Engineering Systems Doctoral Seminar

ESD.83 – Fall 2009

Class 7

Faculty: Chris Magee and Joe Sussman

Guest: Professor Susan Silbey

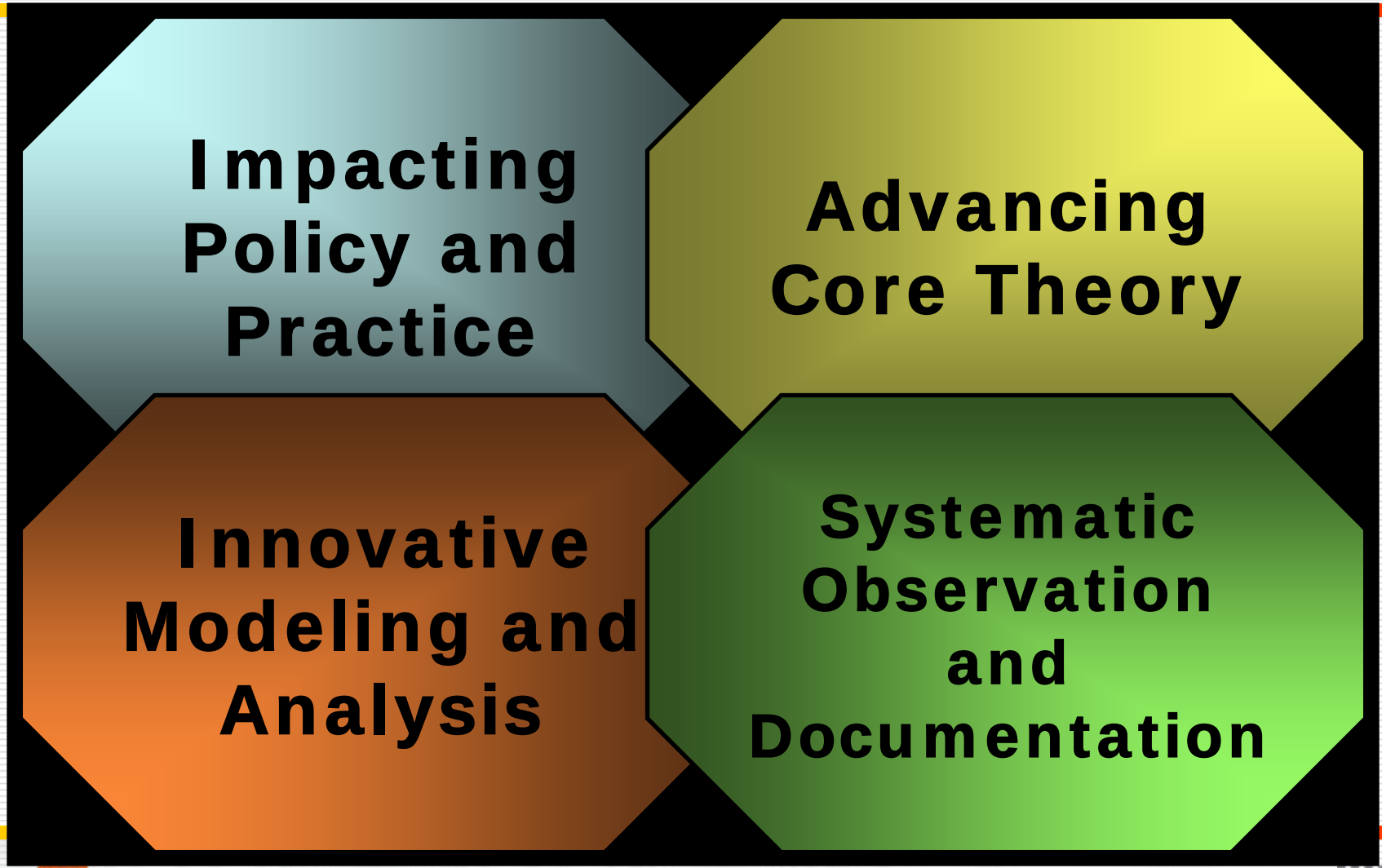
Professor of Sociology and Anthropology

Session 7: Agenda

- Welcome and Overview of class 7 (5 min.)
- Dialogue with Professor Silbey (55min)
- Break (10 min.)
- Discussion of other papers (leads Arzum Akkas and Tom Heaps-Nelson, 40 -50 min)
- Theme and topic integration (Magee)
  - Elements of advancing the field of Engineering Systems and elements of an “Idealized” research process
  - Discussion of assignment 1
  - Report from the Front
  - “Structure” of Observations

- Next Steps -preparation for week 8- (5 min.)

Strategies for Advancing Engineering Systems as a Field



Class Debate: Advancing ES as a Field

You will be assigned to one of four groups, each responsible for one of the core strategies:

Group 1: Impacting policy and practice

Group 2: Advancing core theory

Group 3: Innovative modeling and analysis

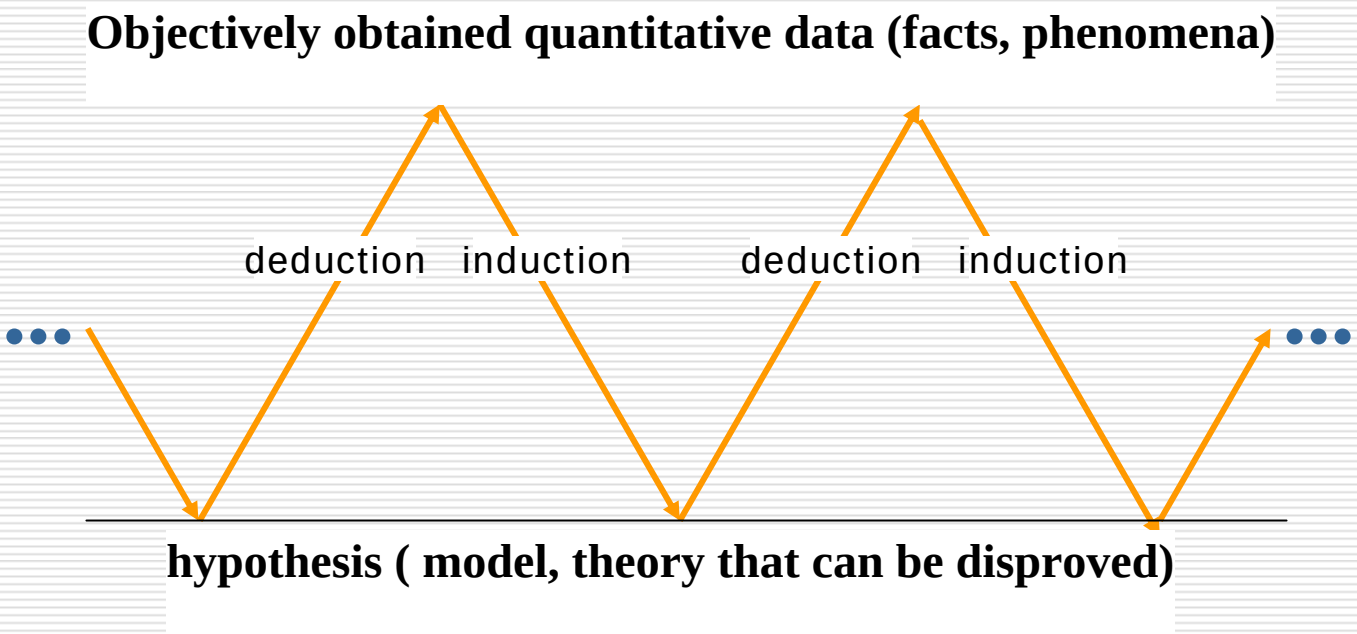
Group 4: Systematic observation and documentation

Prepare "Opening Remarks" (one minute) and a "Rebuttal" (two minutes) during which you will make the case that your group's strategy is the ***most*** important for advancing Engineering Systems as a field

Advancing a field

- What are the criteria for determining the best way to advance the field?
- Should one consider value/resources in academia to be a significant criteria?
- Value in engineering implies practical importance. Is this everything for ESD?

The Iterative Learning Process



A falsified theory/model serves as a stronger basis for "guessing" a better theory/model. ***There can be no falsification without observations of some kind.***

A Research Process

1. Development of conceptual understanding (qualitative framework)
2. Development of quantitative model
3. Observe (system)
4. Analyze observations
5. Generalize or simplify/complicate model

1. Development of Conceptual Understanding (Qualitative framework)

- Identify key variables
- Characterize variables: control, dependent, output/outcome, stochastic,
- Timeframes of interest
- Interactions of variables, possible causal diagram
- Complications for non-linearity, non-monotonic, non-continuous, multi-valued and path dependent functional relationships

A Research Process 2

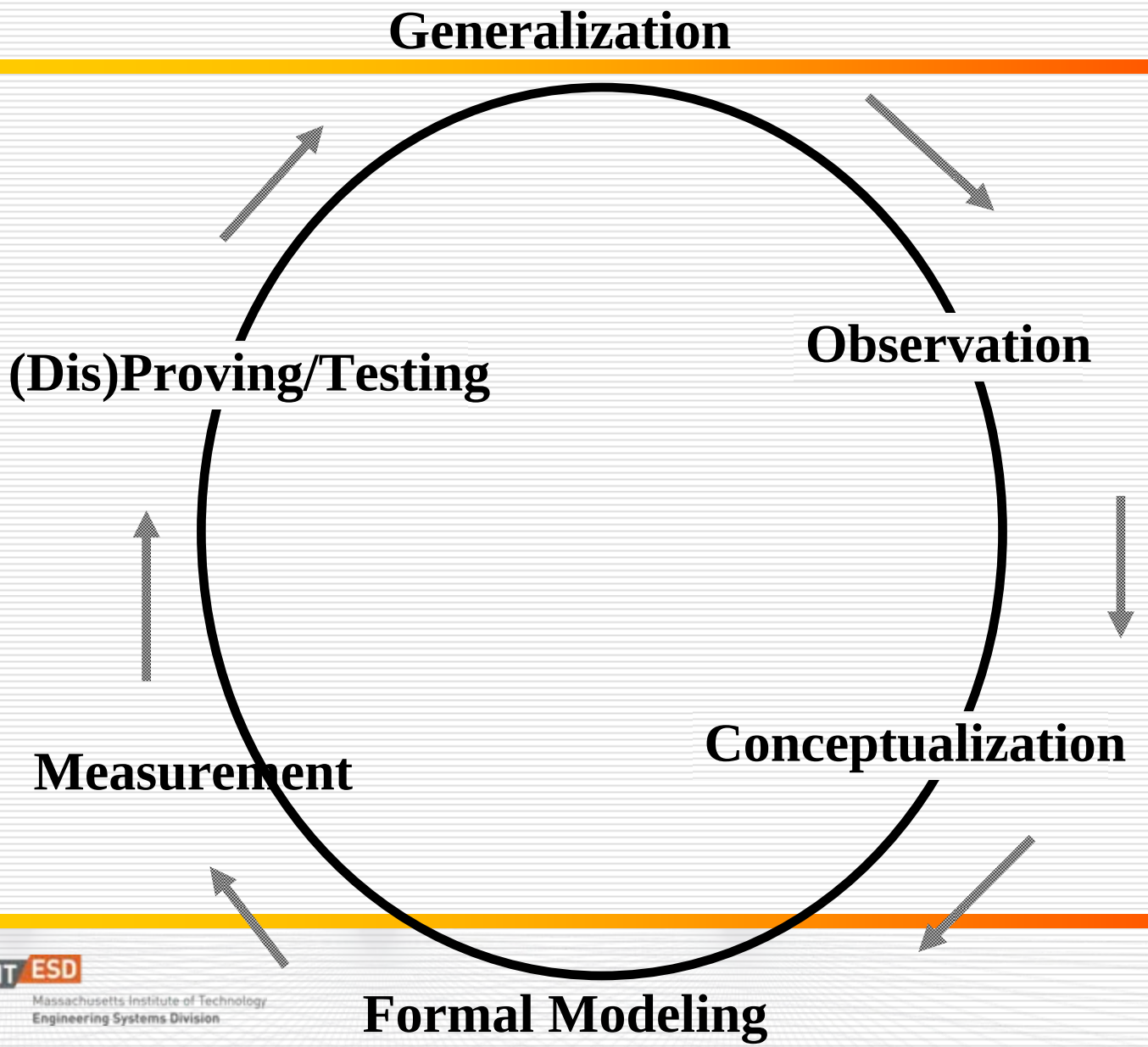
1. Development of conceptual understanding (qualitative framework)
2. Development of quantitative model
3. Observe (system)
   - Design a specific version of a known procedure
   - Develop a new observational procedure
   - Find, and/or extract and combine data
4. Analyze observations
   - Use existing models to “reduce” data to model-relevant
   - Develop new models to “reduce” data
   - “Consilience” among observations of various kinds
5. Generalize or simplify/complicate model

A Research Process 3

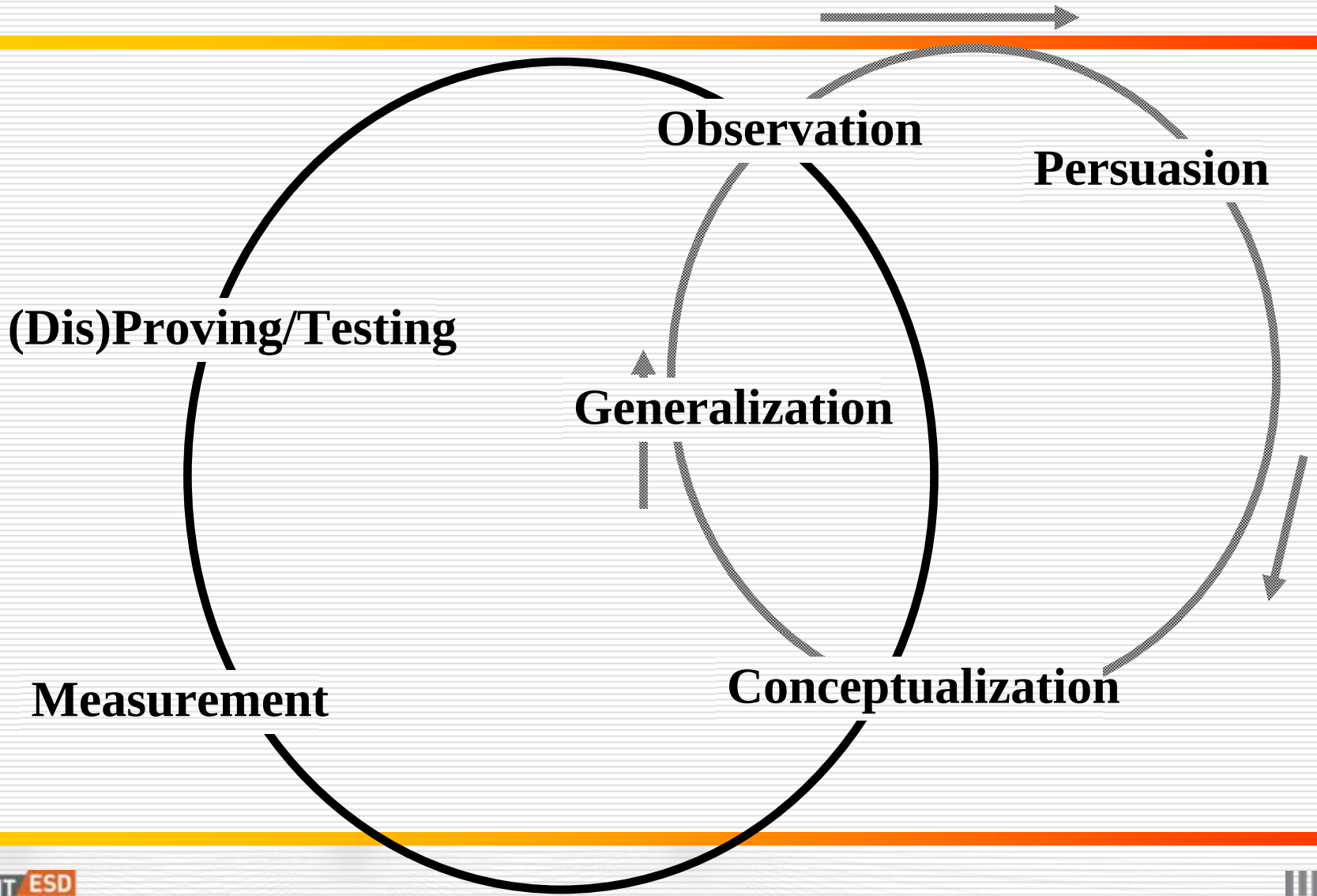
1. Development of conceptual understanding (qualitative framework)
2. Development of quantitative model
3. Observe (system)
4. Analyze observations
5. Generalize or simplify/complicate model

- Research styles (1,2,3,4,5 repeat; 1,3,5 repeat; 1/3, 2/4, 5/1; 3, 4, 1, 2; etc.)
- Are there “not so good” styles?

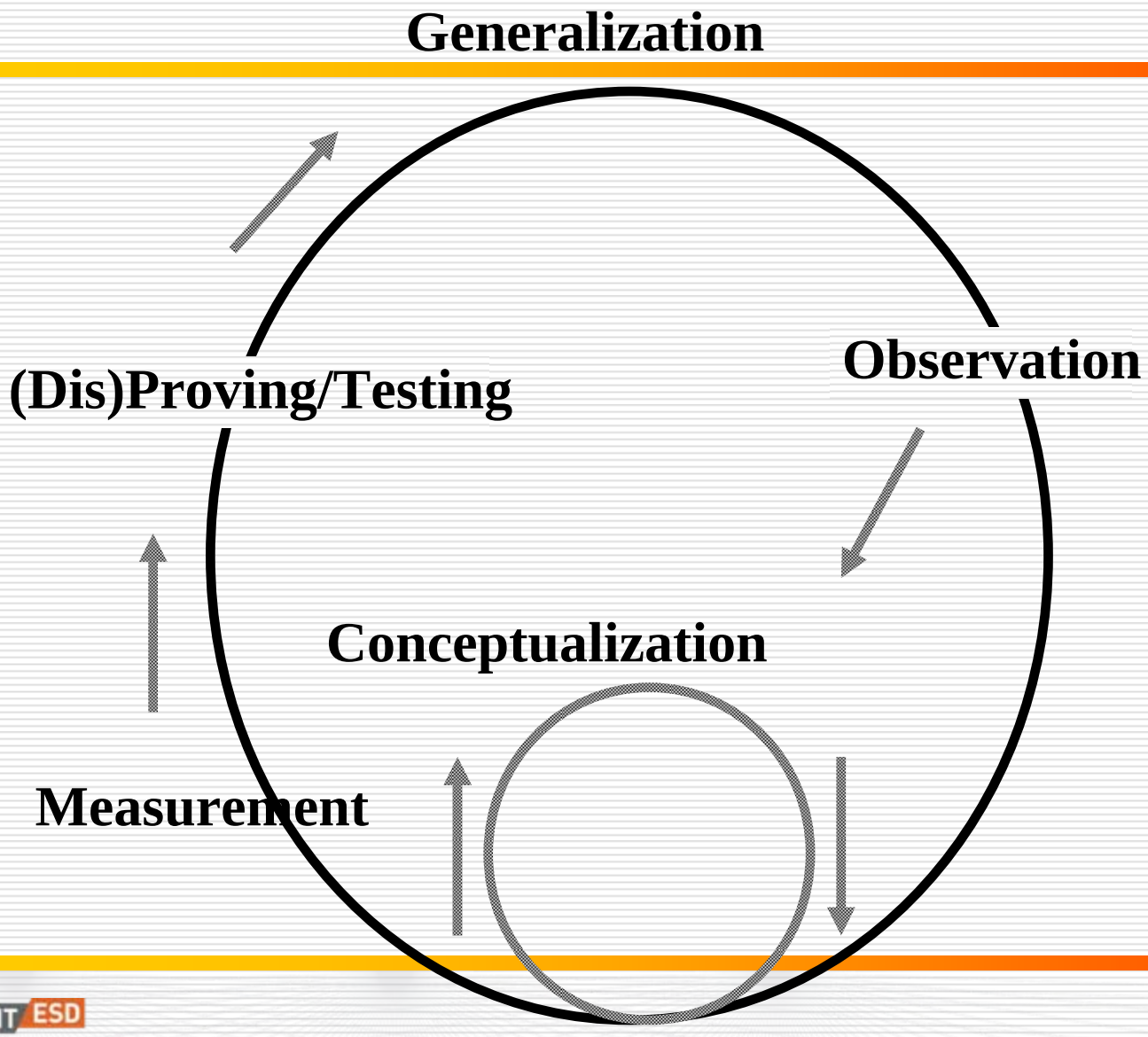
Idealized Research Process



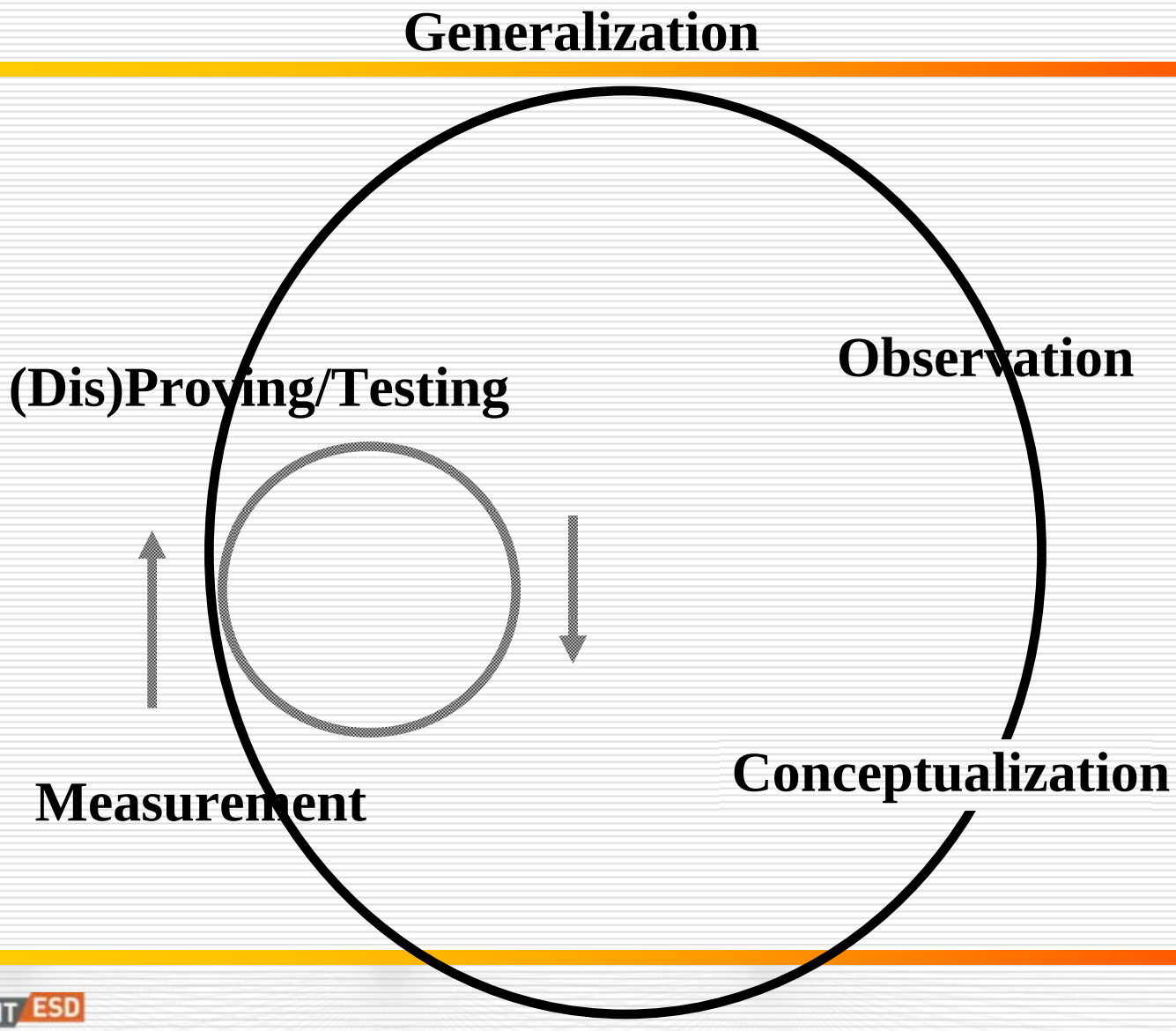
Pathology # 1: "Guruism"



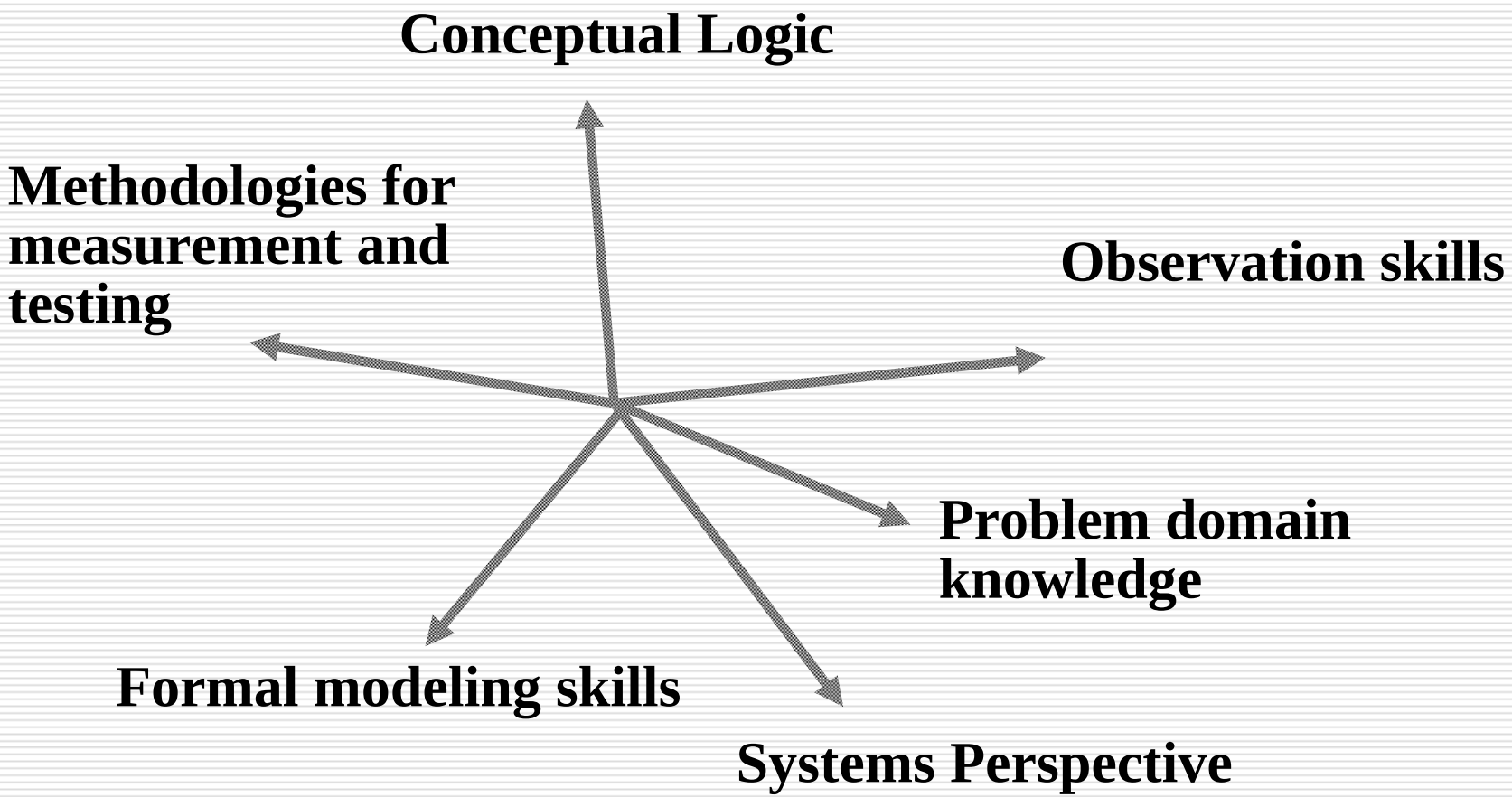
Pathology #2: “Air castling”



Pathology # 3: Empiricism



Desired Capabilities



Advancing a field 2

- What makes a field cumulative in its knowledge acquisition process?
- **Cyclic learning seems to be most important. The pathologies in the preceding slides are non-cumulative**
- **Modeling, theory and objective observation are important aspects of the research cycles—Watts reading**
- Qualitative and quantitative understanding is necessary for rapid cumulative advance
- Productivity in ES requires becoming more cumulative in our research process

Discussion

- Report from the Front- how does the obituary fit into today's topic?
- Assignment 1- examples of observational methods
- How would you differentiate between an experiment and an observational study?
- Experiment = system (individuals treated, nature of treatment, measures of outcomes, etc.) under control of the investigator
- Experiment or observational study?
  - Duflo et al
  - Huising and Silbey
  - Travers and Milgram

ES Observational Techniques

- Need for extensive data analysis and experiment vs. observational study are key differentiating factors among observational techniques
- Case studies (N = 1)
  - Implications of a singular fact ("The World is Green")
  - In-situ: Ethnographic study, surveys, interviews, document study, email studies, minutes, calendar analysis, quantitative and qualitative, etc.
  - Historical analysis: primary and secondary documents, interviews, quantitative and qualitative, etc.
- Medium N- as above but time limited
- High N (possibility of experiment)-
  - Randomly assigned, natural experiment
  - Instrumental variable, others

Comments on ES Observation Techniques

- Insightful work on the implications of singular facts can be "nucleating" events
- Non-subjective, repeatable observational techniques are needed for cumulative progress
- N=1 case studies appear most helpful with a wide variety of repeatable observation types (and over time)
- Quantitative experiments (or psuedo-experiments) that severely test existing theory (a strong possibility of falsifying) are usually best for cumulative knowledge building but are strongest when supplemented by extensive qualitative evidence of diverse types.

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