Engineering Systems Doctoral Seminar

ESD.83 – Fall 2009

Class 1
Lec #1
Faculty: Chris Magee and Joe Sussman
Guest: Professor Yossi Sheffi (ESD Division Head, Professor of CEE and ESD)

Session 1: Overview

- Welcome, Overview and Introductions (10 min.)
- The doctoral Seminar on Engineering Systems: Logistics and Context (20min)
- Assignments discussion and sign up process (30 min)
- Relationships among fields (Magee, 25 minutes)
- Break (10 min.)
- Some key themes and issues for ESD 83 (Sussman, 25 minutes)
- Discussion with Guest (Yossi Sheffi, 40 minutes)
- Follow up with teaching team (15 minutes)

- Next Steps -preparation for week 2- (5 min.)

Background for the Seminar

- Engineering Systems Division as a bold experiment – bringing together diverse areas of expertise into what is designed to be a new field of study
- The full scale and scope of Engineering Systems as a field is still emerging and this seminar is simultaneously designed to codify what we presently know and to give direction for future development
- The seminar content and assignments are targeted at helping in the transition from student to contributing researcher and scholar.
- This seminar evolves as the structure and operation of the ESD Ph.D. curriculum changes. You are the second group to take the 3 core subjects (ESD 83, 86 and 87).

Learning Objectives for ESD 83

- **Basic Literacy:** Understanding of core concepts and principles – base level of literacy on the various aspects of engineering systems
- **Inter-disciplinary capability:** The capability to reach out to adjacent fields in a respectful and knowledgeable way and the ability to engage with other ES scholars in assessing the importance to ES of new findings in related fields
- **Historical Roots:** Understanding of historical/intellectual roots of key concepts and principles in engineering systems
- **ES and observations, data sources and data reduction:** An appreciation of the importance and subtlety of empirical study to cumulative science and its difficulty in complex socio-technical systems
- **Critical Analysis:** Ability to critically assess research and scholarship aimed at furthering knowledge in engineering systems; **development of** defendable point of view of important contributing disciplines in Engineering Systems Field
- **Links Across Domains:** Ability to identify links/connections across different fundamental domains relevant to engineering systems
- **Scholarly Skills:** 1) The ability to write a professional-level critical book review; 2) a beginning level ability to develop and write a research proposal in the ES field; 3) the ability to present and lecture on critical analysis of material that one is not previously familiar with; 4) developing wider reading skills and habits
- **Social objective**

Class Session Pro-Forma (3 hours)

- Introduction (faculty 5 min.)
- Guest presentation and Discussion (55 min); **being on-time is expected**
- Discussion leader (30-45 min)
- Break (10 min.)
- Teaching time (faculty, 55 min)
  - Lecture, discussion and integration
  - Report from the Front
  - Next Week's class (5 min.)

Assignment Summary (syllabus)

- ***1. Observations, Data Sources and Data Reduction Assignment (no more than 1000 word paper, 10% of the total)***

  Students will be expected to select and read an NBER working paper from a faculty-provided list and to prepare a no more than 1000 word paper, performing a critical analysis on the author's choice(s) and use(s) of observations as well as the assumption(s) required by, and conclusion(s) drawn from such observations. The **learning** involves appreciation of how empirical observations are handled in a field of research that **studies complex systems systematically and empirically**.

Assignment Summary (syllabus) 2

- ***2. Redactor Role (considered as part of class participation)***
  - For each guest, one student will serve as the redactor for Wednesday's class.
- ***3. Discussion Leader Role (considered as part of class participation)***
  - For each class, student discussion leader(s) will be assigned to lead the class in a critical analysis of ESD.83-faculty-provided readings prepared for that Wednesday.
- ***4. ESS Poster Presentation and/or Research Brainstorming Session in the TA session*** (considered as part of class participation)***

Assignment Summary (syllabus) 3

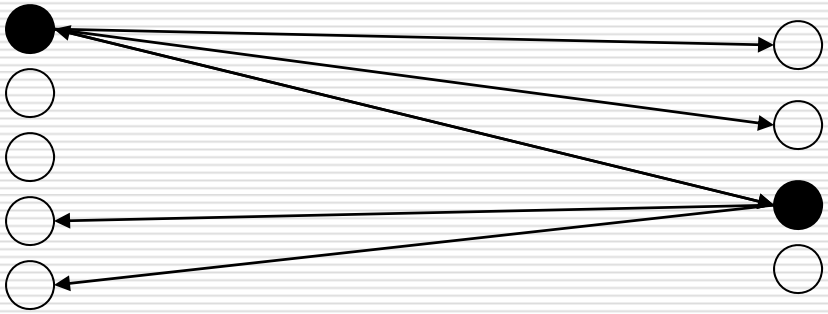
- ***5. Book Review (750 word book review, 10% of the total)***

- ***6. Historical Roots and Current Methodologies of Engineering Systems Paper and Presentation (Approximately 5000 words, 30% of total)***

ESD.83 Assignment 6: Historical Roots and Current Methodologies of Engineering Systems

- One paper per two-person team, approx. 5000 words; 30% of total grade
- Due November 4 (written) and November 18 (presentation in class)

Historical Roots ES Methodology



Teams of Two:

Each team will choose a historical root and an ES methodology and trace forward from the root and backwards from the ES methodology to understand the intellectual structure of the field of ES.

ESD.83 Assignment 6: Historical Roots and Current Methodologies of Engineering Systems II

- Your historical root may trace forward into ES methodologies not specified in the assignment
- Your ES methodology may trace back to historical roots not specified in the assignment
- Both of these are reasonable-- even desirable-- outcomes
- Thinking about *how* to present your results is an important part of this assignment

Assignment Summary (syllabus) 4

- ***7. Systems Thinking Assignment (1000 word paper, 10% of the total)***
- ***8. Developing a Well-Posed Research Question*** (750-word paper, 10% of the total)***
- ***9. Learning Summary (750-word paper, 10% of the total)***
- ***10. Seminar Participation (regular attendance and contributions, 20% of the total)***
  - Redactor, lead discusser and presenter at TA session
  - On-time and full attendance- one excusable absence may occur but communication ahead of absence is necessary as make-up is required

Relationships among fields of knowledge

- What do you take from the “Two Cultures” by C. P. Snow Reading?

- Are there significant differences among different sciences?

Relationships among fields of knowledge 2

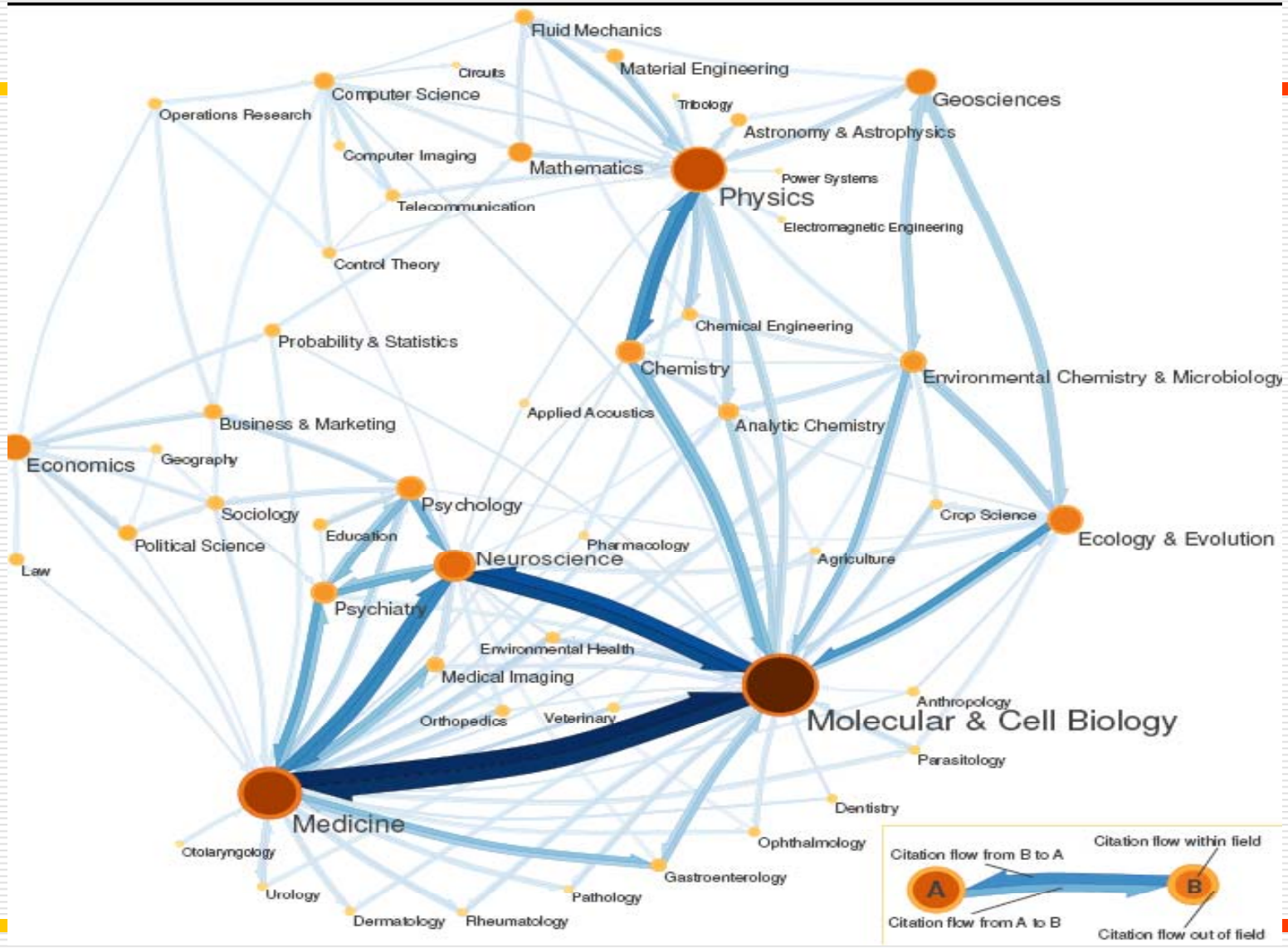
- There are significant differences in different fields with “how we know what we know”, the process for gaining new knowledge, the methods used in observation, the use of mathematics in the knowledge generation process, the application of knowledge to societal issues and so forth.
- Such significant differences exist:
  - Among fields of science – between social sciences and natural sciences and among social sciences (but perhaps not as strongly among natural sciences)
  - Between engineering and science
  - Between humanities and various sciences
  - Between mathematics and various sciences

Relationships among fields of knowledge

- What do you take from the "Two Cultures" by C. P. Snow Reading?

- Are there significant differences among different sciences?
- *How might one consider closeness of relationships among sciences?*
- *What role(s) might engineering play in the relationships among fields?*

Citation analysis can be visualized



Courtesy of eigenFactor.org. Used with permission.

Consilience (The Title of a 1998 book by the biologist E. O. Wilson)

- Definition - "Literally a jumping together of knowledge by the linking of facts and fact-based theory across disciplines.."
- Wilson argues that each discipline should be "consilient" with established science in other disciplines.
- He distinguishes between examples comparing consilience by reduction (dissect a phenomenon into its components) and consilience by synthesis (predicting higher-order phenomena from more basic physical principles).
- What disciplines is he most interested in?

Session 1:
Some Ideas and Framing Questions for ESD.83

Joseph M. Sussman
JR East Professor
Professor of Civil & Environmental Engineering and Engineering Systems
Massachusetts Institute of Technology

Framing questions for ESD.83 I

- What is a complex system?
- What are our ways of thinking about these complex systems?
- What kinds of research questions do we want to **ask** in the field of Engineering Systems and how do we **answer** them?

Framing questions for ESD.83 II

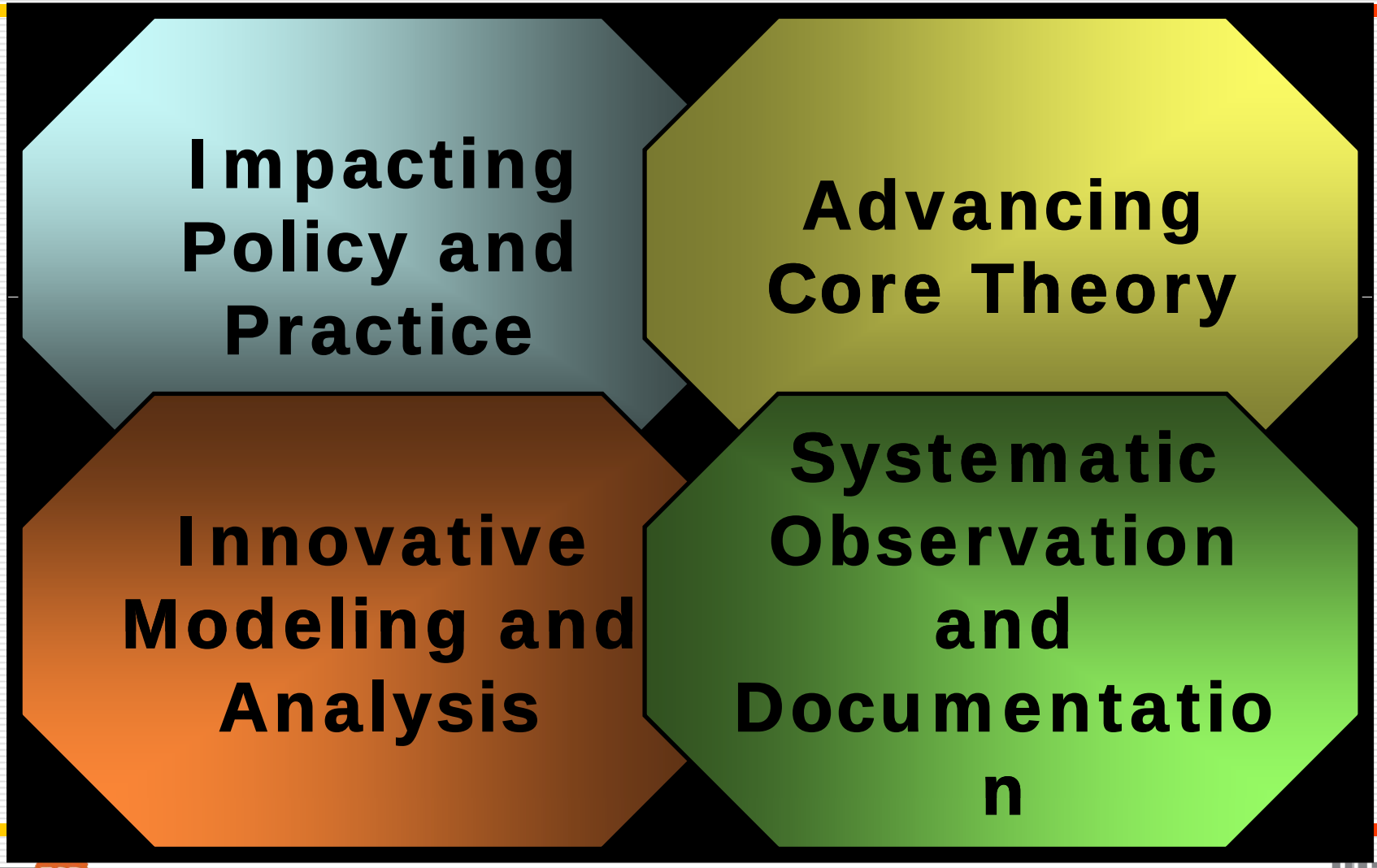
- What are the historical roots of the field of Engineering Systems and what is their relevance to contemporary engineering systems issues and concepts?

- What does “practicing” Engineering Systems mean?

Framing questions for ESD.83 III

- What are the **design** principles of Engineering Systems?
- What does it mean to advance the field of Engineering Systems and how do we accomplish it?
- How do we integrate engineering, management and social science in Engineering Systems?

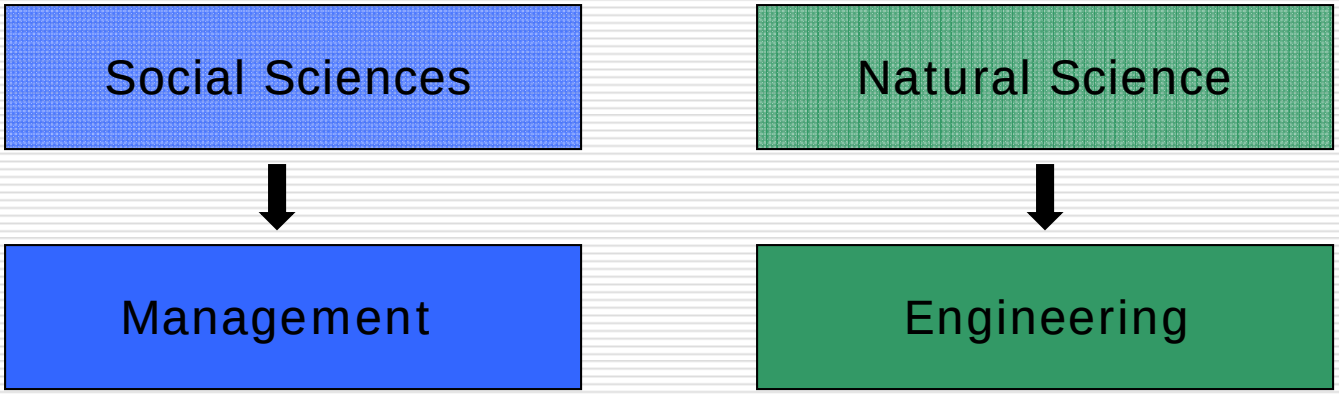
Strategies for Advancing Engineering Systems as a Field



Engineering Systems as an integrated field

- Engineering/Social Science/Management

A view of these fields



What do you think?

ESD.83 Doctoral Seminar in Engineering Systems

Fall 2009