Science, Technology, and Values

PHIL 4310: Philosophy of Technology
HUHI 6351: History and Philosophy of Science and Technology

Professor Matthew J. Brown
Spring 2014

Note: This course has two sections, one graduate and one undergraduate, with somewhat different requirements.

1 Instructor Information

1.1 Contact

The most effective way to contact me is via email at mattbrown@utdallas.edu. I am a moderately reliable email correspondent, but in the flood of daily email I sometimes miss your missives. If you have a time-sensitive query, please send it well in advance. If I fail to respond to your email within 24 hours, please feel free to send me a reminder. I will not be offended by a gentle reminder, so long as you do not abuse the privilege.

If you want to meet in person, it is better to schedule an appointment via `http://doodle.com/mattbrown` than to try to arrange an appointment via email. Doodle appoinments are fairly easy to use. Please suggest a variety of times and dates, as the doodle calendar does not always exhaustively reflect my time commitments. My office is JO 4.120.

I am obligated to inform you that I can be reached in my office by phone at 972-883-2536. It is not a very reliable way to get in touch with me.

1.2 Notes on Forms of Address

It is appropriate and courteous to refer to your professors by the title of "Professor" or "Doctor" as in "Professor Brown" or "Dr. Brown," though in some circles the latter connotes someone with an MD rather than a PhD. Unless you write for the New York Times, it is generally inappropriate to refer to your professor as "Mr." or "Ms./Mrs./Miss." Having been educated in part in the informal academic climate of California, it would also be fine if you call me "Matt." (Please don't call me "Matthew," only my mother does that.) Having also been educated in the South, I am fine being referred to in a formal fashion as well (and would be happy to refer to you formally if you prefer).

2 Course Information

2.1 Course Website

Check the course website for updates and links to readings:
http://classes.matthewjbrown.net/stv/

2.2 Course Description

The technosciences are objective, value-free, rational, and inevitable: these are the myths that this course will question. Our human values and social concerns have deep connections to science and technology. This course will explore those connections from a variety of philosophical perspectives. The development of science and technology involve personal, social, and political decisions. In this course, you will learn to question whether those developments are responsible and appropriate.

2.3 Course Objectives

Some objectives should be shared by all courses: to enjoy and celebrate the life of the mind, to help the student grow, mature, become more interesting, become a better person, etc. Here is what I hope you will achieve in this course in particular:

- Students will come to better understand the nature of science and technology and the role of values therein.
- Students will demonstrate an awareness of the contingency in our choices about technical design, scientific progress, and change in technical and scientific paradigms, as well as the role of choice and thus responsibility in those processes.
- Students will think critically and deliberately about the role of science and technology in our lives, in general and in the case of particular scientific and technical achievements.
- Students will become a positive force for socially responsible scientific and technological development.
- Students will learn to do research in the mode of history and philosophy of science, technology, engineering, mathematics, and medicine.
- Students will develop abilities to read and write about complex texts.
- Students will demonstrate effective written and oral communication skills

That will be quite enough for one semester, I should think.

2.4 Texts

All students will will need to obtain a copy of the following book:

- Hubert Dreyfus, *On the Internet* (second edition, 2009)[1]

All students will also need to obtain a copy of "In the Beginning was the Command Line" by Neil Stephenson, which can be had:

- For free from the author, as a rather long, plain text file.
- As a handy, inexpensive little paperback.
- In various other formats. Google around.

These books are required for graduate students:

- Herbert Marcuse, *One-Dimensional Man*
- Evgeny Morozov, *To Save Everything Click Here*
- Heather Douglas, *Science, Policy, and the Value-Free Ideal*
- Wagner & McGarity, *Bending Science*

You should also consider picking up the following two introductory texts, as they help provide an overview of the main fields for this class:

- Val Dusek, *Philosophy of Technology: An Introduction* (2006)
- Gillian Barker and Philip Kitcher, *Philosophy of Science: A New Introduction* (2014)

These texts are all on order at Off Campus Books, but not the campus bookstore.

All other readings will be provided electronically. You are required to bring all relevant readings to class for discussion. You should bring readings in a distraction-free format, whether that be physical printout, ebook reader, or laptop with internet access shut off.

The ability to mark up a book (or an essay) is indispensable to active reading. Therefore, you must choose a way of reading that permits annotation. For some, that will mean paper copies and pencil. For others, you know well how to annotate on PDF or your ebook reader.

[1] The first edition will not do.

2.5 Assignments

The first assignment on each list is worth roughly twice what the other assignments are worth. (Also, see below on "Citizenship Points.")

2.5.1 Graduate section

1. Research paper - 8000 words or less
2. Research records - Full annotated bibliography, search records, reading notes, etc.
3. Research reports - Periodically during the semester, students will have to give preliminary reports to the class on the progress of their research project, and another report at the end.
4. Reading questions - Due 24 hours before class begins, by email.
5. Attendance and participation

2.5.2 Undergraduate section

1. Service learning project - Group project, with presentation and individually-written papers
2. Ethics advising project
3. Reading questions - Due 24 hours before class begins, by email
4. Attendance and participation

2.6 Class Schedule

Dates in brackets, e.g.: [**G:**1/13::**U:**1/21], which means the graduate section will be on January 13th, the undergrad on January 21st. When some readings are listed in **bold**, they should be the focus of your attention.[2]

2.6.1 Unit 0: Introduction

1. What are science and technology? How do they work? Why do they require values? [**G:**1/13::**U:**1/14]
   - **Readings:** No required readings, but it is recommended that you have a look at the books by Dusek and Barker & Kitcher. A good introduction to traditional ways of thinking about science is Stephen Carey's *A Beginner's Guide to Scientific Method*. An alternative to Barker's & Kitcher's introduction to philosophy of

[2] That is, you should devote the most time to working through them, consider asking reading questions about them, and if you start to run out of time, make sure that you read them. Some weeks have significantly more reading than others, and so this is meant as a guide through those weeks. Unbolding readings might be secondary sources that explain the bolded readings, or may broaden or extend the topics of the core readings. You should generally be familiar with all of the readings before coming to class.

science is Peter Godfrey-Smith's *Theory and Reality: An Introduction to the Philosophy of Science*. For more on the philosophy of technology, Carl Mitcham's *Thinking through Technology* is a more thorough and historically oriented introduction. The Stanford Encyclopedia of Philosophy has a nice overview as well `http://plato.stanford.edu/entries/technology/`.

2.6.2 Unit 1: The Value of Science and Technology

2. The Value of Science [**G:**1/13::**U:**1/21]

   - **Readings:** Richard Feynman, "The Value of Science"; Ian James Kidd, "The Truth, the Good, and the Value of Science"

3. Existential and Materialist Critiques of Technology [**G:**1/27::**U:**1/28]

   - **Readings: Martin Heidegger, "The Question Concerning Technology"**; Hubert Dreyfus, "Heidegger on Gaining a Free Relation to Technology"; **Herbert Marcuse, *One-Dimensional Man* (selections)**; Andrew Feenberg, "The Critical Theory of Technology"
   - *Graduate students:* Also read the rest of *One-Dimensional Man*, focusing on the Introductions, "New Forms of Control," and "The Closing of the Political Universe."

4. Pragmatist Theory of Science and Technology [**G:**2/3::**U:**2/4]

   - **Readings: John Dewey, "Science and Society"; Larry Hickman, *Philosophical Tools for Technological Culture* (selections)**; Matthew J. Brown, "John Dewey's Logic of Science"
   - *Graduate students:* Also read John Dewey, "Common Sense and Scientific Inquiry" and "Science and Free Culture"

2.6.3 Unit 2: The Role of Values in Science and Technology

5. What are the aims of science and technology? Which problems should we try to solve? [**G:**2/10::**U:**2/11]

   - **Readings: Kitcher, "Well-Ordered Science," *Science in a Democratic Society***; Reiss and Kitcher, "Biomedical Research, Neglected Diseases, and Well-Ordered Science"; Flory and Kitcher, "Global Health and the Scientific Research Agenda"; **Evgeny Morozov, "Solutionism and Its Discontents," *To Save Everything, Click Here***
   - *Graduate students:* Also read the rest of *To Save Everything, Click Here*.

6. How do we produce data ethically? [**G:**2/17::**U:**2/18]

   - **Readings: The Nuremberg Code**; World Medical Association Declaration of Helsinki; Paul McNeill, "Experimentation on Human

Beings"; **Leonardo De Castro, "Ethical Issues in Human Experimentation"**; Public Health Service Policy on Humane Care and Use of Laboratory Animals; Bernard E. Rollin, "The Moral Status of Animals and Their Use as Experimental Subjects"; Bernard E. Rollin, "The Regulation of Animal Research and the Emergence of Animal Ethics: A Conceptual History"; **JJ Sylvia, "The Ethical Implications of A/B Testing"**

7. How should we frame solutions? [**G:**2/25::**U:**2/25]

    - **John Dupré, "Fact and Value"**; **Kevin Elliott, "The Ethical Significance of Language in the Environmental Sciences"**; **Kathleen Okruhlik, "Gender and the Biological Sciences"**; The Biology and Gender Study Group, "The Importance of Feminist Critique for Contemporary Cell Biology"; Sarah Blaffer Hrdy, "Empathy, Polyandry, and the Myth of the Coy Female"; **Carl Zimmer, "In Ducks, War of the Sexes Plays Out in the Evolution of Genitalia"**; Patricia Brennan, "Why I Study Duck Genitalia"

8. How do we decide that we have the right solution? Accepting scientific hypotheses. [**G:**3/3::**U:**3/4]

    - **Readings:** Richard Rudner, "The Scientist *qua* Scientist Makes Value Judgments"; **Heather Douglas, "Inductive Risk and Values in Science"**; **Helen Longino, "How Values Can Be Good for Science"**; Elizabeth Anderson, "Uses of Value Judgments in Science"; Matthew J. Brown, "Values in Science beyond Underdetermination and Inductive Risk"
    - *Graduate students:* Instead of "Inductive Risk…" read *Science, Policy, and the Value-Free Ideal*, focus on Chapters 3-5.

9. *Spring Break* - No Class [3/10-3/14]
10. How do we decide that we have the right solution? Ethical and political considerations in designing artifacts. [**G:**3/17::Ue:3/18]

    - **Readings:** Langdon Winner, "Do Artifacts Have Politics?"; Peter-Paul Verbeek, "Morality in Design"

2.6.4 Unit 3: Evaluating Technoscience: Case Study

11. A critique of the Internet. [**G:**3/24::**U:**3/25]

    - **Reading:** Hubert Dreyfus, *On the Internet*, focus on the introduction and chapters 1, 2, and 4.

Also, the science and technology of food provide an interesting case study that will be informing the lectures and events of the UTD Center for Values in Medicine, Science, and Technology. On February 27, David Kaplan will deliver a lecture on "Whats Wrong With Food Additives." On 4/23, Roberta Millstein's evaluates genetically modified organisms in her lecture, "Genetically Modified Food: Feeding the World or Fouling the World."

2.6.5 Unit 4: Who Creates Science and Technology?

12. The effect of sexism in tech culture and the tech industry. [**G:**3/31::**U:**4/1]

    - **Watch: Anita Sarkeesian, "Tropes vs Women in Video Games,"** ***Feminist Frequency***
    - **Read:** Elise Hu, "Sexism In The Tech Industry Takes Center Stage" NPR *All Things Considered*; **Joseph Reagle, " 'Free as in sexist?' Free culture and the gender gap,"** ***First Monday***
    - *Also:* Do some reading up online about "dickwolves", "titstare", "Adria Richards", and the low representation women in tech fields and majors.

13. The effect of corporate influences on science. [**G:**4/7::**U:**4/8]

    - **Readings:** Justin Biddle, "Lessons from the Vioxx Debacle: What the Privatization of Science Can Teach Us About Social Epistemology"; James Robert Brown, "The Community of Science"; Julian Reiss, "In favour of a Millian proposal to reform biomedical research"
    - **Watch:** James Robert Brown, "Patents & Progress"
    - *Graduate students:* Also read Wagner & McGarity, *Bending Science*, focus on chapters 1-3, 10-11.

14. *Research and writing days* - No class [**G:**4/14::**U:**4/15]

2.6.6 Unit 5: Moving Forward by Slowing Down and Looking Backward

15. Can we take a more deliberate, appropriate, and responsible approach to science and technology? [**G:**4/21::**U:**4/22]

    - **Readings:** Wendell Berry, "Why I am Not Going to Buy a Computer"; Alan Drengson, "Four Philosophies of Technology."; Janet Kourany, "Socially responsible science"

16. What can we learn from the past? [**G:**4/28::**U:**4/29]

    - **Readings:** Hasok Chang, **"Complementary science"**, "Philosophy as complementary science", and **selections from *Inventing Temperature*; Neil Stephenson, "In the beginning was the command line";** Ted Nelson, "Ted Nelson's Computer Paradigm, Expressed as One-Liners"
    - **Watch:** Ted Nelson, Computers for Cynics

2.6.7 Final Exams

Students will have required in-class presentations during the final exam period. Details forthcoming.

3 Course Policies

3.1 Citizenship Points

Each student begins the semester with two citizenship points. Citizenship points can be spent in the following ways:

- 1: Skip this week's reading questions (must be "cashed in" by the deadline)
- 1: Delay preliminary report 1 week (grad students, 24 hours notice)
- 2: Free absence (no impact on attendance grade)
- 3: Skip a preliminary report entirely (grad students, 24 hours notice)
- 3: Bump participation grade up 1 letter grade (end of semester).

Citizenship points can be earned in the following ways:

1. Submit really excellent reading questions (I expect to usually award 1 at most in any given week).
2. Really excellent class participation (ditto).
3. Attend a Center for Values event or activity.

A few other ways to earn points may arise throughout the semester.

3.2 Late Work and Make-Up

No late work or make-up exams will be allowed without consent of the professor *prior to* the due/exam date, except in situations where University policy requires it.

3.3 Class Attendance

While reading and writing are crucial parts of the course, a central part of intellectual activity is in-person discussion. (Hence the continuing importance of talks and conferences in every academic field.) While class will occasionally involve bits of lecture, this is merely an instrument to a more well-informed discussion and other structured activities. **Attendance is thus considered mandatory.** Missed classes will count against your participation grade, and egregious absenteeism will be grounds for an **F** in the course at the professor's discretion. In-class assignments and activities likewise cannot be made up unless the professor agrees to it before the class is missed. Disruptive late arrivals or early departures are poor classroom citizenship and will also negatively impact your participation.

3.4 Classroom expectations

You are expected to have read the assignments before class, and it would be to your benefit to also read them again after class. You are expected to bring all of the texts assigned for each day's class, and have them available to refer to. You are expected to listen respectfully to the professor and your fellow students, and participate in class discussions and activities.

3.5 Other Stuff

http://go.utdallas.edu/syllabus-policies

A syllabus is not a suicide pact. This syllabus is subject to change in the interest of improving the quality of the course.

4 Narrative Syllabus

What follows is an extended overview of the topics of this course and the relation of the particular topics and readings to the general topic and course objectives. Reading assignments can be found in the schedule above.

4.1 What are science and technology? How do they work? Why do they require values?

There are many ideas out there about these questions. Though the question "what is science" may seem innocuous, philosophers, historians, and scientists themselves have been wrangling over the question for centuries. We will start with a basic approach, but it would be misleading to describe it as entirely uncontroversial. Throughout the course, different authors will raise some serious trouble for some of the following ideas. Nonetheless, we must start the discussion somewhere.

Science is concerned first and foremost with explaining, predicting, and controlling various phenomena in our world. Such phenomena include various physical objects and their behavior, chemical reactions, living organisms, the mental or cognitive capacities of sentient creatures, the operation of society, and so on. Science accomplishes its task by attempting to identify and stabilize natural **structures**. Science generally presupposes some sort of unobserved connections between those phenomena we experience. Its tools are, on the conceptual side, **theories** and **models**, and on the empirical side, instrumentally-mediated **observations** and controlled **experiments**.

Technology is the invention, refinement, and deliberate deployment of tools and artifacts for the support of human ends.[3] Technology also requires *structures* that can be stabilized and relied upon, and eventually packaged and made habitual. Technology involves principles of **design**, techniques of construction, explicit theories and models of how systems should behave, and so on. Technology is different from the habitual use of tools and artifacts, which we can call "technique" or "technical" rather than "technology."

[3] This definition is heavily influenced by Larry Hickman's reading of John Dewey, which we will discuss in a few weeks.

The two form a continuum and are reciprocally involved with one another. Technology relies on relatively stable structures that can be used to control parts of the world. Science relies on various tools and instruments for observation, experimentation, calculation, modeling, and theorizing. Scientific knowledge can itself be understood as a set of tools for explaining, predicting, controlling, and inquiring. The metaphor of a "machine" or "mechanism" plays an important role in the scientific analysis of natural structures. Technology can be understood as a science of the artificial.[4] The obviously important field of medicine seems to involve both. For these reasons, it has lately become fashionable to talk about **technoscience** rather than science and technology. Nonetheless, for the most part theorists still rely on separate terms, often engaging in inquiries into science and technology separately.

One thing that unites science and technology as defined above is that both are forms of systematic **inquiry**. Inquiry is the process of investigating situations that perplex and frustrate us, identifying problems and seeking solutions that can resolve our perplexity. When the perplexity in question arises in our deployment of explanations and predictions of about world, or our attempt to intervene in natural phenomena, we tend to call that inquiry "science."
When the frustration in question involves tools or artifacts, we tend to call that inquiry "technology."

Values are necessary considerations in science and technology because of the pervasive element of **choice** in each.[5] Scientific inference or technological design involve inherent uncertainties. Scientists, engineers, and designers must make choices in the face of those uncertainties. Choice implies **judgment** and **responsibility**. If I make a choice, I ought to judge carefully and be held responsible for the consequences of my errors. A failure to consider values at all when making such choices would be reckless or negligent.[6] In other words, we make judgments in science and technology about which hypothesis or model, tool or technique, experiment or data analysis is *best* for the job. Those evaluations of what is best (or good enough) are not value-free, subject to merely rational or technical criteria. Such evaluations must be sensitives to our purposes, goals, and ideals, as well as the consequences that follow from making those choices.

Historically, this way of thinking about the role of values in science and technology is rather controversial. Scientists and philosophers have long defended an ideal of science that we might call "the ideal of epistemic purity" or simply "the value-free ideal." Scientists and policymakers have likewise defended a model of the relation of pure and applied science (or science and technology) called "the linear model," according to which pure science produces a store of knowledge,

[4]See Herbert Simon, *The Sciences of the Artificial.*

[5]By "values" we mean that which we care about, desire, approve of, take as an ideal, and evaluate as worthy. Ethics, politics, culture, and religion are some of the major sources of values in our lives, but so are practical concerns and personal preferences. We value beneficial consequences and we disvalue harmful ones. We value rights and duties, and we value virtue and good character. As you can see, "values" are a complex and varied thing, a fact that discussions of values in science and technology can sometimes sadly ignore.

[6]This way of thinking about the role of values is heavily indebted to the work of Heather Douglas, which we will read later on.

which can then be applied to the problems of policy, technology, and so on. Likewise, technology has often been conceived as a neutral tool, an instrument to any end, with no value in and of itself. Hence, "guns don't kill people, people kill people." Yet the idea that science or technology are value-free has slowly eroded over the last half-century, to the point where few philosophers of science and technology who think about these matters find it plausible in its starkest form.

When we think about the role of values in science and technology, we must then think of it in the variety of choices that we make in scientific and technological inquiry. The first part of this course will be structured according to those questions. We will look at relatively general and abstract philosophical versions of those questions, as well as questions about particular scientific and technological developments. We will also consider related questions such as the role of *who* is doing or backing science and technology (and what their values are) has on our evaluations of science and technology, and how future technoscience might proceed in a more ethically responsible fashion.

4.2 What is the value of science and technology?

The first question one must ask is the most basic, speaking to the fundamental role of science and technology in society. Is approaching the world as an object of technoscientific inquiry always, sometimes, or perhaps even never appropriate? What is the value of engaging in science and technology in the first place?

On the traditional view, the value of science and technology themselves can be defended merely by pointing to the **epistemic value** of science and the **instrumental value** of technology. But this view cannot be held uncritically, and is starting to be seen as untenable. We might point also to the aesthetic value of science, its ability to satisfy our curiosity. Going further, **ethical** questions about **the good life** and **existential** questions about our **orientation** in and toward the world may be essential preconditions of understanding the value of science and technology as such.

One way of understanding Martin Heidegger's existential critique of technology (and science) is that technology requires a way of viewing the world (or more accurately, a way of being in the world) that takes the instrumental value of **efficiency** and transforms it into a idol, an overarching value that obscures all other facets of the world besides their function as interchangeable resources. Something very similar is going on in Herbert Marcuse's critique of technology, now transfigured from the existential-phenomenological approach of Heidegger, to the materialist, Marxist approach of the critical theorists. Marcuse questions the role of technology in advanced industrial society, its ability to keep us enslaved to oppressive social and economic institutions though we believe we are free.

For Marcuse, the possibility of change cannot arise from the politically powerful, who benefit from the current system, nor from middle- or working-class people, who are enslaved by the system and unaware of their bondage. It could only arise from those marginalized in the current society. Andrew

Feenberg is somewhat more optimistic. He sees technological development as more contingent, and more responsive to various social pressures. Thus he sees hope in the possibility of intervening in technical planning and design, and the role of technology in society generally. The critical theory of technology could thus prepare the way for a more democratic approach to technological inquiry.

The importance of technology and democracy also loom large for John Dewey. If science and technology are to be of value, we must recognize them as human products, instruments to *our* ends and *our* goods, not the inhuman good of technical efficiency and impartial truth. Science and technology are not *just* problem-solving inquiries, but inquiries that resolve perplexities and frustrations that arise in human practices that matter to us. The results of science and technology should thus serve our values and our interests.

4.3 The role of values in the stages of science and technology

4.3.1 What are the aims of science and technology? Which problems should we try to solve?

The next decision we face, once we determine that it is valuable to pursue scientific and technological inquiry, is what the aims of that inquiry shall be, i.e., what problems we should try to solve. This question cannot be answered by banal exhortations to "seek the truth," for the truth is everywhere and often easily had. Nor can it be answered by mere consideration of instrumental or practical power. We are after *significant* truths, or the answers to *significant* problems, and that **significance** is a question of ethical and social values. We want (or ought to want) not just any power, but the power to bring about social good rather than ill. We need to make value judgments to guide our decisions about what research is worth pursuing (and funding!), what problems are worth solving, which products are worth producing. Clearly, not every question is worth the time it takes to answer it, nor does every important problem have a technical fix.

4.3.2 How do we produce data ethically?

Gathering **facts** to guide our inquiry is generally not so easy as "look and see." **Data** must be produced or constructed in interaction with the world, according to certain methods or techniques. Those techniques must be honest and rigorous. In many types of research, human or animal research subjects may be the main sources of data. These research subjects have interests that must be protected. They must be protected from certain undue **harms**. Medical trials can only go forward when treatment and control meet the **principle of equipoise.** Human subjects must give their **informed consent** before agreeing to take part in research.

It is not only science and medicine that involve research on human subjects. Engineering and design, even if they do not conduct formal experiments, conduct research on human subjects in the form of beta testers, focus groups, and customer feedback. Consider the recent prominence of A/B testing for products on the web. Don't many of the same ethical considerations apply here as to any human subjects research?

4.3.3 How should we frame hypotheses?

The language or conceptual repertoire that we develop and make use of in our inquiries has a surprising effect on our results. How we choose to make use of language matters. This is in part a result of the fact that most of our concepts are not purely neutral, descriptive in content, but also normative. That is, when I make use of a term like "feminine" or "divorce," for example, the connotations of those terms are not merely descriptive, but also evaluative. "Divorce" may not just carry the meaning of a marriage ended, but also a negative sense of failure. When we allow that evaluation to come along with the terminology, it inevitable shapes our inquires. For example, it can make us more likely to exclude or overlook the experiences of those who find divorce to mean freedom from a unhappy or abusive situation.

The choice to pursue one hypothesis is, simultaneously, the choice not to pursue many others. We may think it worthwhile to start with hypotheses that we expect, if true, to maximize social good. But often, scientists and engineers do not spare enough thought for alternatives to the ideas that occur to them. In this way, a variety of biases may naturally (if temporarily) accrue to science.

4.3.4 How do we decide that we have the right solution?

Once we have determined which problem we are trying to solve, framed our hypothesis about how to solve it, and gathered our evidence, we face a further decision about how to evaluate our solution in light of the evidence. Traditional models of science tell us that scientific inference is a matter of the logic of induction or falsification, and in such matters, values play no role. We may guide our decisions about what questions to ask, what answers to pose, and how to gather evidence with our ethical and social values, but when it comes to determining how well our answer fits the evidence, it would be pure wishful thinking to let such values guide our decisions about whether the evidence confirms or refutes a hypothesis. Likewise, determining whether a particular technology works is not a matter of whether it suits our values.

Unfortunately, the matter is significantly more complicated than the traditional view presupposes. There is no decision procedure in science, for confirmation or refutation, that determines whether we should accept or reject a hypothesis. Thus, there is always some degree of choice in that decision. The need for choice is partly a result of two related phenomena termed "underdetermination" and "inductive risk." Because our inferences are uncertain, because the evidence fails to uniquely determine the inference to be made, we must make choices. The choices we make generally have consequences for things that we value, and potentially quite hazardous consequences if we should choose in error.

Thus we are obligated to consider those consequences and other values in making those decisions.

So too, deciding whether a proposed tool or technique is the right solution to a technical problem is more than a matter of determining in a value-free way whether the technology "works." The design of artifacts does more than solve the problem at hand; it reshapes the built environment and our daily lives. Choices of technology can be used to settle political issues, creates advantages and disadvantages to different groups, and requires or encourages certain sociopolitical institutions. As such, technological decisions are ethical and political decisions, rather than "merely technical."

4.4 Evaluating technoscience: Case studies

So far, we have considered a variety of philosophical tools for thinking about the role of values in producing science and technology. In many cases, those tools have also been applied to evaluating current or past technoscientific developments. To put our philosophical tools to the test, and to better understand the role of values in science and technology, it is worthwhile to consider some existing and important technoscientific developments in detail.

In *On the Internet*, Hubert Dreyfus applies a variety of philosophical ideas, including those of Heidegger, Dewey, Kierkegaard, and Merleau-Ponty to various Internet tools and practices. In this short book, Dreyfus discusses the organization of information via hyperlinks (the main protocol for the Web), distance learning, telepresence, anonymous forums and chat rooms, and virtual worlds like *Second Life*. Dreyfus gives us reasons to be skeptical of the unbridled optimism that we often see in discussions of the Internet. (You should compare Dreyfus's critique to Morozov's more recent critique of the Internet in the context of technological solutionism.)

Major technoscientific innovations now play a role in many facets of food production, many of which have become sources of controversy, including the use of artificial food additives and the growing use of genetically modified organisms (GMOs). On February 27, David Kaplan will deliver a lecture at the UTD Center for Values in Medicine, Science, and Technology on "Whats Wrong With Food Additives." On April 23, Roberta Millstein will discuss "Genetically Modified Food: Feeding the World or Fouling the World." You are encouraged to attend these events.[7]

4.5 Who creates science and technology and why it matters

So far, we have talked about the role of values in science and technology and how to evaluate existing science and technology. In the background of these discussions is the question of *whose* values. In general, we have assumed that

[7] You can receive a citizenship point for attending any of the Center for Values events this semester.

ethical reflection or political decision-making processes ought to inform the values at work. In some cases, the question of *who* is producing the research and innovation matters very much. As we saw in cases of gender bias in framing hypotheses, who is doing science may have an impact on which hypotheses are pursued, which technologies are developed. Patterns of exclusion may thus lead to biased and suboptimal results.

What's more, those exclusions may be unfair in their own right. There has been a growing recognition lately of a pervasive degree of **sexism in "tech culture,"** including especially the culture around video games. Anita Sarkeesian, a media critic and creator of the "Feminist Frequency" YouTube video series, has recently drawn attention to the sexist tropes in video games. In return, she has been subjected to a barrage of vulgar harassment. It is common to find "tech bros" making sexist jokes, talking down to women, and engaging in other misogynistic practices (see "Titstare" and Adria Richards). Further exclusionary forces are seen in the gaming webcomic and blog turned media empire, Penny Arcade, and the associated gaming convention, Penny Arcade Expo (PAX), which have engendered controversy by publishing rape jokes and transphobic comments.

Sexism and other exclusionary practices make a difference. Representation of women in the tech industry, i.e., in information and communications technology (ICT) professions, are estimated as somewhere between 10-30% (much lower than that amongst startups and open source software projects). Many women speak about the hostile climate of ICT workplaces. The percentage of women majoring in computer science has been steadily *decreasing* for the past thirty years.

Some influences on science are equally if not more nefarious. In recent decades, there has been an increasing entanglement of commercial interests with science. Corporate-backed researchers as well as university researchers who receive various kinds of corporate funding have had an increasingly important role in a variety of industries. Patenting and licensing of the products of scientific research has become increasingly a part of research, especially in the biomedical sector. **The commercialization of science** is increasingly an important phenomena, in part because it is a potential source of biased and socially irresponsible science.

4.6 Moving Forward by Slowing Down and Looking Backward

4.6.1 Can we take a more deliberate, appropriate, and responsible approach to science and technology?

Part of the problem of values in science and technology is the way that science and technology move ahead without deliberate, explicit reflection on risks and consequences, on the ethical and political values that will be impacted by various courses of research and innovation. There are several approaches to the development of science and technology that are not entirely skeptical or pessimistic, but that recommend slowing down and proceeding with caution.

A **conservative** philosophy of technology would recommend that we only pursue the development of technologies that are consistent with existing values, that do not destroy something good that already exists. Conservatism prefers the certainty of existing goods to the possibility of future goods when the latter comes at the cost of the former, even if there is reason to believe that innovation could bring about much greater value by disrupting existing values. It is, in other words, a very cautious, deliberate approach, but not one that would necessarily disrupt all innovations. A related approach is known as **"appropriate technology,"** which is focused on developments that are environmentally sustainable, decentralized, locally controlled, and appropriate to the values and needs of a particular situation.

Within philosophy of science, one such view is Janet Kourany's **socially responsible science**, which insists that a scientific result is acceptable if and only if it meets a high standard of ethical evaluation that matches the existing standards of epistemic evaluation. In other words, "scientifically sound but socially irresponsible" becomes a contradiction in terms rather than a common problem. We would replace our sense of what counts as *good science* in terms of what is ethically as well as empirically "good."

4.6.2 What can we learn from the past?

History may turn out to be a crucial tool for learning how to proceed in the future. One thing that careful historical work helps undermine is the sense of the **inevitability** of the development of science and technology. This sense is bolstered by existing **dogmatism** about the achievements of science and technology, the existing standards, conventions, and ideas in those fields. This dogmatism serves a valuable role in restricting the range of possible questions at the forefront of the field to something manageable, something on which scientists, engineers, and technologists might hope to make progress. At the same time, we may be left with the false sense that science and technology follow a determined path, governed only by rationality, truth, and efficiency, and that there is no room for choice or for values in that assessment.

Hasok Chang conceives of the work of history and philosophy of science in precisely these terms as **complementary science.** "Complementary science," he tells us, "asks scientific questions that are excluded from current specialist science." Chang believes in doing so that we can produce a kind of scientific knowledge that is excluded from, but complementary to, current scientific knowledge. Perhaps, in the long run, history and philosophy of science could thus create positive transformation in science itself. Likewise, we might examine the history of technology, including the many possibilities left unexplored, to conceive of alternative, complementary technological developments that might improve our current world.