



## THINKING LIKE AN ENGINEER

205      **Fall 2016**                      **MATH/PHIL194**                      **Olin-Rice**

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### About this course

From driverless cars to wearable computers, from microwave ovens to mobile phones and tabletop robots, we all live and think in an environment saturated by the products of engineering thinking. But, what does it mean to think? And what does it mean to think like an engineer? In this course, team-taught between a mathematician with a background in engineering and a philosopher of technology, you will have an opportunity to explore questions such as these. The course will be grounded in an emerging understanding of engineering as an interdisciplinary field, where design problems are not solely technical, but are inseparable from ethical, social, political, economic, and historical dimensions.

We will begin the course with a reading about technology by the Spanish philosopher José Ortega y Gasset, and end by looking at debates over engineering for human enhancement. In between, you'll have the opportunity to read and discuss works by both philosophers and engineers. You'll learn how values can be unintentionally embedded into engineered objects that reinforce gender and other stereotypes, but can also be consciously embedded for the aims of social justice and sustainability. You will be making arguments and also be making things, including a team-developed engineering project. Your path in this course will be

stereotypes, but can also be consciously embedded for the aims of social justice and sustainability. You will be making arguments and also be making things, including a team-developed engineering project. Your path in this course will be illuminated by discussions about electrical power, solar energy, and lightbulb design. We welcome all of you to this class, whether you are interested in pursuing academic interests in design, engineering, ethics, and/or philosophy, and/or whether you want to better understand the engineered world as a consumer, citizen, or simply as a reflective human being.

### **Learning goals**

You'll find the learning goals for this course are organized around three themes: substance, skills, and self-awareness.

With respect to substance, this course is designed to help you acquire an increased understanding of: (a) the diversity and ubiquity of ways in which engineering helps to shape the contemporary world; (b) a deeper understanding of the material world and material culture; (c) what it means to "think like an engineer" and how this thinking is similar to/different from other kinds of technical and creative reflection; (d) the engineering design process and key concepts of engineering design, and (e) how technical and social/political/ethical perspectives are joined together in engineering problem framing and problem solving.

The design of this course is also intended to assist you in developing key skills in college-level reading, writing, and in-class discussion. By the end of this semester, you should be: (a) better able to read and analyze texts with an inquisitive and thoughtful mind; (b) more at ease with "doing" philosophy, including forming philosophical questions, framing ethical issues, and constructing philosophical lines of thought; (c) more adept in analytical and argumentative writing; and (d) more able to engage in the "participatory" give-and-take involved in classroom discussion.

Self-awareness as a philosophical learning goal has its roots in Socrates' observation that "the unexamined life is not worth living." Your professors hope this course will expand your own capacities for: (a) thinking about how to live creatively and responsibly in a technologically-infused environment; (b) respecting the well-reasoned views of others, even when they may be at odds with your own, (c) valuing the different kinds of thinking found in a variety of liberal arts disciplines; and (d) understanding the positive value of being confounded and confused.

### **Reading and design materials**

In this class, we will be discussing a number of innovative ideas, arguments, and perspectives reflected in a variety of sources, including these three books which you can purchase at *The Highlander*, Macalester's campus bookstore. Please note the books can all be found in the Philosophy textbook section.

Henry Petroski, *Invention by Design*. Harvard, 1996.  
978-0674463684

Eugene Ferguson, *Engineering and the Mind's Eye*. MIT, 1994.  
978-0262560788

Gordon Marino, *Ethics: The Essential Writings*. Modern Library Classics, 2010  
978-0812977783 (This book will serve both as a source of specific readings and as a reference volume for this course.

Other readings for the course, from academic essays to reports to magazine

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Other readings for the course, from academic essays to reports to magazine articles, will be available either online or on Moodle.

In addition to these three books, this course will also require a solar electronics kit. It will be available for purchase at the Highlander the week of 12 September.

### **Academic Integrity**

In this course, it is anticipated that the work you do will be honestly presented: in other words, that wherever you incorporate the ideas, words, or sentence structure of other authors into your own work, you will give them credit. In reviewing your work for this course, your professors will adhere to Macalester's *Academic Integrity Policy*. This policy can be found in *Student Handbook*. For your convenience it is also posted on the Moodle site for this course.

### **Accessibility of Content and Assignments**

Your professors are committed to making course content and assignments accessible to all of you taking this course. If there are any course elements that might be inaccessible to you, reasonable academic accommodations may be implemented. If you think you might need accommodation for a disability, you should contact the Assistant Dean of Students, Robin Hart Ruthenbeck, early in the semester. She is reachable at [rhartrut@macalester.edu](mailto:rhartrut@macalester.edu) or at 696-6874.

### **Devices in the classroom**

As the best device you can bring to this class is your own attentive mind, your professors ask you to “virtually” power down your other devices when you come to class. In particular, we ask you to refrain from googling, texting, tweeting, doing Facebook, and checking in-coming messages during class. You should also regard class time as being “Pokémon No Go” time as well. And, of course, please do put your cell phones on a setting so they will not ring out loud.

You might wonder why we are including this on our syllabus. First of all, paying attention in class allows you to participate to your fullest, and so helps to create and sustain a vibrant learning environment. It is also a sign of respect to your fellow learners, including your professors. And, last but not least, a growing body of research shows that “distracted learning” in class can inhibit understanding and recall of the material being discussed.

We encourage you to keep to this policy in order to avoid having points deducted from your final course grade.

### **Course activities--Writing**

In addition to learning how to think like an engineer by doing the readings and taking part in class discussions, you will be writing two, 1250-word argumentative papers and completing ten informal writing assignments. In conjunction with your final design project (see below), you will also write a 1500 word reflective paper, in which you will “walk” your reader through the process you used to create your final design project, discussing what you took to be the key questions/decision points in this process, and explaining why, when you came to these points, you chose to go in one direction rather than in another. This reflective paper should also bring out how, as you developed your project, you were concerned to bring in both technical and socio/ethical/political/historical perspectives into your work. This class will not have any problem sets, quizzes, or tests.

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Because *Thinking Like an Engineer* is a “Writing as Argumentation” (WA) course, it will count toward the fulfillment of your three-course graduation requirement in writing. The writing requirement is designed for you to receive instruction in writing that focuses on writing as a process (writing is rewriting), and that provides individual feedback on the mechanics and substance of your prose (paraphrased from the Registrar’s webpage). The two academic argumentative papers planned for this course will give you an opportunity to analyze the thoughts of others and to construct your own positions in support of a particular issue related to engineering.

For the first paper, you’ll take an engineered object of your own choosing which you find to be problematic for ethical or other design-related reasons, explain why you find it problematic, and, while paying explicit attention to trade-offs, discuss and defend what you might do in order to improve it. In the second paper, you’ll be asked to develop and defend your own position on a live, “tough” issue related to engineering design. Should fully autonomous vehicles be allowed on the roads? Should “tabletop robots” be designed so as to reflect gender? (You’ll have a small set of questions, or “prompts,” to choose from on which to write.)

Once you turn in a first draft, you’ll get it back with comments on how well your paper works as an example of academic writing (including mechanics and expression), and how well the arguments within it are presented. You will then have a week from when you get your paper back to revise it. First drafts will be returned with a preliminary grade on them, but the grade itself will not be recorded. Revising your paper may improve your grade by as much as, but not more than, a full letter grade. Revisions will be mandatory for your first paper and at your discretion for the second. If you choose not to revise your second paper, your preliminary grade will become your grade for that paper.

Late papers will be accepted without penalty if you have a good reason for turning it in late and you let us know in advance of when it is due that you are unable to turn it in on time. *Unexcused late papers will be accepted up to one week after the due date, but you will lose half a letter grade (e.g. B+ to B) on the first day your paper is late, and every two days thereafter.*

In addition to writing your three papers, you will have the opportunity to develop your argumentative writing skills through both in-class and out-of-class writing practice. These ten, informal, short assignments will be graded on a check plus/check/check minus basis. The most you can receive on an out-of-class assignment turned in late is a check. We’ll distribute small notebooks for you to use as writing journals in doing these assignments and for keeping notes about what you learn from this class about good writing, particularly about the process of good argumentative writing itself.

### **Writing Assistant**

Daniel Lyew ’17 will be the writing assistant for this course. Dan will be available to talk with you about your papers--from your preliminary ideas and outlines through first drafts and revisions. He’ll also be able to give you an experienced student perspective on how to use your time effectively, on how to study well, and on other aspects involving your transition to academic life at Macalester.

### **Course Activities—Making Things**

This course will include three design activities and a final design project. The first activity, which you’ll be doing individually, will be to “re-purpose” a solar light.

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You will also be working in teams of four for the final design project for this course. For this project, you'll be asked to come up with an idea for an innovation that could (hypothetically) be integrated into the Macalester campus, and take your idea through the steps of the engineering design process itself. While each of you will be involved on your teams in all the steps, you will also serve individually as a project manager for one aspect of the design process. The end result should be a model or a mock-up for you to present to the class at the beginning of December. More details on this project will be given in class, and some resources to inspire your thinking will be posted on Moodle as well.

### **Evaluating your work**

Here are the percentages that will be used to determine your final grade for this course.

Informal writing practice	15%
Three design activities	15% (5% each)
First paper	15%
Second paper	15%
Third paper	20%
Final design project	20%

In this course, there will be ample opportunity for you to contribute to class discussions by raising questions, commenting on the readings, responding to points brought up by others, and the like. Your contributions to class discussions will be taken into account in determining your course grade; and can raise or lower it by one-half a letter grade.

As far as attendance goes, you will get two unexcused absences. Beyond that, each unexcused absence will result in three points being subtracted from your final grade for this course.

### **Schedule of Readings and Due Dates**

**Please come to each class meeting prepared to talk about the assignment for that particular day. This schedule may change at the discretion of your professors.**

#### **Week One**

1 September  
Grand Avenue? And, if you could add a light somewhere, where and what kind would it be? Meet at the southeastern corner of Macalester Street and Grand Avenue for a very brief field trip

of Macalester Street and Grand Avenue for a very brief field trip

In-class writing practice

## Week Two

6 September

What is engineering? Is it a science? Is it an art?  
What is the relation between engineering and design?  
What do engineers aim to do?

**Reading:** Ferguson, Chapters One and Three; selections from José Ortega y Gasset, “Man the Technician,” in *History as a System* (on Moodle)

8 September

The engineering design process

**Reading:** Petroski, Chapters Two and Seven; Don Norman, “Knowing What to Do: Constraints, Discoverability, and Feedback,” in *The Design of Everyday Things* (on Moodle)

Out-of-class writing assignment--due next class period

## Week Three

13 September  
Utilitarianism

Ethical perspectives in engineering design:

**Reading:** selection from John Stuart Mill, *Utilitarianism*, in Marino, Chapter 9

Introductory design activity: Solar light take-apart and put-together; first paper and final design project introduced

15 September  
(1)

What kind of knowledge is engineering knowledge?

- Know-how, skill, and heuristics

**Reading:** Ferguson, Chapter 5; Joseph Pitt, “Fitting Engineering into Philosophy” in *Philosophy and Engineering: Reflections on Practice, Principles, and Process* (on Moodle). [Pitt is a philosopher who writes about engineering]

First design activity introduced:  
Repurposing a solar light

Out-of-class writing assignment: introduction to library research and technology at Macalester

## Week Four

20 September  
(2)

What kind of knowledge is engineering knowledge?

- Risk, uncertainty, and tradeoffs

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**Reading:** William Bulleit, “Uncertainty in Design,” in *Philosophy and Engineering: Reflections on Practice, Principles, and Process* (on Moodle). [Bulleit is a civil engineer who write about philosophy]

Today’s class will include a presentation on and discussion about how to write an argumentative paper in philosophy.

22 September

Ethical perspectives in engineering: Kantian ethics  
**Reading:** selection from Immanuel Kant, *Foundations of The Metaphysics of Morals*, in Morino, Chapter 8.

### Week Five

27 September  
show

First design activity due. Each of you will be able to  
and talk about your repurposed solar light.

29 September

Today we will be meeting in the library’s instruction room for an introduction to the library’s research print and electronic resources. Following class, we will walk over together to the Campus Center for the first plenary session of the International Roundtable.

### First Paper Due

### Week Six

4 October

Today David Schmit will visit our class to talk about his work in sustainability and design. David is an engineer working in the Twin Cities.

6 October

Engineering Grand Challenges and the concept of a “wicked problem”

**Reading:** Petroski, Chapter Eight

Second paper introduced

Out-of-class writing assignment—due next class period

### Week Seven

11 October

Second design activity introduced: Remember the spork? Now you get to work in pairs to design and make a pitch for a new eating utensil!

**Reading:** Mark Miodownik, “Indomitable,” in *Stuff Matters*; Tom Fisher, “Fashioning Plastic,” in *The Social Life of Materials*, ed. Adam Drazin and Susanne Küchler (Both essays are on Moodle.)

Out of class writing assignment—due next class period

(Both essays are on Moodle.)

Out of class writing assignment—due next class period

13 October Class field trip to the I-35W Bridge Remembrance Garden

In preparation for this trip, please read this [article](#) on the history of the bridge and the tragedy of its collapse. Also, please read the “Conclusions” section of the National Transportation Safety Board [report](#) on the bridge failure.

### Week Eight

18 October What can be learned from engineering failures?

**Reading:** Ferguson, Chapter Seven; Petroski, Chapters Five and Nine

20 October **Fall Break**

### Week Nine

25 October “De-gendering” engineering

**Reading:** Diane Michelfelder, Galit Wellner, and Heather Wiltze, “Designing Differently: Toward a Methodology for an Ethics of Feminist Technology Design” (on Moodle)

27 October Second design activity due. Each design team will be able to present and make a pitch for their eating utensil.

Out-of-class writing assignment—due next class period

### Week Ten

1 November Today we will spend time talking about the third design activity, which will involve your making solar elements for feral cat shelters designed by with Professor Taylor Allen’s first year class students at Oberlin.

3 November The challenges of systems engineering

**Reading:** Petroski, Chapter Six

**Second Paper Due**

### Week Eleven

8 November The driverless car: not only engineering for the road ahead

**Readings:** Neil McBride, “The Ethics of Driverless Cars,” Anita Kim and others, “Review of Federal Motor Vehicle Safety Standards for Automated Vehicles” (please read to

**Readings:** Noni McBride, “The Lanes of Divergence Cars,” Anita Kim and others, “Review of Federal Motor Vehicle Safety Standards for Automated Vehicles” (please read to the bottom of p.20). (on Moodle)

10 November

Engineering and social justice

**Reading:** Carolyn Baillie and George Catalano, Part III of *Engineering and Society: Working Towards Social Justice*. (on Moodle)

In-class writing practice

### Week Twelve

15 November

infrastructure

Flint Michigan drinking water: a case study in deteriorating

**Reading:** Michael Torrice, “How lead ended up in Flint’s tap water.” *Chemical & Engineering News* 94, pp. 26-29 February 11, 2016. (on Moodle)

17 November

Possible guest speaker

Out-of-class writing assignment—due next class period

### Week Thirteen

22 November

Third design activity due. Each team will have a chance to present their YouTube videos and to talk about their work and the design process leading up to it.

In-class writing practice

24 November

**Thanksgiving Holiday**

### Week Fourteen

29 November

light?

What if we could see infrared and other kinds of

Human enhancement: Reengineering the human body

**Reading:** Alberto Giubilini & Sagar Sanyal. 2015. “The Ethics of Human Enhancement” (on Moodle)

Out-of-class writing assignment—due next class period

1 December

What super-power would you like to have? Class discussion on re-engineering the human body

**Readings:** Donald Bailey, “The Case for Enhancing People “ in *The New Atlantis* (on Moodle); selections from John Rawls, *A Theory of Justice*, in Marino, Chapter 19

### Week Fifteen

6 December

Presentation of team design projects

**Week Fifteen**

6 December Presentation of team design projects

8 December Presentation of team design projects

14 December **Third Paper Due.** Please e-mail your work to both Professors Flath and Michelfelder.

Acknowledgment: The photo on the front of this syllabus is of an untitled abstract work by the neon artist Gerson Rosenfield.

[atlanticneon.com/NeonArt.htm](http://atlanticneon.com/NeonArt.htm)