AC 2012-3653: DO WE CONTROL TECHNOLOGY OR DOES TECHNOLOGY CONTROL US?

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Do We Control Technology or Does Technology Control Us?

Abstract:

William Wulf has suggested that the use of tools, i.e. technology, is what defines us as human. Might technology also be a genie that once released cannot be returned to its bottle? This paper describes a course for a mixed group of first-year engineering and liberal arts students, designed to explore the history and future of the human-technology relationship. This course is part of a college-wide program that develops students' critical reading, writing and discussion skills. The expectation is that exploring the relationship between technology and society will engage both engineering and liberal arts students.

From the classical myth of Prometheus to Mary Shelley's *Frankenstein* to IBM's Watson computer and beyond, the course explores the relationship between technology and progress, technology and happiness, and technology and human freedom, offering students contrasting views of what drives technology and how best to cope with its uncertainties. Students examine the social context in which technology operates, ethical considerations related to technology, and gain practice in critical reading, writing and presentation skills.

1. Introduction

Do we control technology, or does technology control us? Since technology is a human activity – indeed the former Director of the National Academy of Engineering, William Wulf, suggests that technology is what *defines* us as human – the answer seems self-evident: of course we control technology.[8] But might it be the case that technology is a genie, which once released cannot be coerced back into its bottle?[43] How does this change us as humans?

These fundamental questions provide the opportunity to engage first-year students from both engineering and the liberal arts with important issues regarding the direction of technological progress and more generally, the relationship between technology and society. Addressing these questions will also help students develop critical reading, thinking and communication skills and more importantly will help prepare them to live in a more technologically complex future.

While not specifically created as a course in "technological literacy," certainly it is the expectation and intention that students understanding of the social aspects of technology will be enhanced, and success in this endeavor will be tested. To provide context for the technology component of this course, consider the four "Standard Models" developed at a 2007 workshop sponsored by the NSF and the National Academy of Engineering.[38] Four general types of tech lit courses were described, along with examples of each. The course here fits in category 4:

1. Technology Survey courses, which address a broad range of technologies
2. Technology Focus or Topics courses, which cover a single technology in more depth
3. Engineering Design for Everyone, often with a hands-on design component
4. Technological Impacts, Aspects and History courses

The paper proceeds as follows. The next two parts describe the overall content of the course, and a sample of readings. The material is chosen to promote the objectives of the course, namely to provide students with opportunities to practice the critical reading, writing and discussion skills which are important learning outcomes of a college education. An additional goal of this course is to promote students' ability to address the relationship between technology and society, and the fourth section describes the course design, assignments used, and an overview of how specifically students' awareness of social aspects of technology will be assessed. The concluding section suggests ways in which this course fits into the broader national initiative to better integrate engineering and liberal education.[35, 73]

The goal of this latter initiative, as demonstrated at Union's annual Symposium on Engineering and Liberal Education, [74] is to lead students to think broadly and see how ideas from different disciplines can be brought to bear on questions of mutual interest, rather than addressed in isolation. When problems are pigeon-holed into disciplinary boxes, answers may be easier, but without context, those answers may not be correct or complete. Forcing students to relate ideas from different disciplines is intended to force them to think at higher levels in Bloom's taxonomy, and engage in synthesis and evaluation.[39] In 1959, C.P. Snow lamented the breakdown in communication between the Two Cultures: humanities and science/ technology.[67] The course described is also intended to provide a model of the type of social discourse desirable for managing the future directions of technology.

2. Course content

Advances in artificial intelligence, as exemplified by the success of the IBM computer Watson on the TV game show Jeopardy,[31] driverless cars developed by Google,[45, 71] and smart systems that control urban traffic,[75] illustrate the beginnings of technologies that "think." As technology becomes smarter, the self-replicating robots of Capek's *R.U.R.*[10] seem less fantastical, and the coming singularity, when machines overtake or merge with humans,[42] seems a real possibility. Even today, we can ask whether we can live without our technologies. We are certainly inconvenienced or worse when our technologies fail. Moreover, when technologies bite back, we wonder what should or could have been done.[72]

As modern society becomes more entwined with its technologies, a host of other questions arise: Does technology make us happier? If not, what is its purpose? Is technology creating a new class structure, a technological ruling class? And ultimately, how is technology changing what it means to be human?

Ours is not the first generation to ponder the relationship between humans and our technologies. Myths were created to describe what happens when humans step outside of nature and 19th Century Luddites felt powerless during the industrial revolution. We are not the first to feel that we live at a pivotal time, but something undeniably new and dramatic *is* happening to us, with technology at its core. Population is exploding, we have discovered and rapidly exploited new energy sources, and we have dramatically enhanced the capabilities of the human brain with computational tools that dwarf human abilities.

Moore's law, which states that the number of transistors on a standard chip will double every two years, has held since 1970. It is, of course, a law in neither the political nor the scientific sense, but rather is a pattern of technological evolution, spurred by human ingenuity and competitive spirit. The human genome project, predicted to take 15 years to complete in 1990, was finished in only ten and the life-cycle of technology products gets shorter and shorter. McKibben talks about our moment in technological history as being at the "knee of the curve" of exponential growth in technological change, adding "the rate of exponential growth itself seems to be exponentially growing."[46] Kurzweil dubs this the "law of Accelerating Returns."[41]

To some, it appears that technology is willing *itself* forward. This is the idea of technological determinism, sometimes also called the "technological imperative." Authors like Kevin Kelly and Neil Postman suggest that technological evolution is an extension of biological evolution, and follows an evolutionary pattern of its own. [34, 58] Others see the sweep of human history as having been shaped in response to technology.[66] The unifying theme of the determinists is that technology becomes so pervasive in culture that people lose the ability or the will to exercise control.

Minor exceptions notwithstanding, the evidence suggests a fairly continuous evolution toward more complex and ubiquitous technology. But evolution toward what? How much of a step is it from IBM's Watson,[31] to the HAL of *2001,*[40] to *The Matrix*?[79] How far are we from technology as servant to technology as master? Who or what is in charge here, and should we care? Unless we are to become the proverbial frog in a frying pan, we (engineers and everyone else) must be prepared to think proactively about these questions. Proactive thinking does not mean trying to stop technology, but rather trying to understand and plan for where it is heading. The intent of this course is to lay the groundwork for this kind of thinking.

3. Core readings

Core readings for the course will be drawn from many times, places and disciplines, and will include a mix of primary and secondary material. The organization will be loosely chronological, from past to present to future.

a. Origins of technology: Mythical and historical origins

Diamond, "The Worst Mistake in the History of the Human Race,"[15] and *Guns, Germs and Steel* (excerpts)[14]
The Book of Genesis (excerpts)[24]
Hesiod, *Works and Days,* (excerpts on the myth of Prometheus)[28]
Panofsky, *Pandora's Box* (excerpts)[55]

In this portion of the course, students explore the beginnings of technology, as humans first begin to use tools and systems. Neil Postman has dubbed this long era of human development as the "tool-using" era.[58] Technology existed to solve specific problems, although then as now, technologies like agriculture (Diamond[15]) and fire (Hesiod[15]) began an apparently irreversible process of technological change.

b. Technology and progress: The human drive/obsession with technology-based progress

Allenby and Sarewitz, *The Techno-Human Condition* [3]
Kubrick, *2001: A Space Odyssey*[40]
Miller, *A Canticle for Leibowitz* [48]
Petroski, *Remaking the World* (excerpt: "Men and Women of Science")[56]
Shelley, *Frankenstein, or the Modern Prometheus*[64]
Stoll, *The Great Delusion*: *A Mad Inventor, Death in the Tropics, and the Utopian Origins of Economic Growth*[70]
Winner, *The Reactor and the Whale* (excerpts)[80]

While technology carries with it the connotation of being utilitarian, it was with the scientific and technological revolutions of the 16th – 18th centuries that the idea of equating technology and progress was born. Mumford credits Francis Bacon with the idea of scientific and technological progress as the engine to better the human condition.[49] The readings in this section examine the ways that progress has been interpreted. While most 19th century observers accept the notion of a technological utopia, Mary Shelley is among the first to challenge the blind faith in technology as progress. [64]

c. Technology and happiness: (How) Is technology making us better off?

Easterbrook, *The Progress Paradox: How Life Gets Better While People Feel Worse*[17]
Csikszenmihalyi, "Future of Happiness"[12]
Sahlins, "The Original Affluent Society"[60]
Sarewitz, "Science and Happiness"[61]

One element of progress is assumed to be happiness. In this section, students explore the links between technological advance and the human condition. This includes examining the (inexact, to be sure) science of happiness, and the connection between material wealth and a sense of satisfaction. Postman views us as having moved from the "tool-using" era, through a technocracy, to what he calls a technopoly.[58] In this current stage, according to Postman, technology has become the source of meaning in our lives, replacing older forms of meaning and identity. The question posed by the readings in this section deal with what choices people have regarding their engagement with technology.

d. The future of technology: Visions of the technological future in fact and fantasy

Capek, *R.U.R.*[10]
Fukyama, *Our Posthuman Future* (excerpt)[21]
Joy, "Why the Future Doesn't Need Us"[32]
Kaku, *Physics of the Future* (excerpt: "Future of Humanity")[33]
Kurzweil, *The Age of Spiritual Machines*[41]
Stephenson, *The Diamond Age* [69]
Verne, *Paris in the Twentieth Century*[76]
Vinge, *Rainbow's End* [78]
Wachowski Brothers, *The Matrix*[79]

The future of technology is a large and rich area to explore. Many authors and artists have considered either technological utopias or dystopias, and the poles are if anything getting farther apart. In *2001*, HAL affects the lives of the astronauts aboard Discovery One. The sentient machines of *The Matrix* enslave the human race. Bill Joy sees the time when machines will supplant humans; Ray Kurzweil sees the day when machines and humans will merge. These issues all seem far-fetched, but so did humans on the moon in 1969 when the Wright brothers first flew in 1903, a mere 66 years earlier.

e. Is technology deterministic? (How) Can we control technology if we want to?

Drexler, *Engines of Creation* (excerpt: "Strategies and Survival")[16]
Ellul, *The Technological Bluff* (excerpt: "Human Mastery over Technique")[18]
Kelly, *What Technology Wants* (excerpt: "Lessons of Amish Hackers")[34]
Nye, "Does Technology Control Us?"[53]
Postman, *Technopoly: the Surrender of Culture to Technology*[58]
Smith, "Technological Determinism in American Culture"[66]

Did the flight of the Wright brothers make a trip to the moon inevitable? Did the utilization of oil make the automobile inevitable? Does the human genome project make human cloning inevitable, and does Watson make the Singularity inevitable? The readings in this section raise many questions about how technology develops, and what controls humans can and should have over technological change. There are isolated examples of human control of technology: the Japanese decision not to adopt gun technology; the Chinese destroying their ocean-going fleet; the banning of thalidomide in the U.S., and the global elimination of chlorofluorocarbons for use as refrigerants. Other attempts to slow or restrict technology have been less successful. As one small example, in December, 2011 *The New York Times* reported on government efforts to block the publication of scientific information on a virile form of bird flu. The researcher, however, "expressed doubts that the information can be kept out of the wrong hands."[11]

Beyond the question of technological determinism, students also explore in this section ways that the citizenry can be prepared for the changes technology brings. For example, Drexler, Kelly and Postman each offer proactive approaches to ensuring that future technologies are developed "to serve mankind" in the best sense of that phrase.

4. Course design

A key design feature of the course is that the readings will be drawn from across the academic spectrum: from humanities, the social sciences, the natural sciences and engineering. The variety of readings will mean that no one will be expert in everything, but a desired outcome is for students to develop a comfort level with many different types of texts.

In addition to the assigned readings, students will be encouraged to focus on material from a particular discipline or historic era, including but not limited to: histories of technology (Basalla,[5] Brown,[9] Diamond,[13,14] Petroski[57]); philosophy of technology (Allenby,[3] Elull,[18,19] Fukyama,[20,21] Haraway,[25] Kelly[34]); social studies and visions of technology (Esterbrook,[17] Heinberg,[27] Hughes,[29] MacKenzie,[44] Smith,[66] Staudenmaier[68], Stephenson[69]); visions of the future (Brockman,[7] Kaku,[33] Miller,[48] Nye,[53] Schmidt[62]); and among the latter, the blurring line between humans and machines (h+ Magazine,[65] Huxley,[30] Kurzweil,[41,42] McKibben,[46] Vinge[78]). Students will be particularly encouraged to examine the modern passion for growth and whether the human need/desire for economic growth is a primary driver of technology (Heinberg,[26] Meadows,[47] Nelson,[52] Olson,[54] Schumacher,[63] Victor[77]). Within the context of the course, the plan is to develop "T" shaped students, with each student becoming expert in one aspect of the readings, with general knowledge about the broader subject of the course.

Since one of the college-wide objectives for courses in this program is improved writing, students work will include written reactions to the readings and prepared questions. Students will also complete four or five papers, each three-to-five pages in length, on topics which mirror the organization of the readings. Each week students will prepare either a new or a revised paper, drawing evidence from the assigned readings and beyond. Editing and revision based on peer and instructor feedback are a key component of the course. Students will prepare a poster based on one of their papers for an open presentation. This exercise will give them the experience of condensing their argument into a clear, visually compelling format, and will give them practice in oral expression.

The seminar format of the class means that students will frequently voice their questions, and are expected to prepare for class in small in-person and online groups. In particular, students will frequently work in pairs, a format which offers the pedagogical advantages of groups, while ensuring participation of all (both) members.[22] In addition to the motivating and creative aspects, pairwork enables students to explore the questions they bring to class, and to try out their arguments on their peers.

In addition to a college-wide end-of-term student course evaluation, students course are assessed using a six-point writing rubric. Because of the highly interdisciplinary nature of this section, there will also be some formative assessment administered during the course to help gauge how well students are engaging with one another and with the diverse text material. The success on the latter score will also be evident in the quality of the written work submitted.

An important component of the assessment process will be to examine how students' awareness of the social aspects of technology have developed. The course will utilize a variant of the exercise and rubric developed by Krupczak and Misovich which was designed to assess ABET outcome (h) among first-year engineering students.[39] The exercise simply asks students to predict possible social impacts of some recently introduced technology. Responses are scored on the basis of the quantity and quality of listed impacts. Table 4.1 describes the Krupczak-Misovich rubric. Versions of this exercise will be administered on the first and last days of the course, and to a random group of students in other sections of Union College's First-Year Preceptorial, sections which do not deal with the topic of technology and society.

Table 4.1: Rubric for Scoring Predictions of Societal and Global Impacts.[39]

0 points	Answer is not an impact
1 point	Direct, obvious, readily apparent.
3 points	Insightful and less obvious direct impact.
5 points	Second-order impact, such as an impact from an impact

Although as first-year undergraduates, the students will not be very far into their disciplines – some may not have even declared a major – the course will seek to overcome some of the documented problems with interdisciplinary courses. Following Richter and Paretti,[59] students will be asked to observe how each discipline addresses a particular problem, to see the strengths and weaknesses of different disciplinary approaches, and in particular to see the modes of thinking and methodologies of different disciplines.

5. Conclusion

As noted, in 1959 C.P. Snow suggested that the language barrier between the sciences and the humanities ill serves both.[67] Whether or not technology is truly deterministic, beyond anyone's control, when scientists and engineers do not, or cannot communicate with the broader public, then as far as that public is concerned, the path of technology is beyond control. One objective of the course is to foster informed, mutually intelligible discourse.

The learning outcomes listed by ABET for engineering students[1] and by AAC&U for liberal education[4] both include the ability to integrate information from multiple sources in addressing new questions and issues. It is important for the next generation of humanists and engineers to think collectively about where technology taking us. The phrasing is deliberate, because it appears that technology is indeed leading. Or more accurately, technology is continuously opening doors through which we are powerless to resist entering. We sometimes resist for a short time, and some will refuse to pass through, but experience suggests that once something *can* be done, it very likely *will* be done.

It is equally important for engineering students, indeed for all students to be open to new ideas and methods of inquiry. In recognition of the need, there is a rising chorus of voices calling for a more holistic approach to engineering education, and the same desire for integrative thinking exists in other parts of the academy.[6, 23, 35, 36, 37, 50, 51, 73, 74] It is the author's hope that this paper will provide the motivation and an entry into the literature on one particularly relevant area of discourse, technological determinism, and encourage others to challenge their students, both in engineering programs and in other fields to work together in addressing questions about the evolution of technology.

A New Yorker cartoon from the 1940s by Charles Addams depicts a long row of humanoid robots standing in front of a workbench on which they are assembling identical humanoid robots. Two men are walking along the row and the one in the white lab coat remarks, "Sometimes I ask myself, 'Where will it ever end?'"[2] Today we may *feel* that we have lost control of technology, but today's students may well live to see technology *actually* begin to create itself and actively take control. This course is designed to help students critically examine different theories about how technology moves, and to prepare them to guide it wisely. The question in the balance is, will we control technology, or will technology control us? We may not have the answers, but today's students should at least be armed with the tools to pursue them.

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