many different facets which require careful technological governance.[11] Biotechnology holds the potential to ensure that troublesome diseases that have plagued humankind for centuries can be treated more effectively or even prevented. Second, biotechnology holds the tools to combat hunger and starvation through innovative agricultural methods. Biotechnology may lead to higher crop yields, as well as to new strains of crops that resist disease and pests. As promising as these developments seem, they raise troublesome and

[8]Thomas P. Hughes, "The Evolution of Large Technological Systems," in The Social Construction of Technological Systems, Bijker, Hughes and Pinch, eds. (MIT Press, Cambridge 1987)
[9]Strategy for Science, Technology, and Innovation. Republic of Ireland. 2006-2013.
[10]Alfred Watkins and Michael Ehst, editors, "Science, Technology and Innovation: Capacity for Sustainable Growth and Poverty Reduction," (World Bank: Washington D.C., 2008).
[11]National Biological Information Infrastructure, Coordinated Framework for Regulation of Biotechnology, United States Regulatory Agencies Unified Biotechnology Website, http://usbiotechreg.nbii.gov/

thorny ethical questions. Cloning animals, human cells or organs raises issues about food safety, animal welfare, environmental regulations, and presents questions about the boundaries between the scientific and the spiritual.

One example of biotechnology which requires careful governance is the use of stem cell technology. Stem cells, the body's master cells, are a promising treatment to many diseases and disabilities because they have the potential to develop into any cell type in the body. For example, doctors can use a patient's own cardiac stem cells to help a damaged heart grow more muscle tissue after it has been damaged by a heart attack. Yet, despite these promising developments, informed and thoughtful people can disagree vigorously regarding the correct course of action for future research with stem cells. The Catholic Church has expressed concern regarding any stem cell research that might result in the destruction or exploitation of human embryos. Given the social, ethical and moral issues involved, governance issues around stem cells require compromises that balance health benefits with societal values.

One policy response to this dilemma is the creation of bioethics commissions. Such commissions have been in place at the United States Presidential level since 1974. According to the New York Times, such commissions have served to familiarize the public with new advances and have developed guidance on contentious issues like genetic engineering, human cloning and research on humans. US President George W. Bush convened a philosophically and religiously oriented commission, which allowed government-financed scientists begin research with human stem cells, but only with existing cell cultures. President Barack Obama decided to re-orient the Council so that it offers more practical policy options.

Another emerging policy issue in biotechnology that will require careful governance and sophisticated policy solutions is the management of genetically modified crops. Genetically

modified organisms, or GMOs, can be used in a variety of industrial processes. GMOs are particularly prevalent in the arena of crops generally grown for human consumption such as soybeans, corn, barley, rice, safflower and tobacco. They are often pest resistant and may produce much higher crop yields than conventional plant breeds. Advocates argue that GMOs could help "feed the world," (Richard Hellmich, USDA) because GMOs may bring down food prices. Yet, many of these alleged benefits are obtained by breeding genes of insects, animals or other plants into conventional crops like corn. Critics point out that higher crop yields and lower pest threats can be gained through careful organic farming methods, and worry about the risks of GMOs contaminating the food supply, cross contaminating other crops, environmental risks, and the risk of unknown impacts on human health from GMOs. In addition, even if the risks of such outcomes are low, should they in fact occur, the results could be economically and environmentally disastrous.

Governance of genetically modified organisms consists of a delicate balancing act. On the one hand are business interests such as the firms who argue that careful oversight can contain these risks. On the other hand are consumers, farmers, environmentalists and research scientists, who contend that containing these risks is more complex than it first appears and insist that government challenge the scientific evidence produced by the firms. The challenge for government is determining what, if any level of regulation, control, or indeed ban is required for this technology. The European Union has placed a moratorium on the planting of crops derived from genetically modified organisms while further studies are conducted. This approach corresponds to a concept known as the "precautionary principle."[12] According to the World Commission on the Ethics of Scientific Knowledge and Technology,

[12]UNESCO Commission on the Ethics of Scienctific Knowledge and Technology, *The Precautionary Principle*, (Paris: UNESCO, 2005)

> The emergence of increasingly unpredictable,uncertain, and unquantifiable but possibly catastrophic risks such as those associated with Genetically Modified Organisms, climate change etc., has confronted societies with the need to develop an anticipatory model to protect humans and the environment against uncertain risks of human action: the *Precautionary Principle* (PP). The emergence of the PP has marked a shift from *post-damage* control (civil liability as a curative tool) to the level of a *pre-damage* control (anticipatory measures) of risks.

By contrast, the United States and the World Trade Organization argue that "research shows" that such products do not harm the environment, and many commercial crops in the United States are already genetically modified to some extent. The concern, in the area of GMOs, is that each party has its own research, and the results of the scientific research often conflicts, raising questions regarding expertise. The challenge for pro GMO regulators is to allow the research to proceed, in the hopes that some health or agricultural benefits can be realized, while protecting citizens from the real risks. Anti-GMO regulators may prefer partial or complete bans.

Information Technology

There are numerous governance issues surrounding information technology. These can be split into three main sectors, e-governance within government, e-governance towards citizens, and control and censorship of information through technology. First, e-governance concerns the matter of government using information technology to become leaner, more efficient and do a better job of providing services to the citizens. Within itself then, e-government contains an inter-organizational component which leverages information technology to assist different actors of government to interact with each other more efficiently, and it also comprises a component which allows government to harness technology to improve its relationships with citizens. One of the key government to government issues surrounding information technology is the matter of

reducing "stovepipes" between government agencies which interact with each other frequently. (Fountain)

Second, there is a role, albeit a contested one, for government to regulate the content and types of information technologies, as well as role for technologists to design ways for technology to "govern itself." (Lessig 2000) One of the most contested areas of regulation, governance and control is the effort of some governments, such as the government of China, to censor or control the content of the Internet for political materials. Three dozen governments attempt to control their citizens' access to the Internet. For example, Internet censorship in China is extremely stringent. Importantly, censorship of the Internet in China focuses on politically related topics, such as the Dalai Lama, or the crackdown in Tianenmen Square. The Chinese government has mandated the use of software to monitor users, but the installation of the software has been delayed.[13]

According to legal scholar Lawrence Lessig, such software carefully manages the values of intellectual property, free speech, and privacy. These may be threatened by computing architecture itself. Lessig shows how code--the architecture and law of cyberspace--can make a domain, site, or network free or restrictive. Technological architecture, he points out, can be used as a method to govern-- or control-- behavior and values with very little input by government. A related, but more socially accepted method of content control, is the effort to keep sexually explicit or inappropriate content away from children through the use of software "filters."

An interesting test of efforts to control information through censorship or technological controls is posed by the recent presidential elections in Iran in June 2009. Supporters of the main opposition presidential candidate rallied in Iran, despite the Iranian government's efforts to make

[13]Andrew Jacobs, China Requires Censorship Software on New PCs, New York Times, June 8, 2009, http://www.nytimes.com/2009/06/09/world/asia/09china.html

it difficult for their citizens to gather, dissent and rebel.[14] In Iran, the government had been blocking social networking sites like YouTube and Facebook. Yet due to the convergence of technologies such as telephone, video, cameras and email, activists were nonetheless able to email anti-government footage out of the country, where it could be posted by sympathetic supporters. Indeed, Iran's attempts to come to grips with the difficulties inherent in censorship are providing a laboratory for what can and cannot be done in the age of convergence and blended media, thereby providing lessons in both technology and governance to other repressive regimes.[15]

The conventional wisdom regarding ICTs is that they are inherently democratic, and thus good. Ukrainian activists and Colombian protesters have used facebook and cellphones to organize against repressive regimes and leftist guerillas. Technology can help facilitate dissent and spread information, as evidenced by Iran, Egypt, Russia, Belarus and China, and can make group and individual action cheaper, leaner and faster. (Morozov 2009).[16]

However, those interested in the governance of technologies must realize that ICTs can be used for ill, as well as for good. Public discourse is not always improved by ICTs, and at its worse, it can be heavily degraded. ICTs can be a viciously rapid vehicle for disseminating ethnic hate speech and organizing violent mobs, as well as promoting pornography and allowing new types of criminal behavior. For example, In Rwanda an old kind of ICT, the radio, was used to incite genocide as listeners were told to "cut down the tall trees." The Internet and texting can make our views more extreme, and cause us to act on them more quickly than we might in a non-electronic environment. (Cohen 2009).

[14] Brian Stelter and Brad Stone, Web Pries Lid of Iranian Censorship, New York Times, June 22, 2009, http://www.nytimes.com/2009/06/23/world/middleeast/23censor.html.
[15] Ibid.
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Finally,. information technology can assist governments to provide services more quickly and more efficiently to citizens and provide more transparency and accountability in state operations and budgeting. Many local, state, national governments, and even transnational organizations such as the United Nations or the World Bank are using information technology portals as a tool to disseminate information on matters of health and social welfare, collect applications for jobs, provide information for bids and requests for proposals or allow applications for common issues such as drivers licenses. However, many citizens, particularly in developing countries, do not have access to phones, computers, or the Internet, which means that they cannot access these newly provided government and private sector services. These differences in "access" are known as the digital divide, and governance is the key to closing the divide.

Climate Change

Some of the most crucial societal current issues regarding technology and governance involve the environment. These issues include water sustainability, climate change, deforestation, desertification, and many other topics.

Climate change has been in the headlines for the past several years, and is gaining increasing public importance, as policymakers begin to view it as a looming global crisis. Climate change is a problem that itself was brought about by technology. The burning of coal, the releases of pollutants from smoke stacks, the heavy reliance on fossil fuels caused by manufacturing and automobiles and the generation of electricity as a byproduct of the industrial revolution from 1800 to the present are the source of much of climate change. Nations, multilateral organizations, and consumers will have to pay close attention to technological governance and engage in broad cross-societal innovation in order to combat the effects of climate change.

What is climate change? Part of the earth's atmosphere is made of greenhouse gases: (water vapor, CO2, CH4, N2O, and CFCs). Human activities, such as fossil fuel combustion, deforestation, and some industrial processes, have led to an increase in greenhouse gases concentration. As a result of the dramatic increase in greenhouse gas concentrations over the past two hundred years, more infrared radiation has been captured in the atmosphere, causing in the air temperature, precipitation patterns, a rise in the sea-level, and the melting of glaciers.[17] As a result, experts also predict that weather patterns will become more unpredictable, storms more frequent, and droughts more severe.

For several decades, there has been a vigorous debate regarding whether climate change was actually occurring, or whether the variations in temperature being witnessed were simply "blips" in the normal course of climactic transitions over centuries. Some scientists suggested that the science behind climate change was too uncertain to act on. Ben Lieberman of the Heritage Foundation suggests that the impact of man-made emissions on the planet's temperature may be minor.[18] Further, argues Lieberman, current temperatures are within the range of natural variability, pointing to The Medieval Warm Period. He argues that humans and animals will be able to adapt to any predicted change in temperature. The position that climate change is not a serious problem still has supporters. Some go further, for example, United States Representative Paul Broun of Georgia has declared that climate change is nothing but a "hoax" that has been "perpetrated out of the scientific community."[19] These advocates, who believe the risks of

[17] http://web.ceu.hu/envsci/soe/problems/climdef.htm
[18] Ben Lieberman, Frequently Asked Questions About Global Warming, The Heritage Foundation, March 21, 2007, http://www.heritage.org/Research/EnergyandEnvironment/wm1403.cfm
[19] http://www.nytimes.com/2009/06/29/opinion/29krugman.html?_r=1&hpw

climate change are overstated, generally oppose the Kyoto Protocol, and suggest that the US Congress should pass no limits or restrictions on the emission of carbon dioxide.[20]

The international scientific consensus is that climate change is real, although dissenters do remain. On Feb. 2, 2007, the Intergovernmental Panel on Climate Change declared that the evidence of a warming trend is "unequivocal."[21] The report was the first in which the group asserts with near certainty — more than 90 percent confidence — that carbon dioxide and other greenhouse gases from human activities have been the main causes of warming in the past half century.[22] According to economist Paul Krugman, the planet is changing faster than even pessimists expected: ice caps are shrinking, and arid zones spreading, at an alarming clip. And according to a number of recent studies, catastrophe is the most likely outcome if we continue along our present course.[23]

The most urgent governance question on the table with regard to global warming is what citizens, national governments, and multilateral organizations such as the United Nations can do to combat climate change. The United States comprises approximately five percent of the world's population, yet, it contributes about a quarter of greenhouse gas emissions, more than any other country. Nonetheless, under President George W. Bush, United States policy with regard to climate change was "hands off," and the administration rejected the idea of unilateral caps on emissions. President Bush announced non-binding goals, such as a halt in the growth of greenhouse gas emissions by 2025, yet failed to enunciate specific plans or mandatory steps

[20]"Global Warming and Climate Change," Chapter 45, *Cato Handbook for Policymakers, 7th Edition* (2009). http://www.cato.org/pubs/handbook/hb111/hb111-45.pdf
[21] Elisabeth Rosenthal and Andrew Revkin, Science Panel Calls Global Warming 'Unequivocal', February 3, 2007, *New York Times*, http://www.nytimes.com/2007/02/03/science/earth/03climate.html
[22]UNEP, Intergovernmental Panel on Climate Change, www.ipcc.ch.
[23] Paul Krugman, "Betraying the Planet," *New York Times*, June 28m, 28, 2009, http://www.nytimes.com/2009/06/29/opinion/29krugman.html?_r=1&hpw

which industries or citizens should follow in order to attain such reductions.[24] Throughout his presidential term, Bush steadfastly rejected the Kyoto Protocol, which limits greenhouse gas emissions. The Bush Administration's grounds for rejection of the Kyoto Protocol was that the China and India, two developing nations with high levels of emissions, were not reducing emissions quickly enough.[25]

Vice President Al Gore popularized the severity of the issue of climate change with his book and movie, "An Inconvenient Truth." After the election of Barack Obama to the United States Presidency, United States environmental policy has moved towards much stricter controls on greenhouse gas emissions. The United States House of Representatives passed sweeping legislation (HR 2454)-- the Waxman-Markey Climate Change Bill-- on June 26, 2009, to address global warming. This bill is likely to change the way the nation produces and uses energy, capping emissions of greenhouse gases and mandating a boost in electricity from renewable sources.[26] The legislation relies on a cap-and-trade system strongly favored by economists that limits overall emissions of heat-trapping gases while allowing emitters to trade pollution permits, or allowances, among themselves. The cap would grow tighter over the years, pushing up the price of emissions and presumably driving industry to find cleaner ways of making energy.[27]

[24]Sheryl Gay Stolberg and Brian Knowlton, "Bush shifts policy on greenhouse emissions," *New York Times*, April 16 2008,
http://www.nytimes.com/2008/04/16/world/americas/16iht-environ.4.12064726.html
[25] Stolberg, Bush shifts policy.
[26]John Broder, "House Passes Bill to Address Threat of Climate Change," *New York Times*, June 26,2009,http://www.nytimes.com/2009/06/27/us/politics/27climate.html?scp=3&sq=Obama%20policy%20climate%20change&st=cse
[27] Ibid.

By passing the Waxman-Markey Climate Change Bill, the United States is beginning to align itself with the prevailing mode of international governance towards climate change.[28] The 1997 Kyoto Protocol is an international treaty which commits its signatories towards dramatic reductions in ozone depleting greenhouse gases. As many as 183 nations have signed and ratified the Kyoto Protocol to the United Nations Framework on Climate Change, which is aimed at combating global warming. American opponents to the Kyoto Protocol argue that overly strict reductions on emissions may put U.S. businesses and farmers at a competitive disadvantage with nations such as China, India and Brazil.[29] As a result of worries regarding costs on American business and competition from China and India, it is possible that the United States Senate may pass the Waxman-Markey bill, yet fail to ratify the Kyoto Protocol.

Nuclear Nonproliferation

Nuclear fission is a key example of how a technology designed to solve a societal problem can result in unanticipated consequences. In the face of efforts by Nazi Germany to purify uranium 235, the United States Government under United States President Franklin D. Roosevelt began the Manhattan Project committed to building a viable atomic bomb. Over the course of six years, from 1939-1945, Ernest Lawrence, Robert Oppenheimer, Enrico Fermi and Edward Teller worked with several others of the greatest minds in science to create the device that ushered in the Atomic Age. Under the leadership of United States President Harry S. Truman, The United States successfully exploded an atomic device in 1945 at the Japanese cities of Hiroshima and another at Nagasaki, effectively ending World War II. To this day, the United

[28]Pew Center on Global Climate Change, "Cost of the American Clean Energy and Security Act of 2009 Found to Be Small According to Government Analyses," June 2009. http://www.pewclimate.org/acesa/costs

[29] Jim Efstathiou Jr. and Daniel Whitten, "Senate May Pass U.S. Climate Bill, Reject Treaty, Kerry Says," *Bloomberg New Service*, July 2, 2009, http://www.bloomberg.com/apps/news?pid=20601087&sid=aMs9V_EUxE0Y

States is the only country to have used nuclear weapons against another country.[30] The impacts on Japan of these two nuclear explosions were horrific. The loss of life and property was catastrophic, and they type of injuries macabre. The heat generated by nuclear weapons in the atomic blasts was so intense, that it literally burned shadows into the ground.

Although the explosion of these nuclear devices ended World War II, it launched an arms race, and set off the Cold War. The Soviet Union tested an atomic bomb in 1949. The arms race refers to the efforts by the former Soviet Union and the United States to stockpile nuclear weapons, in an effort to assert global dominance. The United States nuclear stockpile consists of approximately 10,000 strategic and tactical warheads. According to the Arms Control Association, "It is generally estimated that Russia also may have up to 3,000 tactical nuclear warheads in service. In addition, Russia may have as many as 8,000 to 10,000 nuclear warheads in reserve."[31] After the explosions at Hiroshima and Nagasaki, however, the world realized that nuclear war must be avoided at all costs. President Dwight D. Eisenhower, who had led US forces in World War II, determined that there would be no winners in a nuclear war, only devastation and ruin that could encompass the globe and throw humankind back to the dark ages.

Due to the seriousness of the threat, nuclear weaponry has required one of the most comprehensive efforts-- informed by careful diplomatic negotiation--in international technological governance that the world has ever seen, or is likely to see. A series of elaborate negotiated treaties followed, which limited various aspects of nuclear weapons over a series of decades. The 1963 Limited Test Ban Treaty, under President John F. Kennedy, ruled out nuclear

[30]Alex Bollfrass, "Arms Control and Proliferation Profile: The United States," *Arms Control Association*, November 2007, http://www.armscontrol.org/factsheets/unitedstatesprofile
[31]Alex Bollfrass, "Arms Control and Proliferation Profile: Russia," Arms Control Association, November 2007.

testing in space, the atmosphere, and underwater, yet still permitted underground tests.[32] President Lyndon B. Johnson rejected out of hand the use of nuclear weapons in Vietnam. According to Spurgeon M. Keeney,

> [President Lyndon B.] Johnson and [Secretary of Defense Robert] McNamara recognized the need to cap the rapid buildup of strategic nuclear arms and to include limits on ballistic missile defenses as well as to maintain stable mutual deterrence. Their thinking on these matters, which was initially introduced to a skeptical Soviet Premier Aleksei Kosygin at a 1967 summit in Glassboro, New Jersey, became the basis for subsequent negotiations leading to the Strategic Arms Limitation Talks (SALT I) and the Anti-Ballistic Missile (ABM) Treaty.[33]

President Richard M. Nixon vigorously pursued nuclear non-proliferation efforts and arms control agreements, initiating agreements that led to the Anti-Ballistic Missile Treaty (1972) and the Strategic Arms Limitation Talks I (1972). SALT II was vigorously advocated by President Jimmy Carter, who pursued a broad and impressive arms control agenda. SALT II was signed in 1979. Under Reagan, the United States moved from a cap on the number of nuclear weapons to an actual reduction under the Strategic Arms Reduction Treaty. President George Herbert Walker Bush quickly completed and ratified START I (1991) and START II (1992), which called for deep reductions in missile delivery systems.

Nuclear nonproliferation is increasingly a matter of global concern. The Nuclear Non-proliferation Treaty (NPT) was ratified by the US in 1970. The Nuclear Nonproliferation Treaty seeks to slow or stop the spread of nuclear weapons to countries that do not currently possess them. Countries such as Russia, Pakistan, Iran, North Korea, Israel, India, all pose threats to global nuclear security. At least 189 countries are signatories to the NPT. Under the treaty, five states, the United States, Russia, China, France, and the United Kingdom, all commit to pursue

[32]Spurgeon M. Keeney, Jr. "Fingers on the Nuclear Trigger" A Book Review of At the Borderline of Armageddon: How American Presidents Managed the Atom Bomb. By James E. Goody, Available at http://www.armscontrol.org/act/2006_10/BookReview
[33]Spurgeon M. Keeney, Jr. "Fingers on the Nuclear Trigger". Available at http://www.armscontrol.org/act/2006_10/BookReview

disarmament, while non nuclear weapon states commit not to acquire nuclear weapons.[34] India, Israel and Pakistan have refused to sign the treaty, however. North Korea has withdrawn from the treaty. In a hopeful sign. Post-apartheid South Africa and Libya eliminated their nuclear weapons capability.[35]The International Atomic Energy Agency has been investigating clandestine actions by Iran to develop nuclear weapons since 2002, and data indicates that Iran may be getting its technology via Pakistan. Although Iran's nuclear program appears to have been halted in 2007, its nuclear capability remains a matter of concern. The United Nations has recently tightened sanctions on North Korea, which conducted an unsanctioned nuclear weapons test on May 25, 2009. Ongoing military conflict on the border between India and Pakistan make those two countries areas of close scrutiny by the international community, although both countries are considered reliable allies of the West. Russia's unstable political and economic environment makes it an area of extreme concern for non-proliferation analysts, who worry that fissile material could easily be transferred from Russia to rogue states.[36]

[34]Jessica Weiss, Nuclear/Ballistic Missile Nonproliferation Fact Sheet, April 2005, Arms Control Association, http://www.armscontrol.org/factsheets/nptfact

[35] Jacob, N. , 2006-03-22 "Nuclear Tipping Point in Reverse: Rollback in South Africa and Libya" *Paper presented at the annual meeting of the International Studies Association, San Diego, California, USA Online* <**PDF**>. 2009-05-25 from http://www.allacademic.com/meta/p98887_index.html

[36] Alex Bollfrass, Arms Control and Proliferation Profile, Russia, November 2007, Arms Control Association, http://www.armscontrol.org/factsheets/russiaprofile

Summary

The topics which fall under the heading of technology and governance are legion. However, certain themes have emerged from this short overview which may have salience for other technologies not considered here.

- Technology can be as simple as a hammer, and as complex as a nuclear power plant, yet no analysis of technology is valid if it does not also consider the human aspects of the use of any tool.
- Technology often appears in systems, not just in the form of one tool. For example, an analysis of the technological system of a nuclear power plant includes, (at a minimum) all the workers who have to be trained to use this delicate technology; the scientists who are able to isolate the fissile material; the engineers that build the plant that keeps citizens safe from radioactivity; the politicians who wish to harness the energy from the plant; the regulatory framework which controls the location and operation of the plant, and the consumers who benefit from the cheaper electricity but also worry about the danger of health impacts.
- Musings on the relationship between governance and technology can be as abstract as ruminations on the ways in which technology shapes society, or as concrete as efforts to harness technology to develop nations.

When governing biotechnologies, citizens and scientists should consider the promise of this science to put food on our plates, and help heal disease. However, they should carefully weigh also the risks that this technology-- like a Pandora's box which once opened can never be closed-- can escape human control, threatening the environment, harming our health, and changing the origins and meaning of human life itself.

When considering information and communication technologies in general, governance questions must include how societies can use technology to improve themselves. ICTs can make governments more responsive, more transparent, and more service oriented. However, some repressive governments use communication technologies to repress dissent, prevent organizing, and spread propaganda. Further, as Lawrence Lessig points out, such controls-- including the kind of monitoring the US government is using to track terrorists under the Patriot Act--can actually be embedded in software or hardware or other types of technology itself, a type of governance built into the technology, and often, these types of monitoring mean limits on civil liberties and freedom of expression.

Climate change refers to global warming caused by greenhouse gases. If the rate of warming is not slowed, the results could be catastrophic for people as well as plants and animals. Greenhouse gases are produced predominantly by the technologies of industrialization, and are produced in large part by European Countries, the United States, and newly industrialized countries such as India and China. Close to two hundred countries have signed the Kyoto Protocol which imposes sharp limits on future emissions. The United States has declined to sign the Kyoto Protocol, but in June 2009, passed the first stage of new legislation that will dramatically curb greenhouse gas emissions. Technological governance issues arising out of climate change include the relationship between countries that have already industrialized, and countries that have not concluded that process. Developed countries like the United States worry that if they are forced to reduce emissions too sharply, they will no longer be competitive. Developing countries like China and India note that most of the global warming we are experiencing today was caused by the industrial revolution in the US and Europe. They question why their economic growth should be limited for a problem they did not create. At the same

time, given that the populations of China and India exceed 1 billion each, these countries are major contributors to greenhouse gas emissions. No real tenable global solution can be crafted that does not include sharp cuts in emissions by the United States, China and India. Crafters of treaties on climate change will be the new architects of technological governance. They would be well advised to look closely at the lessons learned from nuclear weapons in negotiating a series of fairly successful disarmament treaties from the 1970s to the present.

Nuclear war could destroy life on earth as we know it, and throw entire civilizations back into the dark ages. Although many successful nuclear arms reduction agreements have been negotiated, the context in which they have been negotiated has changed. A crucial emerging issue with regard to nuclear governance is that of keeping fissile material out of unstable hands. Russia is a far less stable country than its predecessor, the USSR, and many worry about how former states of the Soviet Union may handle fissile materials in their control.

Future Directions for Research

Emerging issues regarding technology and governance in the field of biotechnology will require sorting out what role the government and civil society as well as religious organizations should play in determining the ethics of new innovations. As cloning improves, governments and societies will increasingly have to wrestle with whether this technology should be banned entirely, or if not, to what extent it should be regulated. In addition, technologies which can help parents select their children's eye color or gender raise disturbing questions regarding eugenics, ethicists, religious leaders, philosophers, lawyers and scientists all have a role to play in determining what social boundaries are acceptable in handling this new technology.

With regard to ICTs, governments and societies must weigh freedom of expression and privacy against the social harms created by pornography, crime and political extremism.

Information technology can be a tool of freedom, but it can also be a tool of repression or monitoring. Research should be conducted on how governance can best keep up with this incredibly fast moving technology, and whether increasing forms of self-regulation may be needed to enforce societal values.

Climate change poses a powerful threat to the planet's very existence. Governments mush work with industry, scientists, innovators and universities to find new ways to cut emissions quickly, while still allowing economic growth: this is the concept behind green economies. New technologies that reduce reliance on fossil fuels can assist in the reduction of emissions. Wind power and solar power are examples of such technologies. However, society will also have to develop behavioral innovations to change how we live, work and commute in order to truly reduce green house gas emissions. In addition, northern developed countries must reach an accord with southern developing countries on how climate change can be averted while allowing development. This debate is particularly salient since the developed world extracted resources while exploiting people and the planet to fuel the industrial revolution that created climate change in the first place.

With the rise of global terrorism, technological governance must pay attention to emerging threats in the realm of biological weapons, chemical weapons, the creation of dirty bombs and other weapons of mass destruction in unstable areas of the world such as Korea, Pakistan, Israel and the Arab Gulf, and Afghanistan. Research on controlling these types of weapons, as well as innovations in governance to update treaties, and educate governments about acceptable global behavior will be crucial over the coming decades.

The field of technology and governance is a massive one, and an exciting one. The policy opportunities and challenges are limitless for the interested student or policymaker.

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