

## Lecture # 3 - Generic Structures and Systems Archetypes

### Project statements

### Generic structures

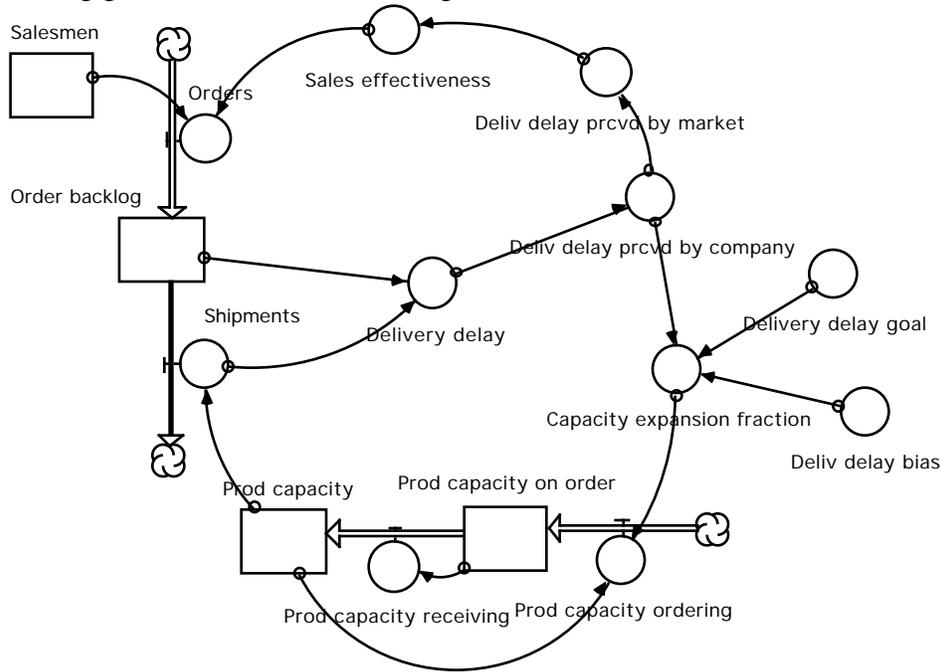
Forrester's *Urban Dynamics* Notes on Complex Systems -- examples?

- 1) Counterintuitive behavior: Past programs intended to help cities showed the potential in simulations to make matters worse, not better.
- 2) Insensitivity to parameter changes: Social system models show this insensitivity, and so do social systems (e.g., cities with dramatically different quantitative characteristics all showing the same overshoot and decline behavior). The reasons: nonlinearity, loop dominance, shifting loop dominance, compensating feedback, ...
- 3) Resistance to policy changes: "A policy is composed of structure (what information sources are selected and how they are used) and parameter changes (determining how much influence from the information and how much action). ... The insensitivity of a system to most of its parameters means that the system is also insensitive to most modifications that would be called policy changes, because often the policy changes are only changes in degree of information influence or action. Here lies the explanation for the stubborn nature of social systems. When a policy is changed, the many system levels shift slightly and offer a new ensemble of information to the policy point in the system. The new information, processed through the new policy, gives nearly the old results."
- 4) Control through influence points: "There are a few points in any system to which behavior is sensitive. If a policy at one of these points is changed, pressure radiate throughout the system. Behavior everywhere seems difference. But people have not been persuaded or forced to react differently. As they respond in the old way to new information, their actions change."
- 5) Corrective programs counteracted by the system: "Active corrective programs imposed on a social system can have far less than their anticipated effect because they tend to displace the corresponding internal processes. ... The active corrective programs shift the system balance so that the corresponding natural processes encounter more resistance and reduce the load they were previously carrying. [Example: underemployed-training program processing 19,100 people yielding a net upward flow of only 11,300] ... Probably no active, externally imposed program is superior to a system modification that changes internal incentives and leaves the burden of system improvement to internal processes."
- 6) Long-term versus short-term response: Worse-before better; better-before-worse
- 7) Drift to low performance: "... The opposite direction of short-term and long-term responses leads to policies that produce a less satisfactory system."

[Note the *style* of this scholarly writing! The contribution here is a set of insights that emerge only after deep reflection on research results. The Forrester model: do not stop when the simulations have been run and the policy recommendations formulated. Press beyond, for insights.]

Forrester's "Market Growth" structure — sliding goals

Sliding goals in the classic market growth structure

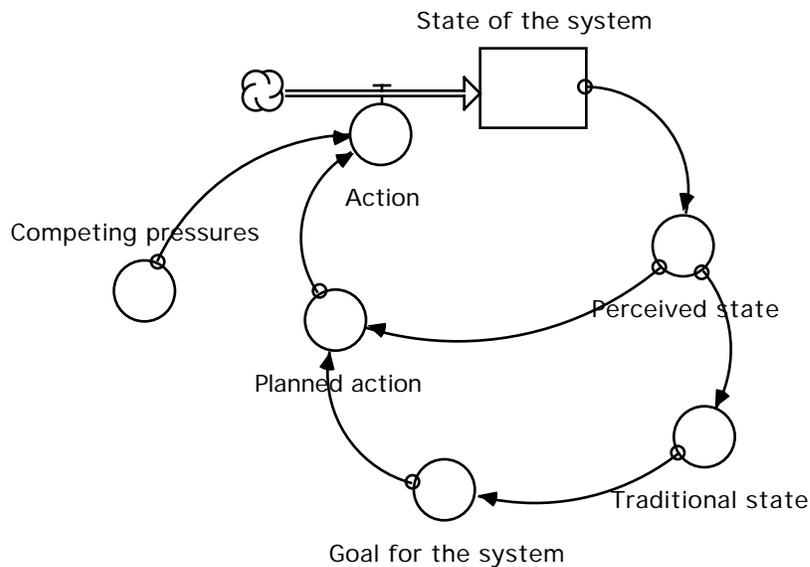


Sliding goals structure isolated

Sliding goals structure generalized

Note two loop structure

Note role of competing pressures



Sliding goals in academic achievement

## Meadows, Whole earth models and systems

### A child's guide to the systems viewpoint

- 1) the concept of a system
- 2) the limiting factor (bread won't rise without yeast, and adding more flour won't help)  
"To shift attention from the abundant factors to the *next potential limiting one* is to gain real understanding of and control over the growth process."
- 3) boundaries - where things come from and where things go. There is no "away" to throw things to.
- 4) feedback - allows one to link causal structure to dynamic behavior. ...But the most powerful aspect of the feedback concept, a truly profound and different insight, is the way you begin to see that *the system causes its own behavior*.

### Advanced understanding - making complex systems work

- 1) Policy resistance
- 2) Drift to low performance
- 3) Addiction
- 4) Official addiction — Shifting the burden to the intervener
- 5) High leverage, wrong direction

## Senge, *The Fifth Discipline*

### "Nature's templates"

- 1) Limits to growth
- 2) Shifting the burden

### Appendix 2

- 1) Limits to growth
- 2) Shifting the burden
- Special case: Shifting the burden to the intervener
- 3) Escalation
- 4) Success to the successful
- 5) Tragedy of the commons
- 6) Fixes that fail
- 7) Growth and underinvestment

### Our list:

- 1) Compensating feedback / Policy resistance
- 2) Escalation
- 3) Limits to growth
- 4) Drift to low performance / Sliding goals
- 5) Shifting the burden / Addiction / Shifting the burden to the intervener
- 6) Fixes that fail
- 7) Tragedy of the commons
- 8) High leverage, wrong direction?

Are there others in public policy that we are acquainted with?