APS1018 - History & Philosophy of Engineering & Innovation (HPOEI) – Understanding the Role of Engineers in Society – Past, Present, Future — 100% Online – For Dates refer to course web site on Quercus

Course Outline

Description: This course has been designed for the reflective Engineer with experience in the workplace. Designed by an engineer for engineers, applied scientists and engineering executives, it will help practitioners reflect on their role in society and understand how that role has been shaped and is constantly changing. Most of the world's leading employers depend on engineers and applied scientists to design new technological systems, products and services and effectively operate and sustains these systems. Human resource leaders are charged with attracting, motivating, developing, and retaining these individuals, as well as partnering with them on large-scale systems change. This course provides insider insight into the way engineers think and feel about the work they do. The course includes methodological background on the nature of engineering work, engineering as an analytical, integrative, and generative thought process.

The course begins by providing a historical background on the evolution and impact of technology on cultural and social change from the medieval period through to modern times. We then explore engineering as a practice, engineering as a profession, and engineering as a distinctive way of thinking from basic science as well as engineering's interrelation to the development of modern business practice. The course includes motivational reflection upon a number of ways in which engineering can be a satisfying occupation, seeking to understand the emotional satisfaction of complex design and problem solving as well as the social satisfaction of working in complex team settings with mixed and varied expertise. The course uses landmark books and papers, critical reading assignments, outside guest visitors and digital and social media to gain these insights, and the course concludes with reflections on recent changes in technological employment and how human resource leaders can help professional engineers - both recent graduates and experienced practitioners - align with the pace and challenge of 21st century practice.

<u>Course Objectives</u>

Upon course completion, the participants will be able to:
- Establish a context for the role of the engineer in society in various countries and cultures through the ages – from antiquity to modern times

<u>**Course Structure and Content:**</u> HPOE is divided into four themes and 12 modules:
The first theme is the **history of technology** that will focus on the impact of technological change in medieval society. We will establish the impact of technology on society and culture. We will cover a broad sweep of history from the fall of the Roman Empire to the scientific revolution in the 17th century, and investigate the role of the clock, print press, and gunpowder. We then explore the first industrial revolution enabled by steam power, the 2nd

industrial revolution enabled by electrical power and the 3rd industrial revolution enable by the computer and information technology.

- The second theme is; **Engineering Professionalization.** We explore the transition from the European artisan professions formed through the medieval guilds through to European apprenticeship system. We will discuss the rise of engineering as a profession in late 18th and 19th century starting with the role of the engineer in the French military system and the rise of the Polytechnic system of education. Then we cross the channel to England and the establishment of the Institution of Civil Engineers (1818) and later the Institution of Mechanical Engineers (1847). We will discover that engineering institutions emerged around the application of new scientific knowledge to the creation of new industries and technologies. As professional societies emerged so to did the adoption of engineering as a UK university subject in the mid 1800's. We then discover how engineering societies emerged later in the USA and their impact on the growth of American industry and innovation. We then assess critically the role of the engineer in the capitalist system.
- The third theme examines; **Engineering Identity**. The role and perception of the engineer in society differs greatly from country to country – from a trade in the UK to preeminent leader in continental Europe particularly Germany and France. We ask the question how did the engineer transition from hero of society in Victorian Britain to the modern perception of British school children as a mechanic with an oily rag? Why are French, German, Italian, Spanish, East European, Chinese, Japanese, Middle East and Indian Engineers groomed for senior executive or government roles while the US and UK groom lawyers, politicians, MBA's as shapers of society – What has the impact of these cultural values been on their society? We also explore the role of apprenticeship in the training of engineers and the impact of a university only education in North America.
- The fourth theme considers; **Role of Engineering in Society in the 21st Century**. We explore the boundaries between a pure scientist, applied scientist, engineering scientist, engineering practitioner, and engineer executive, and how the media confuse these roles and identities and the impact on the role of the engineer in society. Design and creativity is at the heart of engineering but why does society label architects, industrial design and the creative arts as designers. We will explore the role of the engineer as designer and creator of the core quality of life systems.
- In recent years professional career philosophers have turned their attention to the role and identity of the engineer in society mainly in the USA and northern Europe. From these initiatives a new engineering identity is emerging – the Humanitarian engineer and Ecological Environmental engineer.

Course Books and Academic Papers

There are three E-Books that will serve as the core reading for this course:

➢ Bell, Sarah. **Engineers, Society and Sustainability**; **(ESS)** Synthesis, Lectures on Engineers, Technology Society, Morgan and Claypool, 2011
➢ Vermaas, Pieter, et al. **A Philosophy of Technology From Technical Artefacts to Socio-technical Systems; (POT)** Morgan and Claypool, 2011

➢ Van de Poel, Ibo & Goldberg, David. **Philosophy and Engineering - An Emerging Agenda; (POE)** Springer Dordrecht Heidelberg, London New York, 2010

In addition there are specialized academic readings that provide deeper analysis of a topic.

Learning outcomes

Knowledge and Comprehension:
➢ Understand the role of technology in shaping society and culture in day-to-day life and strategic policy levels.
➢ Understand the role of the engineer in different societies with a concentrated focus on English Speaking countries.
➢ Understand the changing role of the engineer in the capitalist system
➢ Understand the role of the engineer as designer of a better quality of life or destroyer of civilizations

Intellectual Skills (Analysis and Synthesis)
➢ Students will develop an integrated framework for strategic thinking to analyze economic and social drivers of change and how the engineering profession influences or does not influence the driving forces of change.

Practical Skills (Application and Evaluation)
➢ Students will develop the ability to assess organizations and society from a social impact and cultural change viewpoint and be able to formulate policies that extend beyond technological systems design / build for purely $$ profit to social and cultural impact
➢ Assess the likely success of technological change on developing a sustainable future.
➢ Be able to design a role for the engineer at the heart of shaping society as a policy maker

Course Grading: The components of the final course grade will be weighted as follows:

Discussion Board Contribution (12 off) – provides breadth in knowledge (Engage in 10)	20%
Mid Term Critical Review Paper (based on discussions Modules 1-6)	20%
One 4-6 minute video that critiques your mid term CR using the Rubric	10%
Final Critical Review Paper (based on discussions in Modules 7-12)	20%
Project Team Report – (includes charter and PPT).	30%

Class Participation – Online Discussions. This course will be offered **online only**. The course will be taught through a combination of video lectures (7 mins-40 minutes), critical review readings, and online discussion. **Use the online discussions input to form your critical review papers. Discussion board contribution can earn 20% -** you will be given an overall grade for the discussions against the performance rubric.

Critical Review Papers. There are a total of 2 critical review papers (mid term and final) required from each student. These papers allow you to focus on the depth of knowledge. The marks are 20% each. Students will post critical review papers on the discussion board. Both critical reviews will be written papers (1200-1500 words) and the mid term paper will include a 4-6 minute verbal self-critique delivered via video – use drop box. The CR's should be formed

around the input in the discussion board. The idea is that you produce a **CR that you build on your learning and reflections from the online discussions to create a stand-alone paper on HPOE**. So for the mid term you will synthesize modules 1-6 and for the final CR you will synthesize Modules 7-12.

Team Project Report. Students will form into teams in the first 3 weeks and undertake a mini research project. Whether in a virtual team environment or as an individual the level of effort is the same. For the final project paper you are free to select a topic in HPOE that interests you. The goal of the final project report is <u>not</u> to do original field research, but to demonstrate to me your ability to find and synthesize information about a HPOE topic. A PowerPoint presentation (approx 12-16 slides) summarizing the project should be delivered in the last week of the course to enable feedback for the final report. The final report should be double-spaced, 12 point font, **(**approximately 1200-1500 words per student**).** Timing is very important to HPOE! <u>**A hard copy and a soft copy of the paper**</u> (using Microsoft Word, NOT an Adobe Acrobat PDF!) must be delivered by email no later than **date in Quercus at 4pm** to my email address, stephenc.armstrong@utoronto.ca - the hard copy to be given to the reception 44 St George Street. **Please note: for guidance purposes summaries of the team project reports from previous classes are available at: http://www.amgimanagement.com/founder/teaching.html**

Office Hours. Because I am an Adjunct faculty member it will be difficult to meet all of you individually in a timely manner because of the class size but I will endeavor to meet you in person and to answer email queries.

Important Milestones: - Dates can be found on Quercus
 - Mod 0 and 1 Open–Online Engagement
 - **Inclass Seminar:** Orientation & Project Teams Discussion-(**MY350)**
 - Project Team Charter Due - E-Copy
 - Submit Midterm Critical Review 1 Paper (Mods 1-6)
 - **Submit 4-6 minute** self critique video
 - Project team Power Point project Summary - **live inclass Option**
 - Submission of Team report (physical hardcopy and e-copy in word)
 - Submit CR2 (Mods 7-12)
 - All coursework grades submitted

Part I – History of Technology

Mod 0 : Orientation, Instructor Background, Syllabus Overview, & Assignments
PLEASE NOTE THIS WILL BE A LIVE CLASS – (9AM – Noon)

An overview of the entire course will be presented. The Mechanics of an online course will be presented. Critical review readings will be discuss (Book Chapters, Academic papers) – These provide the broad scope of History and Philosophy of Engineering.

Mod 1 –Culture, Technology and Ingenuity

- ➢ Introduces the impact of technology on culture and society
- ➢ What is Technology and what is culture?
- ➢ Tekhne versus logos
- ➢ Soft determinism - Hard determinism
- ➢ Technological Change and Social Systems
- ➢ Rise of STS – Science Technology and Science Studies
- ➢ Karl Marx – A Technological Determinist

Mod 2 - History of Medieval Technology;

- ➢ Mechanical Clock
- ➢ Print Press
- ➢ Gunpowder
- ➢ Military Innovations

Mod 3 – History of Modern Technology

- ➢ 1st Industrial Revolution - Steam
- ➢ 2nd Industrial Revolution – Electricity
- ➢ 3rd Industrial Revolution - Information Age of Computers

Part 2 – Engineering Professionalization

Mod 4 - Rise of Engineering functional disciplines and learned Societies

- ➢ 'ingenuity' and 'engineering
- ➢ Engineering Tools
- ➢ Geography of inventions and engineering
- ➢ Ages of engineering – Dark ages - American Experience
- ➢ Engineers before and after the Scientific Revolution
- ➢ Industrial Revolution and the Institutionalization of Engineering

Mod 5 -Engineering and the Capitalist System

- ➢ The Victorian Engineers - Hero's in Britain
- ➢ Railroad Engineers and Business Development
- ➢ The Role of Engineers in the capitalist system in the early 20th Century
- ➢ Engineering revolt in early 20th Century America

Mod 6– The Education and Formation of Engineers

- ➢ From a Craft guilds to a Science based profession
- ➢ Know How versus Know What
- ➢ From Apprenticeship skills based learning to University scientific learning
- ➢ Chartered Engineer v Professional Engineer v Euro Engineer

➢ Gaps in Engineering Education and Formation

Part 3 – Engineering identity

Mod 7–Philosophies of Nature, Design, Change, Innovation, Engineering

➢ What is philosophy of Engineering?
➢ Why does philosophy matter?
➢ Who are the players and societies?
➢ The need for philosophical reflection – the missing basics

Mod 8 – Who are the Engineers, How do they Think and Why?

➢ Engineering Identities
➢ What Engineers Don't Learn
➢ Science versus Engineering versus Technology
➢ The Engineer as Artist

Mod 9 – The Invisible Profession – Status and discontents

➢ The Case of British Engineers – from Victorian Hero's to uncool and crises
➢ The British Media and Engineering Perception's
➢ Why Governance Matters
➢ Professional decline and Industrial decline
➢ Stark Comparisons - Engineers World Wide

Part 4 – Role of Engineering in Society in the 21st Century

Mod 10 – Ethical Responsibilities of Engineers

➢ What does social responsibility mean?
➢ Arguments and Counterarguments
➢ Engineer -Manager Relations in Large Corporations
➢ Whistle blowing
➢ What is professionalism?
➢ Engineering Ethics and Social Values
➢ The Case of the Space Shuttle Challenger – Engineering V Management Culture

Mod 11 – Licensing, Regulation, Registration and Culture

➢ Codes of Ethics and Enforcement
➢ The boundaries between Engineering, Science and Management
➢ The impact of licensing in Canada versus the volunteer registration system of the UK
➢ The role of government in engineering licensing (USA) and Canadian self-regulation

Mod 12 –Humanitarianism, Sustainability, and Ecological Engineering

➢ Beyond Technical Competencies

➢ Cold War versus 21ˢᵗ Century
➢ The Entrepreneurial Engineer
➢ Ten Competencies
➢ To Engineer is Human