Supply Chain Visualization

February 5, 2002

SCV Review Agenda

MIT Faculty Club

SCV Review

1:00-1:15	Introduction & Overview	Jim Rice
1:15-1:45	System Dynamics Model	Jim Hines/Paulo Goncalves
1:45-2:15	Process Handbook Demo/Review	John Quimby/George Herman
2:15-2:30	Break	
2:30-2:45	Walk to Media Lab Tangible Media Group	

MIT Media Lab Tangible Media Group – 1 Cambridge Center 5th Floor

2:45-3:15	Tangible User Interface Demo	James Patten
3:15	Return to Faculty Club	

MIT Faculty Club

MIT Supply Chain Visualization Research Program

Research Funds:	**Intel (MTC, IT R&D Council, AIM, MIT CeB Sponsorship), ISCM**
Research Groups:	**Center for Coordination Sciences, System Dynamics Group, Media Lab, Center for Transportation Studies**
Project Mgrs.:	**MIT: Jim Rice (Center for Transportation Studies) Intel: Mary Murphy-Hoye (IT Industry Research)**
MIT Team:	**Dr. Tom Malone, Dr. Hiroshi Ishi, Dr. Jim Hines, John Quimby, George Herman, Ben Koo, Paulo Goncalves, Chalermmon Lertpattarapong, James Patten**
Focus:	**Cross-discipline research into new ways of representing and manipulating Supply Chain processes and models**

Supply Chain Visualization at MIT

The Problem with Supply Networks (SN)

- **Intangible:** hard to quickly grasp underlying dynamics
- **High complexity:** Hard to manage across entire network
- **Change:** Hard to rapidly invent, redesign, and reconfigure

Vision

- 3D manipulation of SN process models by >1 user

Interdisciplinary: Integrating 3 Components

- Tangible User Interface (TUI)
- Systems Dynamics models and simulations
- Process Handbook Knowledge Repository

Value

Solve SN issues (product mix, demand variability),
Tangibly illustrate dynamics of SN system
Enable comprehensive rapid analysis and redesign

Process Knowledge Repository

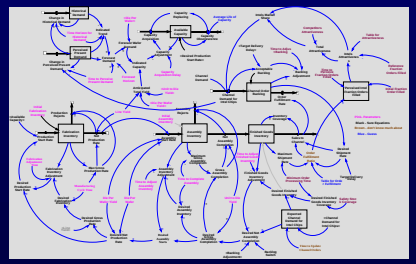
Extending the semantic network of entities and relations with the **Process Handbook** to capture the semantics of System Dynamics modeling

- **Software:** repository engine, web server, editing tools
- **Business Content:**
  - Over 5000 processes & activities
  - Generic business models
  - Taxonomy of generic activity types
  - Case examples

Tom Malone

System Dynamics

- Simulation Engine
- Analytical Approach
- Working with real world data



Jim Hines

Surprising power of applying Process Handbook specialization concepts to systems dynamics models

TUI: Sensetable

Patten, Ishii, Pangaro 2000

Hiroshi Ishii

- TUI platform to track multiple Supply Chain objects and their states on a table with video projection.
- Using GUI to map tangible objects to the things they represent
- WIP: tracking large # of smaller objects to support rearrangement & construction of Supply Chain models

Surprising power of tangibility and the power of using "multi-handed" simultaneous manipulation of controls.

Common problems with supply chains

- Hard to explain “intangible” supply chains to layperson
- Hard to understand and manage supply chain dynamics
  - Within one company, across companies, and over time
  - With rapid response to changing needs
- Hard to rapidly invent, redesign, and reconfigure whole supply chains

Supply Chain Visualization (SCV)

- **SCV Project Background**
  - January 2000 – December 2001 (2002 Research Agenda TBD)
  - Multiple research groups – Center for Coordination Science, Media Lab, System Dynamics Group, Center for Transportation Studies
- **Project objective**
  - To create a tool enabling hands-on design & redesign of supply chains by multiple people at one time
  - Integrate new technology to solve emerging business integration issues. Emerging technologies include:
    - Knowledge Management
    - System Dynamics
    - Business Process Modeling, and
    - Tangible User Interfaces (TUI)
- **Funding from a large high-tech company ,**
  - Integrated Supply Chain Management (ISCM) Program
  - Center for eBusiness

SCV Vision

- **Vision**
  - **3-D manipulation of supply chain process models**
- **Integrating 3 components**
  - **Process knowledge repository**
  - **Tangible user interface**
  - **Systems dynamics simulations**

SCV – Project Elements

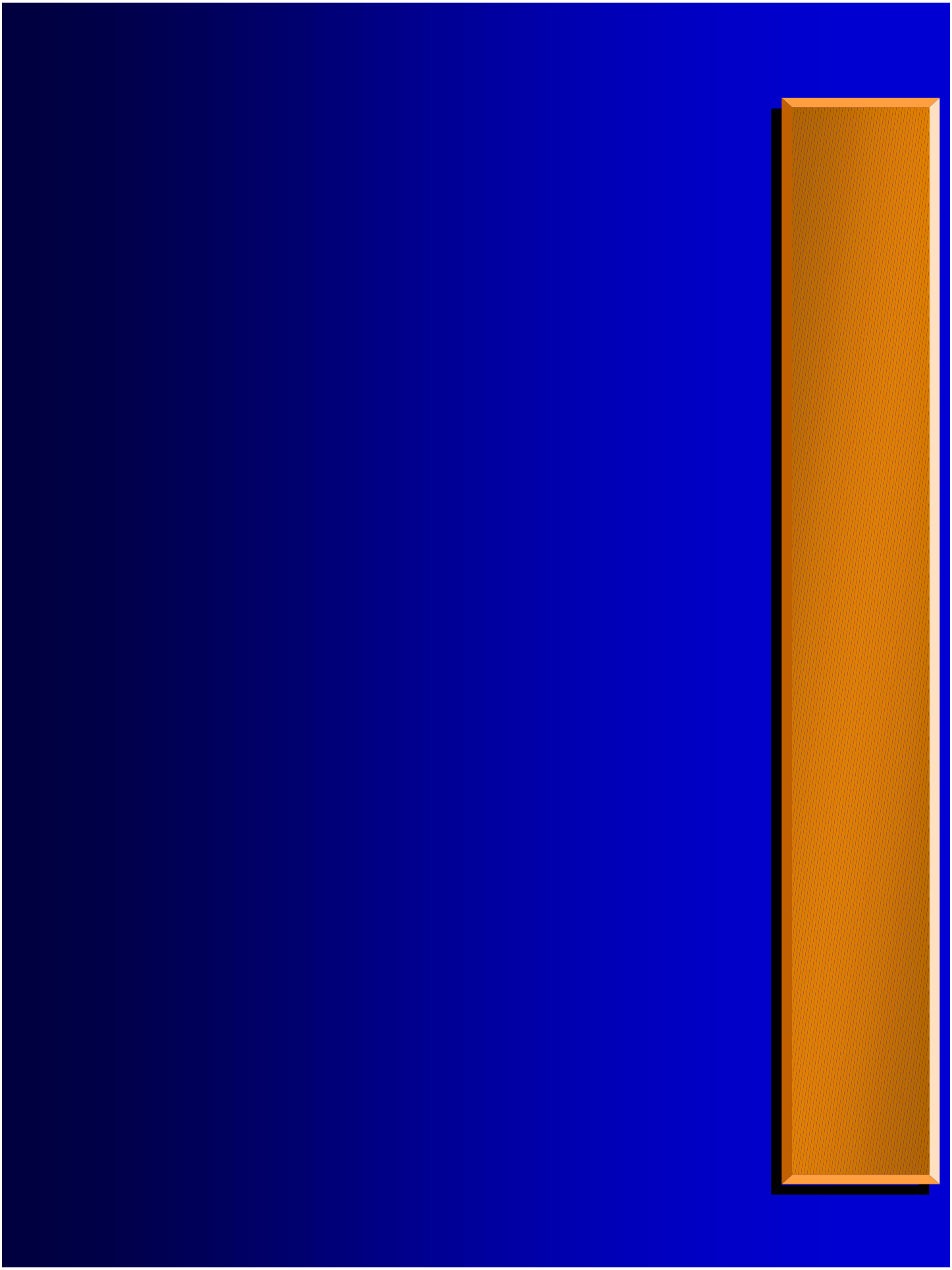
- **Tangible User Interface (TUI) – MIT Media Lab**
  - **A new user interface gives physical form to digital information**
- **System Dynamics Model – System Dynamics Group**
  - **Characterizes long-term relationships of the defined system through modeled policies and processes**
- **Process Knowledge Repository – Center for Coordination Science (CCS)**
  - **"Process Handbook" (and "eProcess Handbook") archives over 5000 processes and the associated types of dependencies**
- **As a system, this integrated group of technologies will permit a group of individuals to design and/or redesign their company's supply chain**
  - **Without a prerequisite deep knowledge of SCM (the process handbook captures the requisite process knowledge)**

Hypothesis

- TUI will greatly enhance how practitioners access and manipulate complex process models that are represented and captured in a Knowledge repository
- The semantic network of entities and relations within the Process Handbook can be extended to capture the semantics of System Dynamics modeling and other simulation techniques.
- Systems Dynamics models can be modularized into a core set of system dynamics patterns - "Molecules of System Dynamics" - and become easily configurable and reusable.
- Applying the integration of TUI, Systems Dynamics Model and Process Handbook to a given supply chain will allow practitioners to better understand the interactions among supply chain parties.
- This business problem also provides a framework for exploring broader extension and innovation of these technologies.

SCV Component Reviews

- System Dynamics
  - Paulo Gonçalves
- Process Handbook
  - George Herman & John Quimby
- Tangible User Interface Demo
  - James Patten & Hiroshi Ishii



Program progress to date – Y1

Year 1 Goals:

Proof of Concept; integration of disciplines to further individual component work and theory.

Y1 Project Accomplishments:

- Initial technology integration idea applied to practical/emerging SC business problems produced results with tangible benefit and applicability.
- Built the connections between the Process Handbook and Systems Dynamics models.
- SD molecules defined and built.
- New TUI capabilities invented that can be tied to the System Dynamics model components.

Program progress to date – Y2

Year 2 Goals:

Integration, Application, and Useability

Y2 Project Accomplishments:

- TUI technology applied to broader problems & NG hardware developed. TUI V3 solves scalability through tile-able architecture, and generalized interfaces for dials / buttons. Useability feedback collected; design changes in development
- PH extended to enable dynamic model creation, refinement, and specification, and the capture of implicit knowledge about model behavior and interaction
- Dramatically simplified method of SD model generation – included molecule taxonomy, PH UI reference model cataloging, and alternative model refinements capability
- SD models investigated a number of Intel supply chain business problems – pull / push factory dynamics related to product mix, internal market analysis, supply-driven stock out phenomenon.
- Integration of discrete and SD simulation techniques to provide different levels of model abstraction. Evaluating impact of localized behavior on global SC performance / instability
- Integration layer created based on XML for model representation and transport from PH to SD to TUI and other simulation engines
- Coordination Theory introduced for assessment and breakthrough thinking for supply chain dynamics
- Internal Markets / Demand Mgmt project defined, scenarios identified and defined, and role-playing tests begun

Learnings

Program Progress to date
General Learnings

- Built a team across MIT centers for multi-disciplinary project components and across Intel groups: have successfully maintained consistent focus across integrated Intel / MIT team.
- Pulled together interested parties at Intel to support this for very disparate reasons (IA, improve supply chain operations, human and computer interface, KM)
- Process of exploration has not uncovered huge roadblocks or barriers to the integration or application of technology to these problems
- Tie into the eProcess Handbook and SCV accomplished through MIT CeB consortium.
- More robust process management, simulation, analysis, and redesign tools being created for supply chains
- Phios contract negotiated successfully for internal use going forward.
- Investment in this project has allowed leveraging of Media Lab technology for business problems of broad interest via Media Lab sponsorship (ensuring some degree of competitive advantage)
- New mechanisms for interacting across supply chains through the use of emerging technologies have been discovered through this research effort.
- Breakthroughs in the fundamental components of the research have also occurred, driven by the business context and component integration requirements.

Value of Integration

- A previously constructed library of model elements makes it easier to:
  - construct simulation models, in general
  - construct models using a tangible interface
- A systems dynamics simulation engine makes it easier to:
  - Compute real, non-intuitive, quantitative analyses of supply chain processes
- A tangible user interface makes it easier to:
  - Understand, manipulate, and communicate about abstract models of supply chain processes
- Each discipline has benefited from the context of business issues as well as the theory and application of each other discipline
- Integration has created new ways to represent & manipulate business models with potentially significant benefits and computationally intensive innovation

Aha's…

- Surprising power from applying Process Handbook specialization concepts to Systems Dynamic models (e.g. Hierarchy of molecules)
- Surprising power of tangibility allows users to directly get & manipulate information
- Surprising power for co-located group-work through simultaneous use of controls
- The importance of using GUI to map tangible objects to the things they represent
- Have created a simplified tool for managers to learn and analyze business processes and models
- Ability to represent relationships, dynamics, and interactions of completely intangible "systems" and determine the impact on their overall performance
- Greatly extends our ability to model, interact contextually, and understand our business at different levels of abstraction
- Coordination theory provides creative methods for business assessment, decomposition, and innovation (Internal Markets for Intel supply/demand management practices)

Conclusions

- **Explicitly and systematically managing business processes will be critical for most successful businesses in the 21st century.**

- **Combining the three perspectives in this project provides a qualitatively different kind of capability for managing supply chain processes.**