

Engineering Systems Doctoral Seminar

ESD.83 – Fall 2011

Class 1

Faculty: Chris Magee and Joe Sussman

TA: Rebecca Kaarina Saari

Guest: Professor Joel Moses, Institute Professor,
(EECS 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 (20 min)
- ❑ Discussion of C. P. Snow essay (10 min)
- ❑ Break (10 min.)
- ❑ Discussion with Guest (Joel Moses), 40- 50 minutes)
- ❑ Relationships among fields (Magee, 20 minutes)
- ❑ Some key themes and issues for ESD 83 (Sussman, 25 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 emerging as 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.
- The high level objectives for ESD 83 are to develop **frameworks** for:
 - Learning to do research (what is it? Challenges in ES; Methods, the importance of empirical work, models and predictions, cumulative knowledge, falsifiability, etc.)
 - Learning about the field of Engineering Systems- knowledge of content of field and thinking about complex systems

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 defensible 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)

- ❑ Pre-reading and submission of comments/questions (Sunday/Tuesday)
- ❑ Introduction (faculty 5 min.)
- ❑ Guest presentation and Discussion (55 min); **being on-time—9AM-- is expected**
- ❑ Break (10 min.)
- ❑ Discussion leader (30-45 min)
- ❑ Teaching time (faculty, 55 min)
 - Lecture, discussion and integration
 - Report from the Front
- Next Week's class (5 min.)

Engineering Systems Doctoral Seminar, Fall 2011

Class 1: ESD: Present and Future -The Incorporation of Social Science and Engineering into Research and Problem Solving

■ *Guest: Joel Moses*

Class 2: How do we know what we know? - The Generation of Cumulative Knowledge in a Field

■ *Guest: David Kaiser*

Class 3: Modeling Paradigms: Useful models and various modeling approaches

■ *Guest: Oli de Weck*

Class 4: System and Enterprise Architecture; Qualitative Frameworks, Quantitative Models and System Representation

■ *Guest: Donna Rhodes*

Engineering Systems Doctoral Seminar, Fall 2011 – continued

- **Class 5: Uncertainty and its analysis in Engineering Systems**
 - *Guest: Mort Webster*
- **Class 6: Complexity in Socio-technical Systems**
 - *Guest: Stuart Kauffman*
- **Class 7: Complexity and Urban Systems**
 - *Guest: Chris Zegras*
- **Class 8: Network analysis and empirical study in sociotechnical systems**
 - *Guest: TBD*

*Engineering Systems Doctoral Seminar,
Fall 2011 – continued*

Class 9: Historical Roots of Engineering Systems

- *Guest: none*

Class 10: Poverty as a problem in complex systems (& empirical study)

- *Guest: TBD*

Class 11: Human Dynamics (and cognitive science) in Engineering Systems

- *Guest: Sandy Pentland*

Class 12: Design of complex socio-technical systems

- *Guest: TBD*

Engineering Systems Doctoral Seminar, Fall 2011 – continued

- **Class 13: Sustainability**
 - *Guest: Noelle Selin*
- **Class 14: Policy Design/Wrap-up**
 - *Guest: None*

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.**

- *Assigned: Session 1; Selected: Session 2, Due: Session 3*

Assignment Summary (syllabus) 2

- **2. Redactor Role (considered as part of class participation)**
 - For each guest, one student will serve as the redactor for that week (report sent Monday to guest).
- **3. Discussion Leader Role (considered as part of class participation)**
 - For each class, student discussion leader(s) will be assigned to *lead* a class discussion: 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)**

Assigned: Session 1; Due: Session 5 (discussion during Session 7)

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

Assigned: Session 2;

Paper Due: Session 7 and Presentation Due: Session 9

- **7. Systems Concepts Assignment (1000 word paper, 10% of the total) [assigned Session 3, due due on Session 10]**

Assignment Summary (syllabus) 4

- **8. Developing a Well-Posed Research Question*** (750-word paper, 10% of the total)**[Session 8 - due Session 12]
- **9. In-Depth Paper Analysis 5% of the total (500-750 word paper** [assigned Session 12; due Session 13]
- **10. Learning Summary (750-word paper, 5 % of the total)** [assigned Session 1, due Session 14]
- **11. Seminar Participation (regular attendance and contributions, 20% of the total)**
 - Redactor, lead discussor 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
 - Having thoughtful (independently posed) questions posted to the wiki (which is for convenience not for building on other people's ideas) on time

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Relationships among fields of knowledge

- ❑ What do you take from the “Two Cultures” by C. P. Snow Reading?
- ❑ Cultural gap existence- how to bridge- specialization effects & ES

- ❑ Are there significant differences among different sciences?

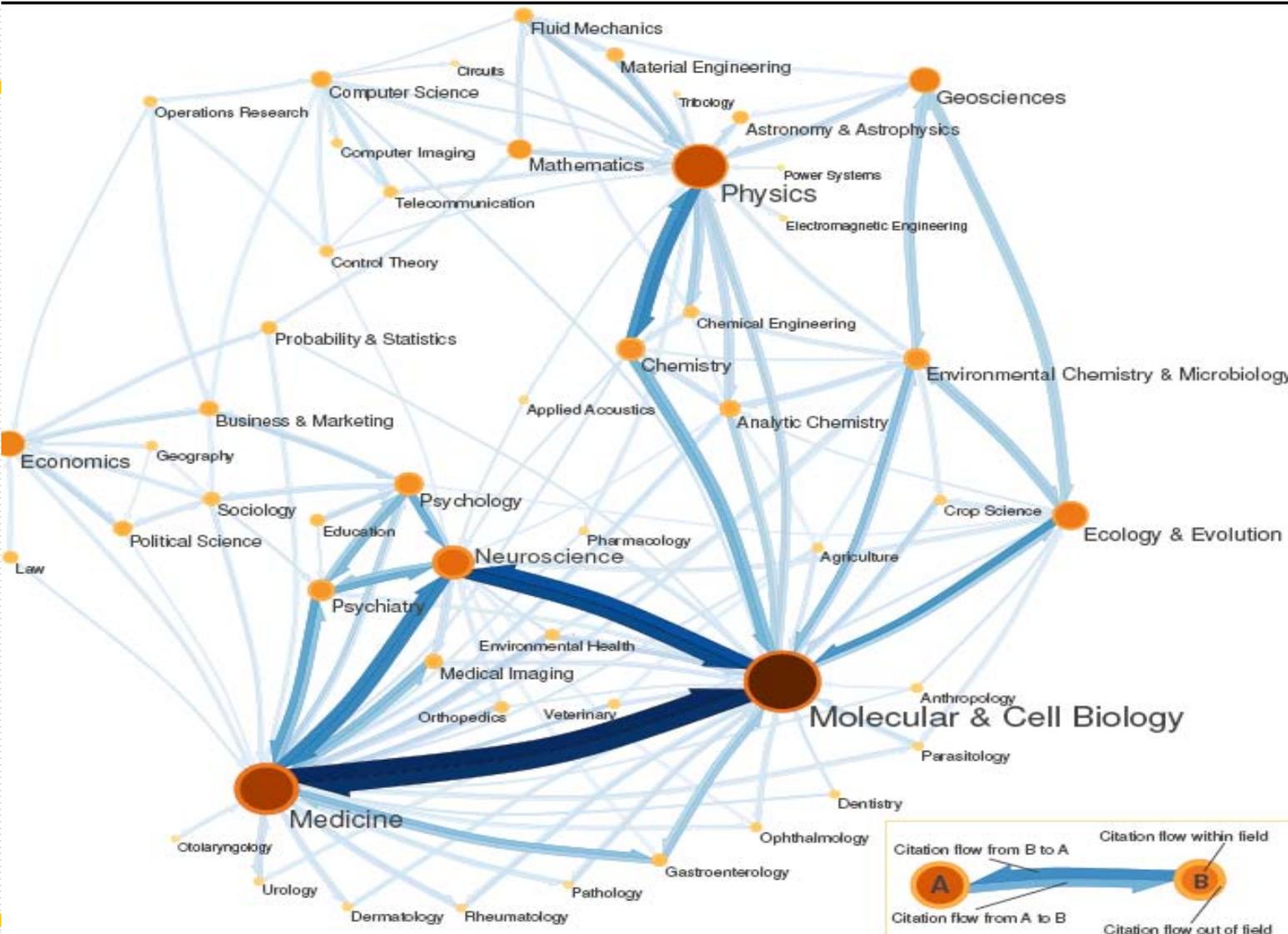
Relationships among fields of knowledge 2

- 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



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Map of relationships among scientific paradigms removed due to copyright restrictions.
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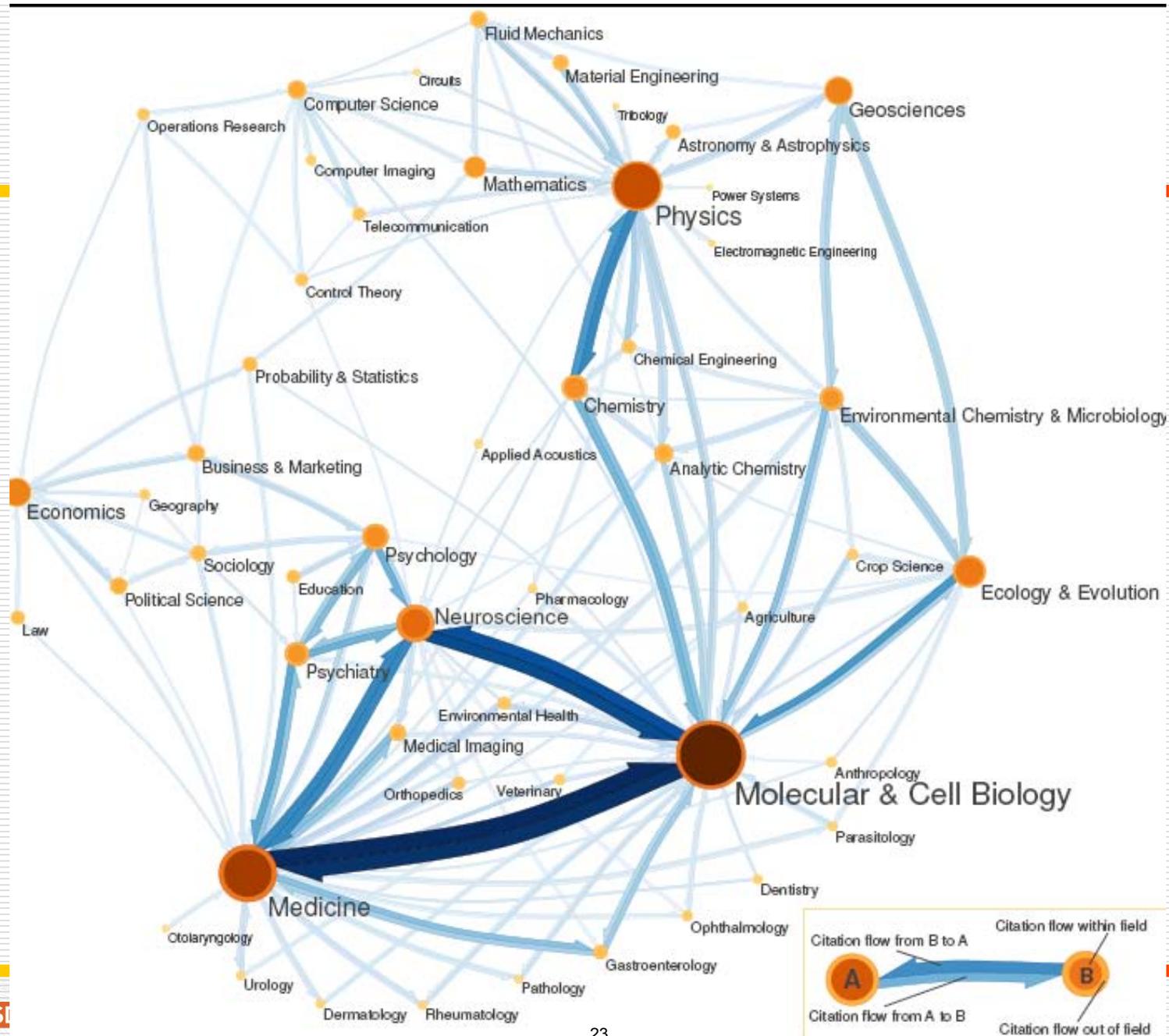
Visual mapping science site

□ (<http://scimaps.org/>)

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?

Map of relationships among scientific paradigms removed due to copyright restrictions.
Original image can be viewed here: <http://informationesthetics.org/node/20>.



C. L. Magee “Introduction”

- ❑ PhD in Materials Science and Engineering (CMU-then CIT)
- ❑ Ford Research staff (1966-71, basic research in materials)
- ❑ Various Ford positions (1971-2001) mostly in product development management)
- ❑ MIT (2000- now) mostly ESD + positions
- ❑ Research in complex socio-technical systems; simultaneous technical/policy design-

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