Efforts to Control Information Flows

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I. Introduction

Both science and engineering have strong traditions of sharing information with colleagues, whether they work in the same laboratory, in one down the road, or in one half way around the world. Though willing to curb information sharing in times of national danger, both professions affirm strong norms of openness and information sharing.

These sometimes come up against desires by governments, corporations, or other groups to limit the diffusion of scientific and technical information. Some of these limits form part of an effort to control who has what information through general censorship. Efforts to secure control over who may use particular information in their own work have become increasingly important since the mid-20th century as intellectual property rights protected by patents or copyright have become more important to corporate business strategies. This has triggered intense debate about how to draw the longstanding distinction between "basic scientific knowledge" available to all and "applied science advances" treated as private property under patent, copyright, and other forms of intellectual property rights. Though the types of information control are perceived similar in many ways, the ambition to block diffusion of information is qualitatively different than the ambition to block use. Hence, each form of information control will be addressed in turn.

II. Efforts to Control Access to Information

Censorship has long been part of authoritarian rulers' repertoire of measures for maintaining their position. Individuals and groups using words, images, songs, and protests to challenge the ruler's position are the most frequent and immediate targets of censorship, but censorship can extend to the population at large whenever rulers perceive dissemination of particular information or knowledge as dangerous to the regime. Geneva vigorously censored religious publications in 1541-64 to suppress any challenges to John Calvin's interpretations of Christian scripture and doctrine. Contemporary China classifies information about epidemics or other developments that might cause discontent among the population as state secrets. Scientific or engineering knowledge may also be subject to censorship. This is particularly likely in wartime, when governments do not want enemies to find out about advances in applied science or engineering producing better weapons, intelligence gathering, or logistics.

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The continuing division of the world into independent states means that no one government or society can exert global control over the flow of information about science, engineering, and advances in scientific or technical knowledge. US efforts to maintain the secrecy of the Manhattan Project developing the atomic bomb succeeded against the Germans and Japanese, but not against the USSR, which exploded its own atomic bomb in August 1949. However, enough information was available in the open scientific literature and the fact that the USA had succeeded in making atomic bombs for others to emulate the feat. Even without any of the information provided by its spies, the USSR would have been able to create its own atomic bomb by 1951, and would have had one faster if it had begun to assemble large quantities of uranium in 1943 rather than 1945.[1] Scientific traditions of open publication mean that information about scientific and engineering advances will be available to those with sufficient training and sufficient access to foreign scientific publications to read it.

Yet, to the extent that a government can control access to information on its territory, or other actors can affect the spread of information in their societies, they can limit the ability of scientists and engineers in that country to keep up with developments elsewhere or to pursue research in the ways they would prefer. The Lysenko Affair in the Soviet Union suggests how far a sufficiently motivated government can deflect the course of scientific activity with censorship and political pressure. Soviet geneticists were already regarded as overly subservient to "bourgeois" notions of science in the 1930s when Trofim Denisovich Lysenko began his rise to prominence through experiments suggesting that it was possible to alter the growing season of plants by exposing their seeds to particular combinations of temperature and moisture before planting. As one of the few biologists of a peasant background and fully committed to socialism, he quickly became an exemplar for Communist Party members most committed to building new "socialist" sciences. His influence spread after 1935, particularly after he became President of the Lenin Academy of Agricultural Sciences in February 1938. In 1948, the Communist Party Central Committee endorsed Lysenko's Theory of Nutrients which posited that in the environment in which an organism lives ultimately shapes its heredity and genetic evolution, returning to strong assertions that the heritability of acquired characteristics allowed guiding the evolution of species that had been abandoned by most geneticists in the 1910s. In endorsing Lysenko's work plan for the Lenin Academy, the Party Central Committee also suppressed research and teaching of standard genetics. Support from Stalin and Khrushchev enabled Lysenko and his followers to dominate Soviet agronomy and genetics until 1965, yet even at the height of their influence they were not able to completely eliminate standard genetics. Genetics advances in other countries were known to the Soviet scientific elite and a core of geneticists were able to continue enough research within institutes of theoretical physics (because of the relation between radioactivity and mutation) and cybernetics (because of apparent similarities between genetics and information theory) to reconstitute their field after Lysenko's definitive loss of influence in 1965.[2] Other areas of science did not suffer as greatly. Physics and engineering received great boosts from Soviet nuclear and space programs;

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[1] David Holloway, *Stalin and the Bomb: The Soviet Union and Atomic Energy 1939-1956*, 222-223. New Haven: Yale University Press, 1994.

[2] Zhores Medvedev, *The Rise and Fall of T.D. Lysenko* (New York: 1969) and Valery M. Soyfer, *Lysenko and the Tragedy of Soviet Science* (New Brunswick, NJ: Rutgers University Press, 1994).

cybernetics and information theory were encouraged on grounds their application would facilitate creation of a communist society.[3]

It would be a mistake to assume that only dictatorial governments engage in censorship of scientific information. Democratic governments can engage in more subtle versions of the same practices. This is particularly likely if a significant portion of their support comes from social groups that have determined views on some matter involving scientific knowledge and push to have the distribution of scientific information conform to – or at least not challenge – their views about proper policy on the matter. In 2002, as the George W. Bush administration was advancing its conservative supporters' "abstinence only" approach to sex education for teenagers, controversy arose over removal from US government health information websites of information about how to avoid sexually-transmitted diseases.[4]

Efforts to control the spread of scientific information can also be pursued by other social actors. Corporations producing hazardous products have often sought to suppress or discredit scientific findings that demonstrate the hazards. The most famous and well-documented example is the long effort by tobacco companies to deny research findings on the health hazards of smoking in the 1950s and 1960s and of exposure to smoke from other people's smoking ("secondhand smoke") in the 1980s and 1990s.[5] As the number of studies demonstrating serious hazards increased, the major tobacco companies shifted strategy from outright denial of any hazard to casting doubt on the findings by suggesting that the emerging scientific consensus rested on inadequate empirical proof. The most succinct statement of this tactic indicated that, "Doubt is our product, since it is the best means of competing with the 'body of fact' that exists in the mind of the general public."[6] As the scientific consensus that greenhouse gas emissions were contributing to rising atmospheric temperatures and these would soon have significant effects on the Earth's climate solidified in 2000-05, climate change skeptics in the USA shifted to similar tactics.[7] In the 1990s there were at least two cases of industry supporters attempting to discredit the research demonstrating the hazards posed by some product by accusing the scientists who produced the research

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[3]Paul Josephson, *Physics and Politics in Revolutionary Russia*, pp. 247-75 Berkeley: University of California Press, 1991 traces the less intense and short-lived effort to inject ideological policing into physics after 1945.

[4] Adam Clymer, "Critics say government deleted sexual material from websites to push abstinence," *New York Times*, 26 November 2002, and Adam Clymer, "U.S. revises sex information, and a fight goes on," *New York Times* 27 December 2002.

[5] Stanton A. Glantz, John Slade, Lisa A. Bero, and Peter Hanauer, *The Cigarette Papers* (Berkeley: University of California Press, 1996). Lisa A. Bero, D.E. Barnes, Peter Hanauer, John Slade and Stanton A. Glantz, "Lawyer control of the tobacco industry's external research program: The Brown & Williamson documents," *Journal of the American Medical Association* 274 (3): 241-247 (19 July 1995) focuses particularly on the central role of the lawyers at Brown and Williamson in selecting the scientific projects to be funded by the tobacco industry's Tobacco Industry Research Council.

[6] Brown & Williamson, "Smoking and health proposal" (undated but most likely written in 1969 according to Glantz, Slade, Bero, and Hanauer 1996), Document 332506 in the collection of documents made pubic under the 1998 Master Settlement Agreement between the Attorneys-General of 46 US states and the major tobacco companies. The documents are available at http://www.tobaccodocuments.org and the Master Settlement Agreement at http://ag.ca.gov/tobacco/pdf/1msa.pdf (accessed 1 July 2009).

[7] Senator James Inhofe (Republican of Oklahoma), "Skeptics' Guide to Debunking Global Warming Alarmism" (2006) is one of the clearer statements. For an assessment of the skeptics' efforts in early 2009 see Andrew C. Revkin, "Skeptics dispute climate worries and each other," *New York Times*, 8 March 2009.

of scientific misconduct. One challenge was raised despite the fact the original work had been reviewed very carefully a decade before,[8] and was ultimately rejected.[9]

The line between honest disagreement on scientific or technical points and artificially inflated doubt can be fuzzy. Only occasionally does some piece of evidence, like identification of the "ozone hole" over Antarctica in 1985, signal "end of discussion" by confirming one view and disconfirming others even in the eyes of those supporting the now-disconfirmed views.[10] More often, the weight of the scientific evidence shifts more slowly and expert consensus takes longer to coalesce. The best atmospheric scientists still disagreed among themselves about the extent to which increased emission of CO_2 and other greenhouse gasses from human activity was altering the atmosphere and the likelihood that the human-caused changes would in turn affect climate in the 1980s. Corporations whose activities would be affected by measures to cut emissions could point to the research indicating little connection without distorting the scientific discussions. Twenty years later, as consensus among atmospheric scientists that human-caused greenhouse gas emissions are altering atmospheric temperature sufficiently to affect the climate, challenging the connection involved distortion.[11] As with secondhand smoke, challenging the results involved a dual track effort of commissioning studies from persons who could be relied upon to report the "correct' conclusions and applying very exacting standards of proof to discredit the "incorrect" conclusions. Invocation of exacting standards has been used so frequently in recent years that the phrase "sound science" is often identified in the USA with efforts by industry groups and others to prevent government regulation of activity through insisting on impossibly exacting standards of scientific proof of a problem before regulations can be issued.[12]

Just as those resisting particular regulations can pass from expressing reasonable doubt to concocting doubt, those supporting particular regulations can pass from expressing reasonable concern to exaggerating the extent to which scientific evidence supports their policy preferences.[13] Environmentalist groups using scientific rather than animal rights arguments about adoption of a moratorium on commercial whaling in the late 1970s and early 1980s emphasized the minority scientific view that cessation of all catches was needed for whale populations to recover rather than the majority view that catch cessation

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[8] Herbert Needleman, et al. "Deficits in psychological and classroom performance of children with elevated dentine lead levels," *New England Journal of Medicine* 1979; reviews summarized in Committee on Measuring Lead in Critical Populations, Board on Environmental Studies, and Toxicology, Commission on Life Sciences, National Research Council. *Measuring Lead Exposures in Infants, Children, and other Sensitive Populations*. Washington DC: National Academy Press, 1993.

[9] Donald Kennedy, *Academic Duty*. Cambridge, MA: Harvard University Press, 1997, pp. 237-238.

[10] Richard E. Benedik, *Ozone Diplomacy: New directions in safeguarding the planet.* Cambridge, MA: Harvard University Press, 1998.

[11] See Naomi Oreskes, "The scientific consensus on climate change," *Science* 306 (no. 5702): 1686- (3 Dec. 2004).

[12] Tactics described in David Vladeck, "Paralysis by analysis: How conservatives plan to kill popular regulation," *American Prospect* 6 (22): (23 June 1995); Charles N. Herrick and Dale Jamieson, "Junk science and environmental policy: obscuring public debate with misleading discourse," *Philosophy and Public Policy Quarterly* 21 (2/3): (spring/summer 2001); Thomas McGarity, "Our science is sound science and their science is junk science: science-based strategies for avoiding accountability and responsibility for risk-producing products and activities," *Kansas Law Review* 52: 897- (June 2004).

[13] Caroline Harper, "Do the facts matter? NGOs, research, and international advocacy," in Michael Edwards and John Gaventa, eds. *Global Citizen Action*, 247-58. Boulder, CO: Lynne Reinner, 2001.

was only needed for certain species.[14] The Natural Resources Defense Council stirred considerable controversy in 1989-90 with a report suggesting that children were at higher risk from pesticide residues on apples and vegetables than many scientists believed was actually the case. The combination of "pesticide," "children," and "risk" was potent enough politically to get one product, Alar (trade name for daminozide) removed from the market by its maker.[15] Though successful in getting Royal Dutch Shell to bring the Brent Spar oil platform back to England for onshore demolition, Greenpeace UK was later charged with having greatly exaggerated the negative effects of simply toppling the platform into the North Sea. Animal protection groups seeking to maintain a complete ban on trade in ivory have been charged with using exaggerated data about population declines.[16] When there is no broad consensus among the most knowledgeable scientists, two-sided contests of exaggeration can flourish. Debates about genetically modified foods features a good deal of both, with major food companies that sell such products downplaying the risks and some opponents exaggerating the risks.[17] Debates about whether to continue or lift bans on selling ivory have been featured.

At the same time, it is important to note that standards of scientific proof change over time as scientists refine their knowledge or as they are influenced by new world views. In environmental areas, scientists are more likely to conclude that there is good evidence for links between pollutants and human disease today than in the 1960s to 1970s because scientists, like much of the rest of the population, have moved from "pre-environmentalist" views of humans as separate from nature and focus on an "average person" as the unit of study to an "environmentalist worldview" stressing human nature connections, more pathways by which chemical substances affect human health (the notion of hormone disrupters was not widely accepted until the early 1990s) and more willing to acknowledge that different categories of persons (children vs adults; persons living near toxic sites or in highly polluted areas versus persons living further away or in relatively unpolluted areas) experience different health effects.[18] This shifting standard of proof, based on a shift in values but also supportable on scientific grounds, heightens controversies between supporters and opponents of particular regulatory measures if they also diverge in their deeper assumptions about how "good science" is done. Particularly in those areas, scientists and other experts increase the value of their contributions to debate when they specify both their criteria for coming to conclusions and the extent and limits of their knowledge about the phenomena under discussion because such transparency makes it easier to identify partisan exaggerations of scientific or technical conclusions.

III. Efforts to Control Use of Information

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[14] Tora Skodvin and Steinar Andresen, "Nonstate influence in the International Whaling Commission," *Global Environmental Politics* 3 (4): 74 (2003).

[15] Kerry E. Rodgers, "Multiple meanings of Alar after the scare: Implications for closure*," Science Technology and Human Values* 21 (2): 177-197 (1996).

[16] Charlie Pye-Smith, "Truth games," *New Scientist* 9 Jan. 1999, p. 1616.

[17]See Marion Nestle, *Safe Food: Bacteria, Biotechnology, and Bioterrorism* (Berkeley: University of California Press, 2003).

[18] Sylvia Tesh, *Uncertain Hazards: Environmental Activists and Scientific Proof* (Ithaca, NY: Cornell University Press 2000, Chapter 4.

The distinction between "basic science" – general knowledge of physical phenomena developed by scientists motivated by broad curiosity about the world – from "applied science" – development of physical objects for everyday use through application of experimental method and accumulated scientific knowledge to develop a particular structure or product is now so well established that it frames many discussions of technological development. It can be traced back to the development of two distinct systems of rewarding scientific and technological development in early modern Europe. In the 17th century scientists committed themselves to norms of open exhibition and publication, freely sharing their results with anyone who cared to pay attention. Though initially adopted at least in part to deflect accusations of engaging in magic or other "dark arts," the norm of open publication soon became a central element in defining proper scientific conduct. Individual scientists who provided notable advances in knowledge were rewarded with fame, prizes, medals, membership in local or national scientific academies, and (as science moved into universities and institutes during the 19th century) steady teaching or research jobs. Inventors made no commitment to freely share information; they were concerned with specific practical problems and using their inventions to further their own enterprises. Inventors were quick to adopt elements of scientists' experimental method, but until the 20th century their work depended much more on the results of trial and error than on direct transfer of scientific knowledge into practical devices. This strong separation between scientific knowledge and advances in technology meant that allowing inventors to assert intellectual property rights over their advances did not appear to pose any problem for the diffusion of basic science.

Patents, copyright, and other forms of intellectual property rights were developed to promote innovation and creativity by giving inventors and writers, musicians, and artists the right to control others' use of their work for a defined period of time – typically 20 years for patents and up to 120 years for copyright.[19] Neither patents nor copyright directly constrain the flow of information: inventors must disclose the method of making their invention and its mode of operation in considerable detail to get a patent while the typical writing, design, or artistic production covered by copyright is clearly visible to anyone who sees it.

However, patent and copyright holders can define the conditions under which others may use that information. If they are inclined to withhold permission for use, they can effectively limit further innovation or creativity that builds on their work. Inventors and business firms can be stymied in some fields by the need to get permission from multiple patent holders to pursue innovation in certain lines of production[20] or by what patent lawyers call "patent trolls" – patent holders who secure patents mainly to keep competitors from developing certain technologies or products any further by refusing to license their patented technology. Patent or copyright holders can also discourage others through demanding large payments for use of their patented technology or copyrighted material.

As long as "basic" and "applied" science appeared to operate in very different realms, open publication norms and intellectual property rights could coexist without coming into serious tension. In a few areas, however, the realms have converged in ways that raise difficult questions of defining what is "basic" (hence part of the common fund of knowledge open to all), and what is "applied' (hence belonging for a time to the

[19] The duration of patents remains largely unchanged. The first copyright laws specified a 14-year duration, which was still the norm in the early 20th century. Copyright duration was extended dramatically in the late 1970s. See David Nimmer, *Copyright: Sacred Text, Technology and the DMCA*. The Hague: Kluwer Law International 2003, p. 63.

[20] M.A. Heller and R.S. Eisenberg, "Can Patents Deter Innovation? The Anticommons in Biomedical Research," *Science*, 280: 698-701 (1 May 1998).

originator and usable only with permission). This has been particularly true in genetics, where recombinant DNA research quickly overlapped with a host of promising and potentially lucrative applications in curing of diseases and development of new varieties of plants.

The implications of patents for basic science in general and genetics in particular were broadened by two changes in US patent law that occurred in 1980. Congress reversed the longstanding rule that both results and direct applications of knowledge gained in publicly funded research automatically enter the public domain and may be used by all. The Bayh-Dole Act of 1980 allowed scientists or their institutes to patent applications of federally funded research and hold the patents as their own intellectual property.[21] The implications for basic science were increased by the US Supreme Court ruling in *Diamond v. Chakrabarty,* that "anything under the sun made by man" is patentable.[22] This led the US Patent & Trademark Office to reclassify biotechnology advances as "innovations" (applied science that can be patented) rather than "discoveries" (basic science), significantly reinforcing the scramble to be the first to uncover new genetic knowledge or develop a new technique for using it. This was not as large a leap into the unprecedented as it might look at first glance; the US government had defined a new category of "plant patents" covering plants reproduced asexually from cut stems or grafting (but not from tubers as the tubers are foods) in the Patent Act of 1930.[23] European countries extended patents to plants bred from seeds after establishing the International Union for the Protection of New Varieties of Plants (UPOV) in 1961.[24]

A logically similar, though physically very different, situation developed in the very different field of computer software. Computer software has been treated as a written production covered by copyright, allowing developers to assert property rights in their work from the start. As office and personal computers became mass-market items in the 1980s, copyright opened up the prospect of making significant amounts of money by writing widely used programs. At the same time, computer users became dependent on software writers' ability to write programs that would function with one another for two reasons. First, industry adoption of computer architectures in which an "operating system' (OS) provides the interface between the programs that run the machine and the programs that human users employ to indicate what tasks the machine should perform meant that all writers of the human-user programs ("applications") had to write programs that could run on an operating system. Second, many people had ideas for complementary applications and "utilities" that would perform particular tasks more effectively than the original version of some application, and these could work only if they were compatible with the main application program.

Patent and copyright protections have been reinforced in recent years. In the USA the Reagan (1981-89), Bush senior (1989-1993), and Bush junior (2001-2009) administrations strongly supported the expansion of intellectual property rights both within the USA and globally through the Trade-Related Intellectual Property

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[21] Public Law 96-517; *United States Code*, Title 35, Chapter 18 (sections 200-220) "patent rights in inventions made with federal assistance".

[22] *Diamond v. Chakrabarty*, 447 U.S. 303 (1980). The dispute involved a bacterium with genetic modifications enabling it (unlike any naturally occurring variety) to break down crude oil.

[23] US Plant Patent Act of 1930, *United States Code*, Title 35, sections 161-164.

[24] The 1961 International Convention for the Protection of New Varieties of Plants and later amendments are available at http://www.upov.int/en/publications/conventions/index.html (accessed 10 July 2009). A database of national plant patent laws is maintained at http://www.upov.int/en/publications/npvlaws/index.html (accessed 10 July 2009).

Rights Agreement (TRIPS) included in the set of international trade agreements administered through the World Trade Organization. The copyright rules covering computer software have been interpreted to mean that software writers are not obligated to disclose all of their source code to hold copyright. This has enabled Microsoft to maintain advantages in the applications software market by refusing to share all the source code of the successive versions of its Windows operating system. Both TRIPS and the decisions to permit patents of genetically modified organisms remain controversial. Many advocacy groups regard them as amounting to a new "enclosure" allowing private individuals and firms to assert ownership over knowledge, medicines, and life forms that ought to be shared in common.
The threat to diffusion of information perceived to be posed by patents in genetics and copyright in computer software evoked strong response in both areas. The response to Microsoft's market dominance combined anti-trust litigation against the company, which had limited success, and emergence of the "free software"/ "open source" movement among computer programmers who, following Richard Stallman's lead, use copyright law to establish and maintain a norm of disclosing all code so anyone can use it. This is accomplished through the General Public License under which a software developer using any of the Unix-style operating systems or application software covered by a GPL as elements of a new software product must reveal all the code and issue a GPL for that new software product.[25] Concerns that patents might be used to shift the traditional line between "basic" and "applied" science by asserting ownership claims to the "expressed sequence tags" (ESTs) that permit more rapid analysis of gene sequences or even to the human genome sequence itself inspired editors of scientific journals to insist that new cell lines, hybridomas and DNA clones described in published papers be made available to other scientists[26] and others to organize projects for getting them into public databases before any patents were granted.[27] Critics of allowing sale of genetically modified plants, foods, or animals have also made reversing rules defining new life forms as patentable part of their campaign in the expectation that removing property rights would reduce corporate interest in developing GM organisms.[28]

The debates about patents, copyright, and other intellectual property are very complex because participants give priority to different values. Inventors and innovators are particularly interested in the financial stakes, particularly in recapturing the costs of developing their inventions into marketable items. Scientists are concerned with maintaining their ability to generate basic scientific knowledge in fields where knowledge-generation depends increasingly on laboratory instruments and particular compounds or other physical objects. Governments increasingly seek to foster innovation but are also pressed by social movements and activist groups to give greater priority to ecological safety and social equity.

Most participants in contentions over intellectual property rights are not proposing to abolish patents and copyright altogether. Debate generally focuses on how long copyright protection should apply, what sorts

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[25] Advocates present their arguments in Chris DiBona, Sam Ockman and Mark Stone, eds., *Open Sources: Voices from the Open Source Revolution* (Sebastapol, CA: O"Reilly, 1999); also see the Open Source Initiative website at www.opensource.org.

[26] Donald Kennedy, *Academic Duty*, Cambridge, MA: Harvard University Press, 1997, p. 206.

[27] Janet Hope, *Biobazaar* (Cambridge: Harvard University Press, 2008).

[28] E.g., the No Patents on Seeds appeal endorsed by farmers' organizations in several countries at www.no-patents-on-seeds.org (accessed 30 June 2009); Mae-Wan Ho and Angela Ryan of the Open University, UK lead an effort to recruit scientists to support such a ban. See M.W. Ho, 2009, "Europe holds the key to a GM-free world" address to the 5th Conference of GM-Free Regions, Food, and Democracy published in *Science In Society* 43 (2): 21-24.

of writings and artistic productions should be covered by copyright, what sorts of innovations should be covered by patents, and when governments should use provisions for compulsory licensing of patented technology contained in virtually all national laws and in the TRIPS agreement.[29]

Except in computer software, which is covered by copyright, debates about intellectual property rights inspired by advances in science or engineering focus on patents. Many critics of genetic modification technology want to remove patent protection from genetically modified plants and animals as a way of reducing the incentive to pursue genetic modification. They believe the prospect of significant financial gain encourages too much research into applications of genetic modification technology and also prompts corporations to ignore its health and environmental risks. Some critics of rising pharmaceutical costs and of the "medicalization" of life by use of drugs to address a wide range of behavioral patterns also propose removing or drastically restricting patent protection for new drugs, others prefer addressing situations in which there is broad need for access to newly developed drugs, as in the global AIDS epidemic, through compulsory licensing.

Study Questions

1.) Why do governments, corporations, and social groups sometimes want to control the spread of scientific and technical information? Are their reasons identical or different?

2.) How might those who want to get hold of that information do so?

3.) In what circumstances are their efforts likely to be successful? Unsuccessful?

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[29] See the WTO's "FAQs on TRIPS and Health: compulsory licensing of pharmaceuticals" at http://www.wto.org/english/tratop_e/trips_e/public_health_faq_e.htm (accessed 10 July 2009).