ESD.84 Doctoral Seminar – Session 4 Notes
Guests Presenting: Dan Whitney

Session Design:
- Welcome and Overview and Introductions (5-10 min.)
- Generating Key Questions from Readings (10-15 min.)
- Views of Product Architecture – Dan Whitney (30-45 min.)
- Analysis of Uncertainty and Complexity as Core Concepts (15-20 min.)
- Break (15 min.)
- Segmented, Linear, Hierarchical Thinking and Systems Thinking – Ozlem Uzner (15-20 min.)
- Systems Thinking in Theory *vs.* Systems Thinking in Practice – Troy Downen (15-20 min.)
- Book Review of John Sterman's *Business Dynamics* by Troy Downen (5-7 min.)
- Integrative Discussion (20-30 min.)
- Next Steps (10-15 min.)

Advance Questions Generated on Product Architecture:
- How generalizable is the combinatorial approach?
- How does the modular architecture respond to innovation in industry?
- Are the methods prescribed in the Denso case generally applicable – where would you and wouldn't you use them?
- Consider general industry tendencies from integrated to modular and back to integrated (Kim Clark) – how does this modular approach fit?
- Is there really a trade-off between performance and modularity?
- Some companies follow parts of this approach – few follow all – what are the implications in transferring the principles to other organizations?
- Is the most fundamental part of this the integration of the social/organizational dimension into the technical operation?

Presentation Discussion with Dan Whitney:

- Lock-in dimensions of product architecture:
    - Product itself
    - Organizational structure
    - Customer relationship – Toyota in this case
- "Lock-in" as a risk factor in relation to response to change – particularly in the context of finely tuned systems
- Flexibility and variety only works in the Denso case within clear boundaries for the variety
- Key finding from Clayton Christianson – disruptive technologies – as major technological leaps, the modular strategy breaks down and has to be more of an internally integrated approach
- Similarly, when architectures are contending, modular approaches are constrained – it depends on a dominant design taking over
- Terminology of "dominant design" versus "common architecture" – the common architecture is what makes the design dominant
- Key architecture dimension at a higher level is special purpose or more general purpose infrastructure – air traffic control system versus railroad system
- Modularity may have advantages beyond re-use in other products and flexible production – such as in facilitating maintenance, upgrades, etc.
- Penalties of complexity became apparent in 1980s in Japanese car industry
- Key challenge – architecture and modularity are better understood in practice than they are in theory – reflecting direct contact with the problem by practitioners
- Link of an economic model and an organizational model to discussions of product modularity
- Logic of an embedded economic model and organizational model may drive more of an incremental approach to successive adjustments in the modular architecture – non-incremental changes are hard to accommodate
- Modular architecture is a risk mitigating strategy, but it doesn't mitigate against the risk of a competing architecture
- To what extent is modular architecture an intentional strategy versus a post-hoc justification or analysis? It depends on the degree of control of the environment
- Most complex systems approaches in industry are "hacks" in response to environmental needs – with the full value only becoming apparent in retrospect – so how can we as academics provide frameworks and guidance that add value?
- There are many trade offs associated with modularity, including:
    - Variety – change trade offs
    - Performance – maintenance trade offs
    - Outsourcing – control over specifications trade offs
    - Customer repair – reliability trade offs
    - Scale manufacturing – upgradeability trade off

**Presentations by Ozlem Uzuner and Troy Downen on aspects of Systems Thinking
Book review by Troy Downen on Business Dynamics**

Discussion:
- Implication of book review on Sterman's book – it might benefit from some modularity for the first 200 pages as a stand-alone product
- Larger issue of the use of a linear exposition in a book or presentation to teach about a non-linear phenomena such as systems thinking – book as building blocks, but also option of recursive reading approach
- Importance of the flight simulator approach to management problems
- Jay Foerster pushed hard on the bounded rationality argument – scare tactics that you need this computer program to do what your minds can't do
- Key insight by Jay Foerster is the way that time delay causes instability in systems
- Value of Senge's causal loop diagrams making system accessable
- Larger issue of multiple ways to represent complex systems – through diagrams, simulations, etc.
- Issue of practitioners who are systems thinkers in practice – whether or not they are using the specific tools and principles
- The issue of non-linearity is a key consideration – different than time delays, but related to it
- How to relate the notions of market adjustment and market efficiency to issues of systems complexity and bounded rationality?