

The Emergence of Stability in Diverse Supply Chains

Self-★ Workshop 2004

Owen Densmore
Xerox, Apple, Sun
"Retired" - Santa Fe

<http://friam.org>

<http://complexityworkshop.com>

Talk

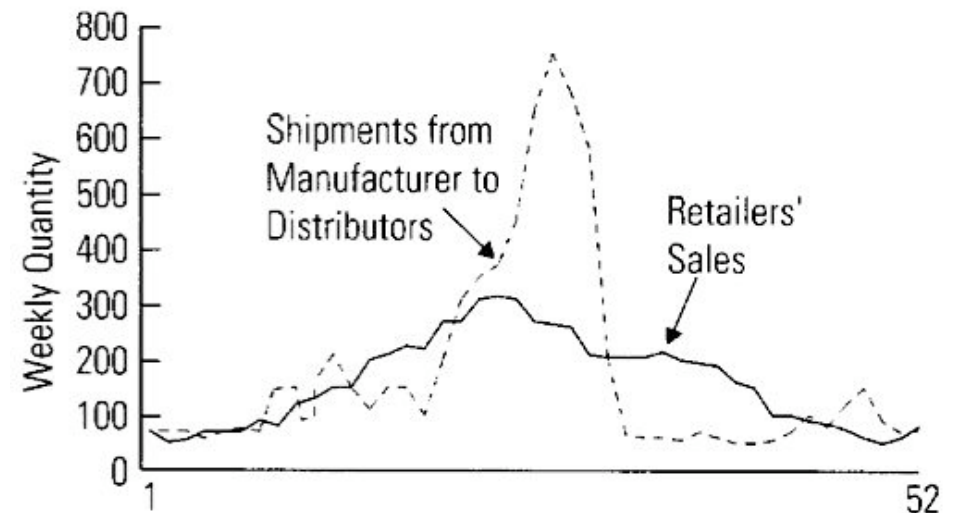
- Example Agent Based Models
- Discuss SFI ValueNet Simulation
- Self-* "Three Step Plan"
- Future Directions

(Remember this is a workshop!)

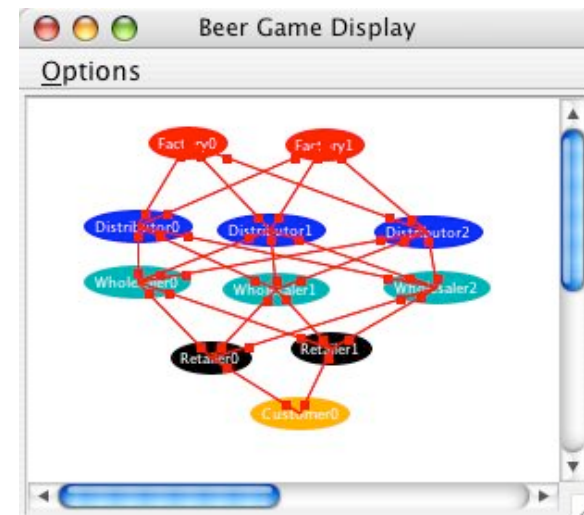
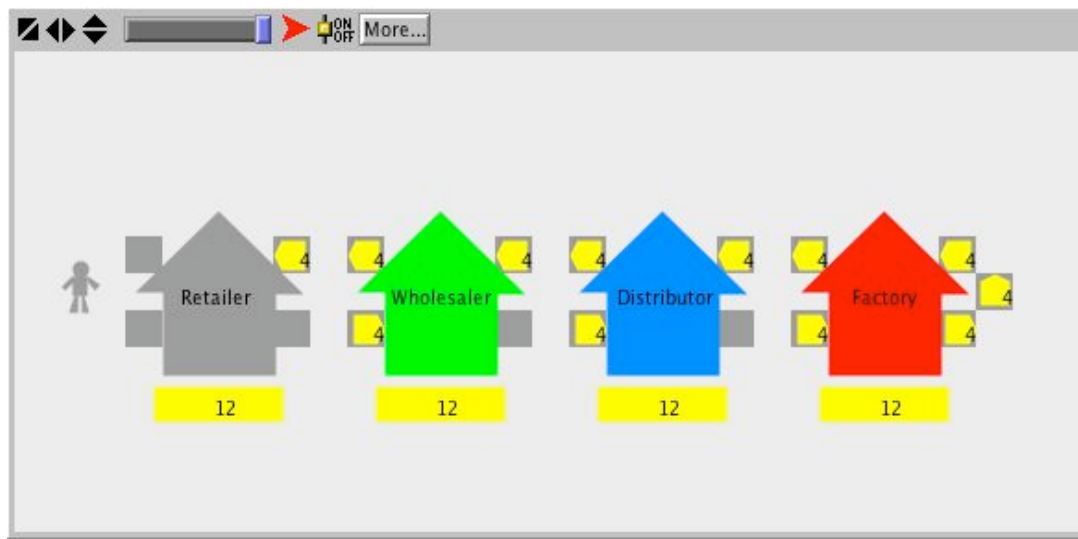
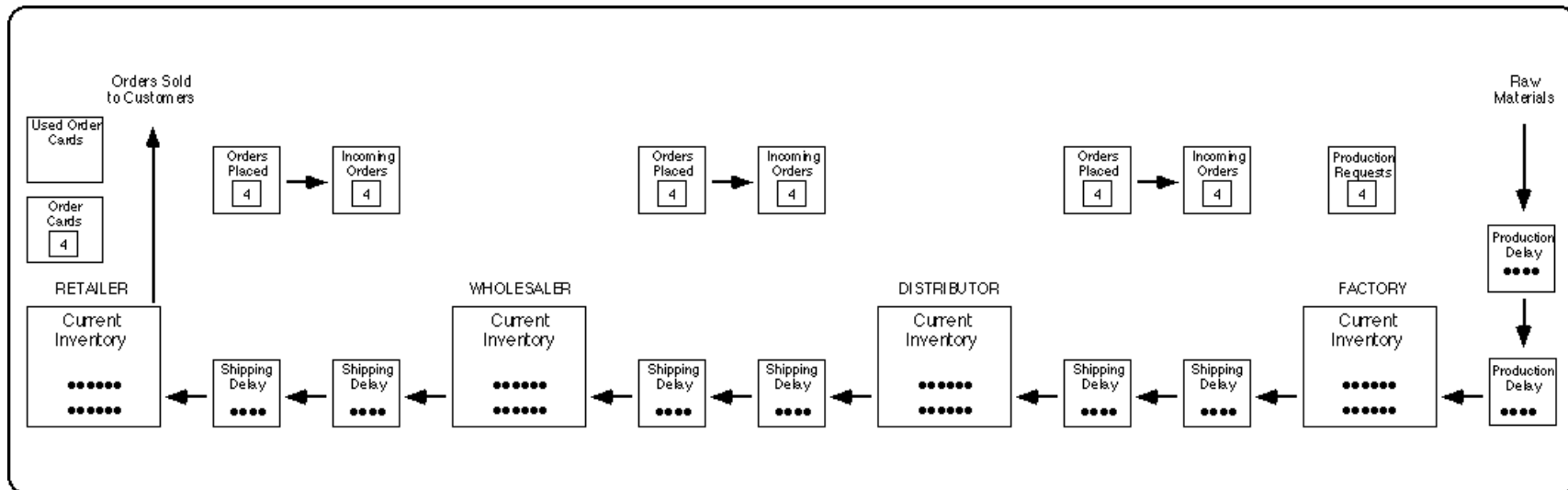
History

- Santa Fe Institute Business Network
- 2001: ValueNet Team
- Project:
 - Repast Beer Game Model
 - Bullwhip Effect
 - Human Decision Making Model
 - Goal: Explore Impact of Mesh & Visibility on Human Decision Making

Figure 3 Bullwhip Effect due to Seasonal Sales of Soup

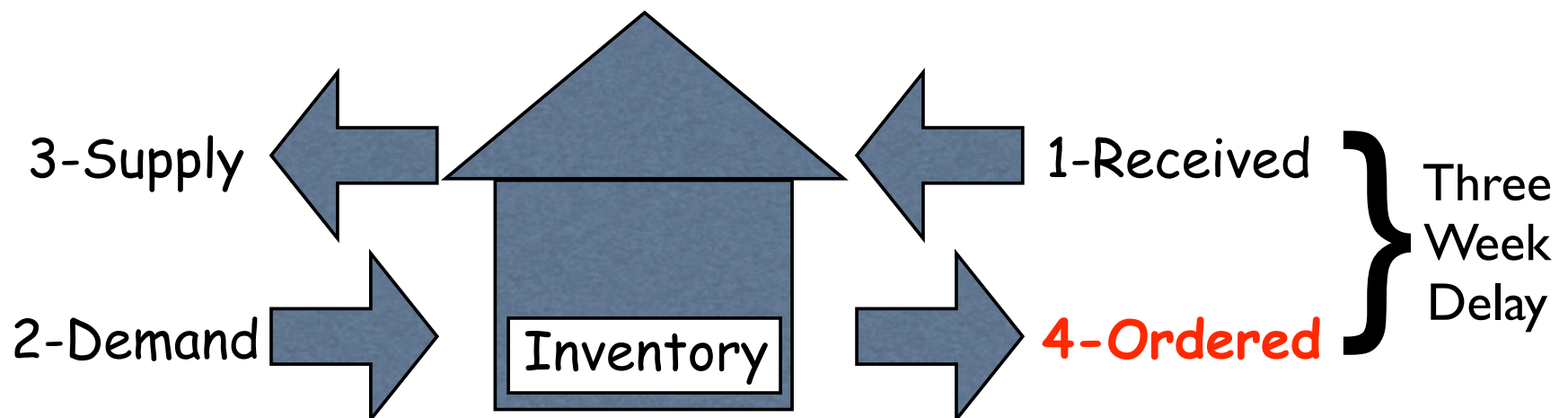


The Beer Game



Game Play

- Each round of play, each Player (Supplier)
 1. Refresh Inventory from Received orders
 2. Get customer Demand
 3. Supply demand from Inventory
 4. **Make Order to update Inventory**
- Delay: 1 week for order processing, 2 weeks for shipping.
- Goal: Minimize Cost = $\$0.50 * \text{stock} + \$2.00 * \text{backorder}$



Sterman 4 Parameter Model

Goal: Minimize Cost = \$0.50 * stock + \$2.00 * backorder
(Note: model human behavior rather than optimize cost)

$Order_t = Expected\ Demand_t + Inventory\ Adjustment$

$Expected\ Demand_{t+1} =$

$\Theta Demand_t + (1 - \Theta) Expected\ Demand_t$

$Inventory\ Adjustment =$

$\alpha (Desired\ Inventory - Inventory) +$
 $\beta * \alpha (Desired\ Pipeline - Pipeline)$

$Desired\ Inventory = Q - \beta * Desired\ Pipeline$

The 4 Ordering Parameters

Θ : Controls expected demand update rate

α : Controls desired inventory vs. actual inventory

**β : Controls desired pipeline vs. actual pipeline
(Ratio of importance of pipeline vs stock)**

Q : Desired inventory + relative desired pipeline

(Note: Inventory = stock - backorder, can be negative)

Model Ordering Rules

The Beer Game agent behavior is entirely in the ordering rules, which contain 4 parameters used in two phases:

1. Predict Demand (Θ)
2. Create an order (Demand, α , β , Q)

1 - Expected Demand_t =

$$\Theta \text{ Demand}_{t-1} + (1 - \Theta) \text{ Expected Demand}_{t-1}$$

2 - Order_t = Expected Demand_t +

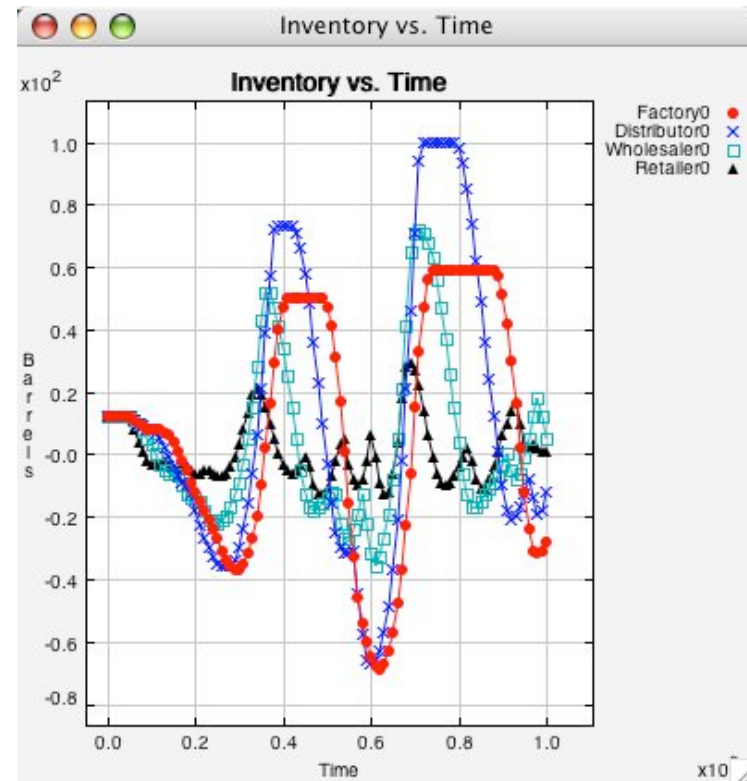
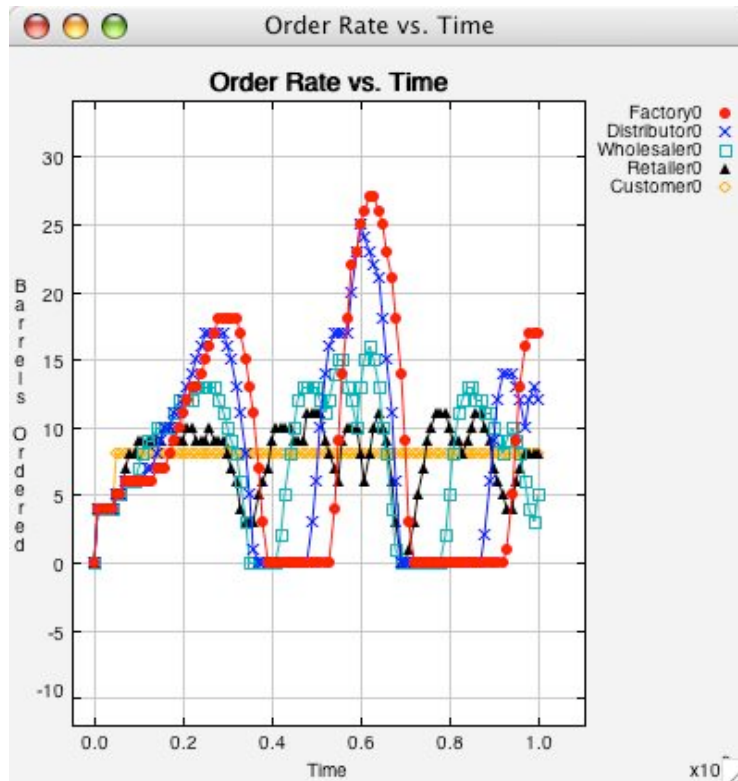
$$\alpha (Q - \text{Inventory}_t - \beta \text{ Pipeline}_t)$$

Completely Deterministic -- no random components.

Customer Orders: 4 4 4 4 8 8

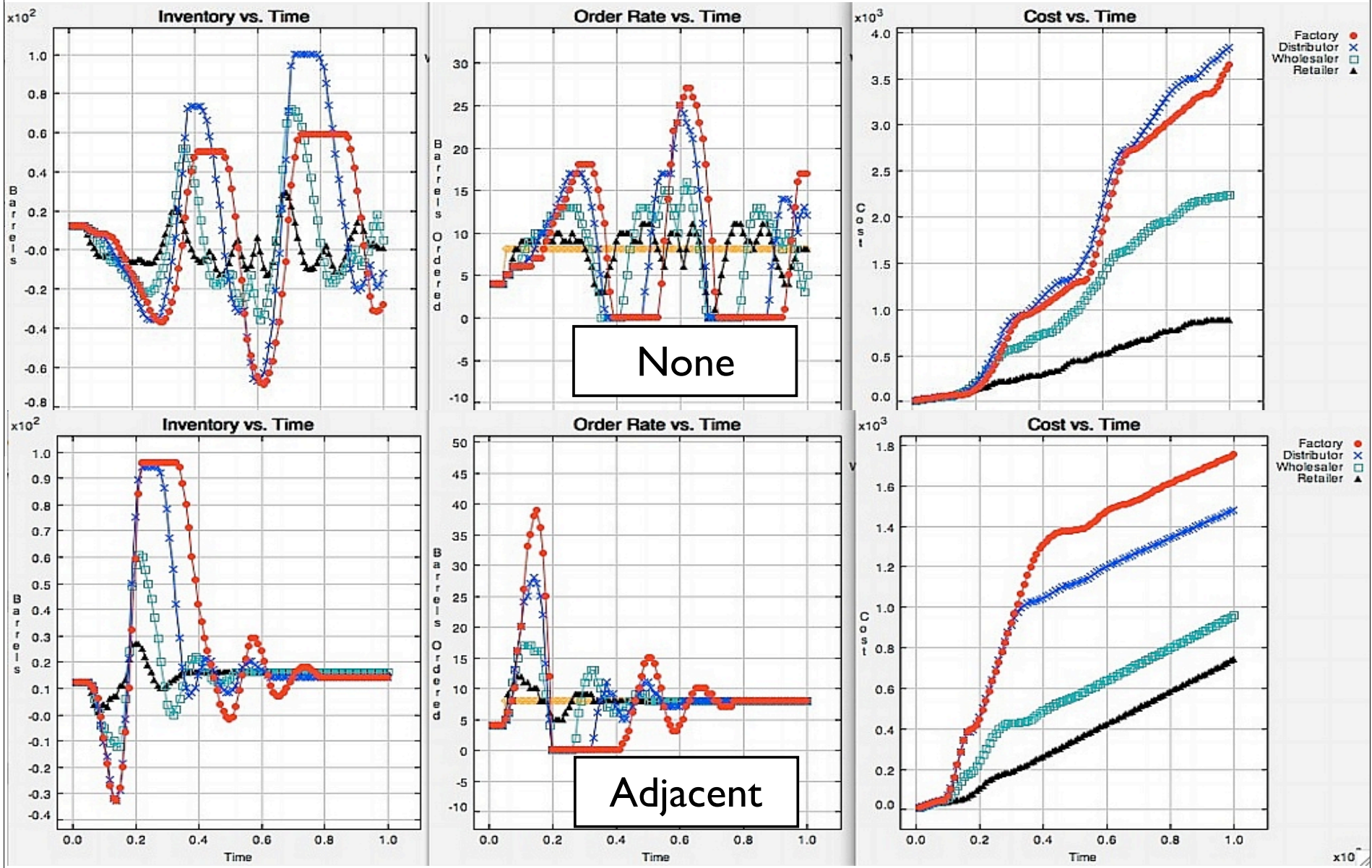
Bullwhip Effect!

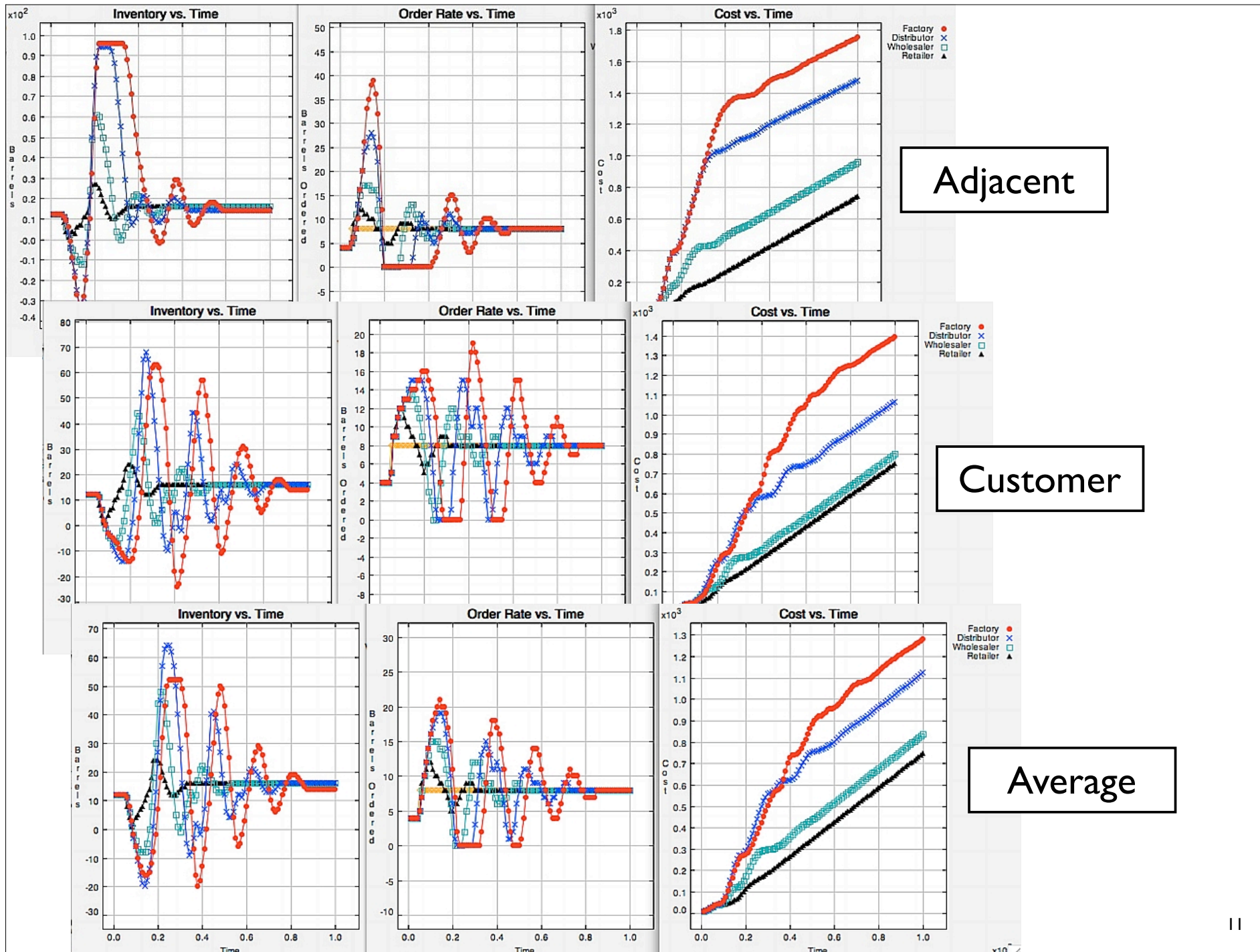
- Many parameter sets lead to extreme volatility.



- Value Net: Model Visibility (RFID) & Mesh (Internet)

Visibility Creates Stability



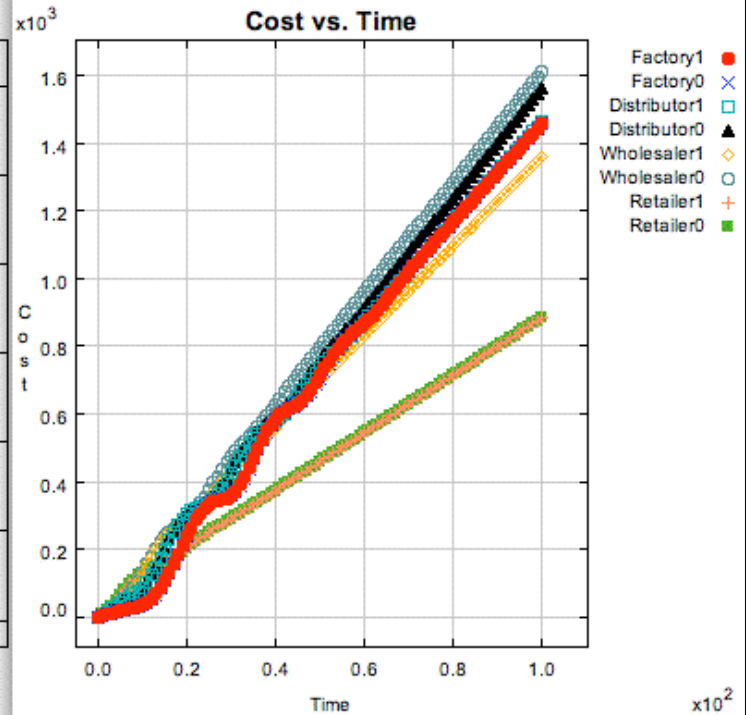
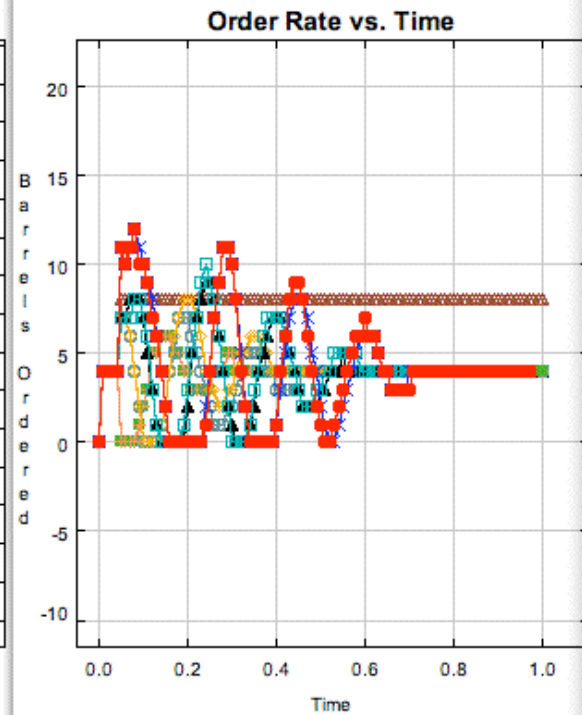
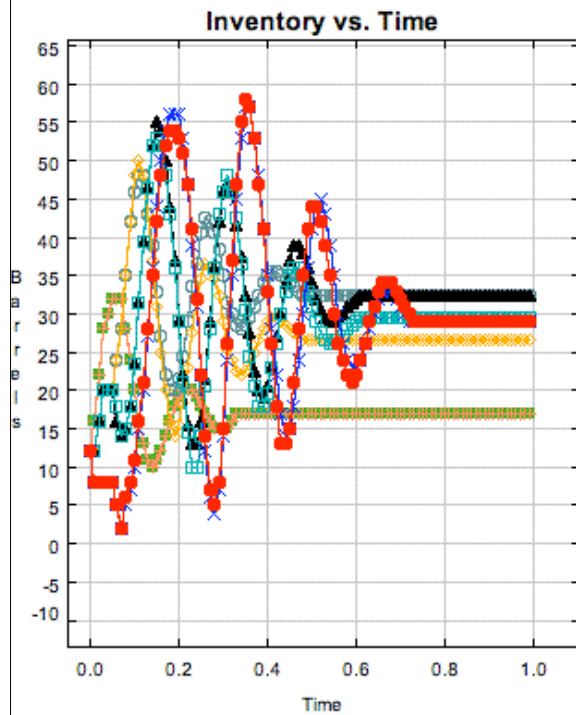
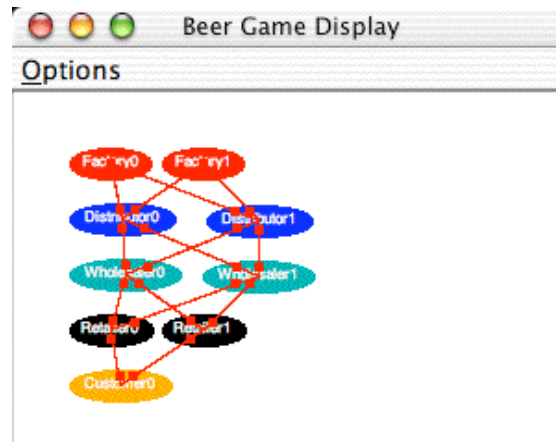


Adjacent

Customer

Average

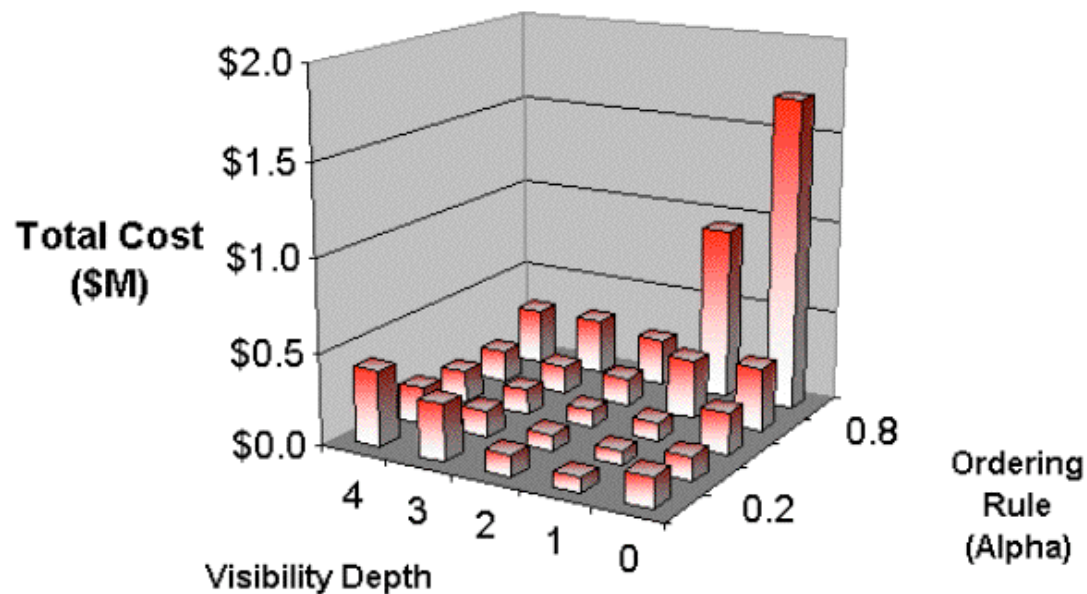
Mesh Creates Stability



Why?

Question: "Why do increased visibility and mesh topology settle into non-volatile behavior?"

- **Visibility: Increasing Knowledge**
- **Mesh: Increasing Choice**
- **Future directions: Auctions, Brokers, ..**
- **Until ...**



Self Star!

SELF-STAR: International Workshop on Self-* Properties in Complex Information Systems

31 May - 2 June 2004
[University of Bologna](#)
[Residential Center](#)
[Bertinoro \(Forli\)](#), Italy



From: Ozalp Babaoglu <babaoglu@CS.UniBO.IT>
Subject: invitation to participate in "Self-*"
Date: October 21, 2003 3:12:17 AM MDT
To: Owen Densmore <owen@backspaces.net>

Dear Owen,

I would like to invite you to participate in a working conference that I am organizing together with Christof Fetzer, Maarten van Steen, Aad van Moorsel, Stefano Leonardi, Mark Jelasily and Alberto Montresor. The conference is called "Self-* Properties in Complex Information Systems" and will be held between 31 May and 2 June 2004 in Bertinoro, Italy.

- **Would Self-* be a good direction for project?**
- **We would be interested in:**
 - How measure Organization/Healing
 - How predict ways to increase Organization/Healing
 - New ABM theories and tools (Algebra, "Derivative", Tools)

Step 2: Read!

- What is Self-*
- How Predict?

THE SCIENCE OF SELF-ORGANIZATION AND ADAPTIVITY

Francis Heylighen,

Center "Leo Apostel", Free University of Brussels, Belgium

Emergence of Constraint in Self-organizing Systems

Stephen Guerin¹, RedfishGroup, Santa Fe, NM

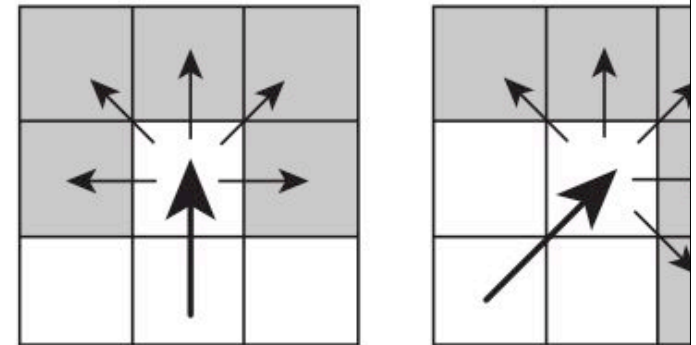
Daniel Kunkle, RedfishGroup, Santa Fe, NM

Abstract 136
model of
of self-o
self-orga
food for

NDPLS, 8(2), Guerin

system and is an example of a *context-free constraint* (J
The direction of an ant is calculated after each step based
and current positions. At time zero each ant chooses a ran

Self-Organizing Systems (SOS) FAQ
Frequently Asked Questions Version 2.93
November 2003
For USENET Newsgroup comp.theory.self-org-sys
(* new or updated questions)
Index



Step 3: Add Analysis Back!

- Model -- $F_{\dagger}:\{\text{parameters}\} \rightarrow \{\text{state space}\}$

Resulting Properties $\{ X_i(\text{state space}) \}$

- Analyze:
 - Parameter Sweeps
 - Entropy
 - $S = -\sum p_i \log p_i$
 - Problem: How determine $\{p_i\}$?
 - Attractors
 - Ex: In 1 hour first night added point-attractor detection.
 - Self-* Ideas: Self-P, Bounded Algorithms, ...
- Language: System \rightarrow Modeling Language

Conclusion

- Self-* has prompted us to become more analytic.
 - Help!
 - Quiz: Which models were Self-*? Why?
-
- Questions??