Engineering Systems
Doctoral Seminar

ESD.83 – Fall 2011

Session 11
Faculty: Chris Magee and Joe Sussman
TA: Rebecca Kaarina Saari
Guest: Professor Alex (Sandy) Pentland

Session 11: Agenda

☐ Welcome and Overview of class 11 (5 min.)

☐ Dialogue with Professor Pentland (55min)

☐ Break (10 min.)

☐ Discussion of other papers (30 -40 min)

☐ Theme and topic integration (Magee)

■ Further discussion of readings; Heuristics and Gis

■ The role of social sciences in Engineering Systems

■ Importance of specific social science disciplines in ES

■ " Human Cognition research overview

☐ Next Steps -preparation for week 12: (5 min.)

Heuristics (and biases)- two possible views

1. Humans use them because of our flawed , limited reasoning capacity

2. From wikipedia With Amos Tversky and others, Kahneman established a cognitive basis for common human errors using heuristics and biases (Kahneman & Tversky, 1973; Kahneman, Slovic & Tversky, 1982; Tversky & Kahneman, 1974).

Heuristics (and biases)- two possible views II

3. Humans use highly evolved (by experience and/or evolutionary history) heuristics because of their superior accuracy resulting from their "ecological adaption".

4. From Gigerenzer "reply to K & T" At issue is the imposition of unnecessarily narrow norms of sound reasoning that are used to diagnose so-called cognitive illusions and the continuing reliance on vague heuristics that explain everything and nothing

Which view do you think better reflects reality?

☐ Does it depend on how one defines the term heuristic?

☐ Specific examples:

☐ Does your preferred viewpoint lead to actions (management or policy)? What are they?

☐ Where is the sought after "toolbox of heuristics"?

Do experts use or eschew heuristics?

☐ Are heuristics a form of abstraction and/or gist?

☐ Is transferability of abstractions from domain to domain likely to be easy?

☐ Are metaphors and analogies a mechanism for such transfer?

☐ Perhaps the "missing toolboxes" are domain specific and the highest level experts in fact have highly honed toolsets....

Session 11: Agenda

- ☐ Welcome and Overview of class 11 (5 min.)
- ☐ Dialogue with Professor Pentland (55min)
- ☐ Break (10 min.)
- ☐ Discussion of other papers (30-40min)

- ☐ Theme and topic integration (Magee)
  - ■ Further discussion of readings; Heuristics and Gist
  - ■ **The role of social sciences in Engineering Systems**
  - ■ **Importance of specific social science disciplines in ES**
  - ■ Human Cognition research overview
- ☐ Next Steps -preparation for week 12: (5 min.)

Where do we stand relative to Social Sciences and ES?

☐ Chuck Vest from the Preface to *Engineering Systems: Meeting Human Needs in a Complex Technological World:* "It is one thing to invert the order of the two words *systems* and *engineering*, but it is quite another to establish a workable framework for integrating social science writ large with engineering. Indeed it is such a hard task that this book really is a guide to the beginning of a journey. But it is a journey that the authors, together with a number of like-minded colleagues around the world, have already begun".

Social Sciences & ES- an exploration

- ☐ How might we gain a deeper appreciation of "Social Sciences in ES"?

- ☐ Is the analogy with Biology entering into engineering useful? Is the further integration of physics and chemistry into engineering (so-called "engineering science" movement) a useful analogy?

- ☐ Four perspectives approach S/S, F, S, T

Function of SS in ES

- ☐ What is the purpose or high level reason for wanting to include SS in ES?
- ☐ Lots of specific problems
- ☐ To better anticipate the impact of technological choices on humans/society?
- ☐ To better anticipate the impact of society on technological choice?

Scale/Scope/Structure of SS in ES

- ☐ What boundaries might we want to think about?

- ☐ Do we want to emphasize research agenda or practice/education agenda?

- ☐ What aspects of each discipline?

- ☐ P/R = deep qualitative conceptual understanding; R = also quantitative theory where emerging

- ☐ What SS disciplines and how deeply in each?

Temporality wrto SS in ES

- ☐ SS in engineering education broadly-now or later? Is this the right time?

- ☐ Taught by SS or by engineers who know SS quite well?

- ☐ Analogies suggest: Start with graduate students and then they undertake teaching UGs when they move to faculty positions

- ☐ One SS at a time or work through several simultaneously?

Choice among social sciences

- ☐ Which do you think are most important for ES?

- ☐ The **social sciences** are a group of academic disciplines that study human aspects of the world. They diverge from the <u>arts</u> and <u>humanities</u> in that the social sciences tend to emphasize the use of the <u>scientific method</u> in the study of humanity, including <u>quantitative</u> and <u>qualitative</u> methods

List of social sciences- adapted from Wikipedia

- The main **social sciences** include:
- Anthropology
- Economics
- History
- Linguistics
- Philosophy
- Political science
- Psychology and social psychology
- Sociology

- **Others**
- Communication
- Criminology
- Cultural Studies
- Education
- Law
- Social Work
- Developmental studies

Which to pursue first?

- ☐ My favorites for deepest understanding for both practice and research are economics and psychology
- ☐ Why?
- ☐ Economics is dominant in policy advising and research on policy (MW)
- ☐ Psychology is the Bridge between engineering and the social sciences
- ☐ Many others are potentially of interest..

Two Overviews of Cognitive Science

- Levels- cells/neurons, axons, brain structure and plasticity, individual and social behavior and decisions
- Experimental approaches:
- Theories and Models:

☐ Decision making-
  - behavioral economics
  - Game theory and rational choice theory

☐ Biology based
  - Brain
  - mind

☐ Social science and culture based

Human Cognition Overview Topics

- ☐ Evolutionary psychology, cultural influences
- ☐ Brain plasticity
- ☐ Emotions and cognition
- ☐ Creativity, metaphors and analogies
- ☐ Group problem solving
- ☐ Memory
- ☐ Brain science, neuroscience, etc.
- ☐ Decision-making
- ☐ AI and modeling, EPIC and HCI
- ☐ Brain structure, modules etc.

Cultural and evolutionary influences

☐ Culture and the self: Implications for cognition, emotion, and motivation. Markus, H.R.; Kitayama, S., Psychological Review, Vol 98(2), Apr 1991, 224-253

☐ Evolutionary psychology

- Tooby, ﺟ. & Cosmides, L. (2005). 2 articles In D. M. Buss (Ed.), *The Handbook of Evolutionary Psychology* (pp. 5-67). Hoboken, NJ: Wiley.

- Steven Pinker: *The Language Instinct, How the Mind Works, The Blank Slate, The Stuff of Thought*

Brain Plasticity

- **Societal effects**
  - Nicholas Carr, *The Shallows: How the Internet is changing the way we think,*
  - Doidge, *The Brain that Changes Itself* (2007)
  - McLuhan, *Understanding Media: The extension of man (*The medium is the message) (1964)
  - Saenger, *Space between Words*
  - Landes, *Revolution in Time*

- **Personal scale Effects**
  - Ramachandran, V. S. Perception of phantom limbs

- **Micro level effects**
  - Begley, Sharon (November 5, 2004). "Scans of Monks' Brains Show Meditation Alters Structure, Functioning". *The Wall Street Journal* (Washington D.C.): p. B1..

Emotions and Cognition

□ Emotions also have been considered harmful to thinking but new work has gone deeper and shown value of emotions

- ■ Damasio, *Descartes Error; the Feeling of what happens*

- ■ LeDoux *The Emotional Brain*

- ■ Pessoa, L. On the relationship between emotion and cognition. Nat Rev Neurosci 9, 148-58 (2008).

- ■ Phelps, E.A. Emotion and cognition: insights from studies of the human amygdala. Annu Rev Psychol 57, 27-53 (2006).

Creativity

- ❑ R. W. Weisberg, *Creativity: Cognitive Processes in Problem Solving and Innovation in invention, science and the arts,* 2006

- ❑ Robert J. Weber and David Perkins, *Inventive Minds: Creativity in Technology*

- ❑ Csikszentmihalyi, M. *Creativity: Flow and the psychology of discovery and invention*

- ❑ Amabile, Teresa *Creativity in Context: Update to the Social Psychology of Creativity*

Analogies and Metaphors

- Donald Schon, *The Reflective Practitioner* 1983 ("Generative Metaphors")

- James Geary, *I is an Other: The Secret Life of Metaphor and how it shapes the way we see the World,* 2011

- Speer, N. K. "Reading Stories Activates Neural Representations of Visual and Motor Experiences", *Psychological Science* 2009

- Engineering Design (lots and some in 2 weeks)

Group Problem Solving

- ☐ "Evidence for a Collective Intelligence Factor in the Performance of Human Groups" Wooley, A. W., Chabris, C. F., Pentland, A., Hashmi, N., and T. W. Malone*, Science*, 2010

- ☐ James Surowiecki, *The Wisdom of Crowds,* 2004 (anecdotes and interesting speculation why averages for crowds of **independent** estimates can be superior);

- ☐ Scott Page, *The Difference, 2007* (models showing benefit of diversity etc.)

Memory

- E. Kandel, *In Search of Memory: The Emergence of a New Science of the Mind* (2006)

- Baddeley, A. D. *Working Memory* (1986)

- *Memory and Cognition* (A Journal)

Brain science- pathways and learning from pathologies

- Molecular Neurobiology of Human Cognition, Edwin J. Weeber, J.David Sweatt, *Neuron,* 2003

- Oliver Sachs: *The Man who mistook his wife for a Hat; Seeing Voices: A Journey into the World of the Deaf; An Anthropologist on Mars; The Mind's Eye*.

Further Readings in Decision-Making

- Ken Binmore, *Rational Decisions*
- Gerd Gigerenzer, *Rationality for Mortals*
- Daniel Gilbert, *Stumbling on Happiness*
- T. Sagara, *Collective Choice? Public Planning and Arrow's Theorem*
- Barry Schwartz, *The Paradox of Choice*

Other areas

- ☐ Visualization:
  - ■ see "A Historical Review of visualization in Human Cognition" by L. P. Rieber
- ☐ IQ and its change over time
  - ■ James Flynn, *What is Intelligence?* 2009

ESD.83 Doctoral Seminar in Engineering Systems
Fall 2011