Designing Simulation-Based Learning Environments: Helping People Understand Complex Systems

A Workshop at the 2005 International Conference of the System Dynamics Society, July 21, Boston

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Overview

• The Value of Simulators--Going Beyond Expert Model Building

• Design Considerations--The Interface
  – Principles
  – Health Care Case Example
    • Background
    • Illustration of Design Principles for Interfaces
  – Media Company Case Example

• Other Design Considerations
  – The Model
  – Learning Experience

• Importance and Principles of Design from the Ground Up

• “Watch Outs!” and Summary
Models...

• **Help Us**
  – Describe the Structure of Complex Systems
  – Understand Relationship Between Structure and Behavior
  – Ask “What if?” Questions Using a Consistent Framework

• **But** It’s Hard to Convey Understanding of Complex Systems Through Static Means Like Power Point Presentations; Interactive Demos Are Better, But...

• Much of the Learning Still Remains in the Head of the Model Builder

• Managers Need a Means of Exploring the System Themselves and Constructing Their Own Understanding

• Simulators Utilize a Model, Interface, and Well-Thought Out Learning Experience to Give Them This Capability
Why a Simulator?--They Can:

• Engage Decision Makers and
  – Let Them Test and Deepen Their Understanding by Experimenting with Their Own Strategies
  – Help to Convey Real Intuition About How the System Works
  – Enable Them to Understand of Strategic Implications of Their Actions Including Unintended Consequences
  – Appreciate the Importance of Systemic Thinking--In General and Especially About Their Own Problems
  – Develop Shared Understanding at Multiple Organizational Levels

• Remove the Model Builder as a Middleman--It’s Not Necessary to Interpret “What the Model is Saying”

• Enable Experiential Learning Through a High Level of Engagement
Examples

- Health Care Delivery and Community Health Status; Dealing with Change in Health Systems
- Newspapers Transitioning to the Internet
- Microfinance Institutions
- School Reform
- Simulators for Teaching Physics and Economics
- Port Operations and Effects of New Security Measures
Design Considerations--The Interface (1)

• Allow for Gradual Introduction (e.g., by Using Pre-Configured Strategies)--To Avoid
  – Overwhelming Users with Choices
  – Video Game Behavior

• Consider Multiple Decision Sets with Different Choices

• Modular Approach for Different Audiences or as Part of Gradual Introduction

• If Appropriate, Make Decision Making More Real-World By Having Users Work Within Resource Constraints

• Design Decision Making in Ways That Support Desired Lessons--e.g., Role Playing to Show Consequences of Sub-optimizing, Opportunities to Make Collaborative Decisions
Design Considerations--The Interface (2)

- Maintain Context, Be Able to Go Up and Down Between Overview and Detail

- Present Data in Multiple
  - Formats to Support Different Learning Styles
  - Hierarchical Levels--Drill Down Capability
  - Slices--System Components vs. Drivers of Performance Measures

- Present Data in a Way That Lets Users Move Between Analyzing Behavior in a Single Simulation and Comparing Among Simulations

- Identify Set of Focal Variables That
  - Together Give a Good Picture of the Health of the System
  - Provide a Basis for Objective Setting
  - Crystallize Comparisons Among Strategies
Design Considerations--The Interface (3)

• Provide Information Support That’s Easy to Get At--Status Reports, Help Screens; Avoid Manuals; Just-in-Time and On Demand as Needed

• Support Sensitivity Analyses to Help Learners
  – Better Understand the Dynamics
  – Not Get Hung Up on Whether Data is Right
  – Identify the Few Parameters that It’s Important to Get Right
  – Appreciate Need for Robust Strategies
Health Care Case Example--Background

- Health Care Changing Rapidly in Mid-1990’s
  - Payment Shifting from Fee-for-Service to Capitation
  - Organization Structure Moving to Vertically Integrated Systems
  - Greatly Increased Competition
  - Horizontal Mergers

Managers Needed to Understand How to Manage Differently and a “Practice Field” to Reduce Risk to Their Organizations

- Overall Objectives--Improve:
  - Understanding, Set Stage for Strategic Planning
  - Strategic Thinking e.g., See the Importance of Making Investments Over Time Rather Than Fire Fighting
  - Systems Thinking Skills--Overcome Departmental Stovepipe Mentality and Focus on Own Roles; Appreciate Big Picture

- Opportunity to Shape New Ways of Working Together--Neutral Turf Created by Hypothetical Situation
Health Care Case Example--Process

• Consortium of About a Dozen Health Care Organizations, Diverse Membership, but Shared Common Challenges
  – Staffs and Stakeholders with Range of Backgrounds
  – Pressure for Concentrated Experience
  – Need for a Neutral Experience, Not Favor Particular Group

• Each Member Sent Team of Six to Initial Meetings, Smaller Design Team Later to Complete Development

• Started with Open Process for Eliciting Ideas and Concerns

• Early Prototyping Drew Rich Feedback Including Complete Redesign of One Module

• Learned Valuable “How Not-To’s”
Pre-Configured Strategies Allow for Gradual Introduction
Role Playing Helps Teach Lessons About Collaboration

Select from the following:

Network-Level Strategies

Roles/System Components

- Network
- Primary Care
- Specialty Care
- Acute Care
- Long Term Care
- Home Care
- Insurance
- Control Control
Each Role Makes Its Own Decisions Subject to Resource Constraints
Network Decisions Provide Opportunity for Collaborative Strategies
Carefully Selected Performance Measures Give Users Balanced View of Their Strategies
Comparisons of Selected Variables Across Simulations
Let Users Identify Consequences of Strategies

Graph for Network Patient Population

Performance Measures

- Population
- Fertility
- Cost per Capita
- Net Income
- Waiting Time
- View Results
- Select Strategies
- Central Control

Health Care Delivery System
Year: 1997
Strategy: INDIV3
Users Can Then “Drill Down” to Understand Why Strategies Produce the Results That Are Observed

System Components

Decision Support

Performance Measures

Decision Support

System Components
Detailed Information Helps Explain Causes of Behavior and Pinpoint Problems with Strategies.
Having Data in Multiple Formats Supports Different Learning Styles

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<th>1997</th>
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<td>Network Market Share (%)</td>
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<td>57.76</td>
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<td>Population per Physician</td>
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<td># of Acute Care Beds</td>
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<td>Home Care Annual Visit Capacity</td>
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<td>12,116</td>
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<td>Network Efficacy of Care</td>
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<td>4.42</td>
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<td>Network Average Waiting Time/Norm</td>
<td>0.165</td>
<td>1.457</td>
<td>1.531</td>
<td>2.122</td>
<td>2.127</td>
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<td>Capitated Premium per Month</td>
<td>100</td>
<td>80</td>
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<td>Competitor Capitated Premium</td>
<td>100</td>
<td>94.17</td>
<td>88.88</td>
<td>83.51</td>
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<td>Fee for Service Premium per Month</td>
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<td>Cost per Capita</td>
<td>113.92</td>
<td>110.00</td>
<td>114.31</td>
<td>138.25</td>
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<td>Total Provider Net Income</td>
<td>24.88 M</td>
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<td>Cumulative Provider Net Income</td>
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<td>4.498 M</td>
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Status Reports and Help Screens Improve Ease of Use

Health Care Delivery System

Add/Subtract Primary Care Physicians

Add/Subtract Primary Care Physicians (0-20 positions for physicians per 2-year period). This decision sets the number of funded positions. Investment of $35,000 per physician for recruiting, etc. plus added operating costs for compensation, support costs, etc. is required to add a position. These positions may be vacant if turnover is high. Physician turnover will go up when workload is high and net income for the practice is negative. A reduction in positions is initially accomplished through attrition; if this does not produce the desired number, layoffs occur.

Starting number of primary care physicians = 40.

Primary Care Decisions

Primary Care Status Report

PRIMARY CARE - STATUS REPORT
Percent of Planned Investments Made: 100%
CAPACITY
Number of Physicians (1997-40)
Percent Experienced: 75.95%
Ratio of Demand to Capacity: 0.23
Average Wait for New Visit (months): 0.01
Population per Physician: 2,500
PRIMARY CARE - FINANCIAL REPORT
Primary Care Revenue: $21,81 M
Primary Care Cost: $19,17 M
Primary Care Net Income: $2,644 M
NOTE: Only costs are reported for Network Manager strategies.
Capitated Payment to Primary Care (pmpm): $12.5
Primary Care Cost per Capitation (pmpm): $15.97
Primary Care Visit Rate: 50
Primary Care Cost per Visit: $78.03

EFFICACY OF CARE
Cumulative Investment in Clinical Info Systems: 0
Efficacy of Care (0-10, norm-9): 4.673
Average Length of Visit (minutes): 24.97

PRODUCTIVITY/COST REDUCTION
Relative Compensation (ratio, 1-market): 1.2607
Turnover Rate (%): 12.07

Copy Last Period
Previous
Decisions
Next
Help
Status Report
Central Control
Sensitivity Analyses Let Users Change Assumptions and Appreciate Need for Robust Strategies
Media Company Example

• Traditional Newspaper That Had Been Profitable, but Facing Increasing Competition

• Growing Online Operation That Functioned as a Separate Business, Not Clear How Profitable It Would Be

• Strategic Questions:
  – How Much to Invest in Online Business
  – Strategies for Achieving Critical Mass in Online
  – How to Integrate Newspaper and Online to Create Synergy; Function as a Media Enterprise Rather Than Collection of Separate Businesses
  – Strategies for Keeping Newspaper Profitable So That It Can Serve as a “Cash Cow” for Investment in Online Business
Media Company Simulator Presents Enterprise-Level Results in Context of Causal Diagram
Alternative Overview at Enterprise Level
More Detailed Overview is Provided for Each Business--Traditional Print Newspaper...
…and New Online Business
Buttons on Overview Screens Take Users to More Detailed Views of Causal Structure,
Behavior of Other Variables That Affect Key Measures,
Comparisons with Other Strategies,
...and Decision Screens
Design Considerations--The Model (1)

• Maintain Right Level of Detail, Resist Pressure for More--Keep Balance Among Issues, Sectors, Stakeholders

• Have Enough (Dynamic) Complexity--People Need to Recognize Their World

• Make Certain That Model Can Replicate Key Reference Modes

• Use a Modular Structure If Possible--Be Able to Deal with Smaller Parts of the Problem and Then Combine to Look at Entire System

• Do Extensive Testing to Avoid Misleading Results
Design Considerations--The Model (2)

• Validation Standard Should Be Robustness, Plausible Behavior Under a Variety of Conditions

• Validity is in Having Some Confidence in Comparative Results, That the Model is a Consistent Test-bed for Strategy

• People Need to Be Sold on the Idea That No Model is Really “Right”, The Model’s Value as a Thinking Tool
Design Considerations--The Learning Experience (1)

• Keep Introduction Short
  – Why a Systemic View? Use Simple Example
  – Case Material
  – Brief Outline of Day

• Get “Hands On” Quickly
  – Make the “Tour” Interactive
  – Use Pre-configured Strategies to Practice the Desired Way of Thinking
    • Anticipate Behavior
    • Articulate Hypotheses
    • Use Results to Understand What Happened, Especially Surprises
  – Group Debrief, Facilitation to Share Learning
Design Considerations--The Learning Experience (2)

• Free Play to Craft and Test Broader Set of Strategies; Allow Open Choice of Strategy or Use Pre-Configured Strategy as Starting Point

• Make Time for Multiple Iterations, Periodic Debriefings, Sensitivity Analyses

• Multiple Modes of Play for Different Audiences--Make It Possible to Do Something Useful in Shorter Time Period

• Discuss Application Back to Organization--Implications for:
  – Learning Needs
  – Strategy
  – Data

• Make Embedded Archetypes Explicit; Provide Archetypes and Templates as “Take-Away’s” for Immediate Application
Design from the Ground Up (1)

• If the Objective is to Improve the Thinking of Decision Makers--
  Start by Getting Inside Their Heads
  – What Are Their Needs, Concerns?
  – What Are the Short- and Long-term Decisions Facing Them?
  – What Are Their Mental Models?

• Where Do Their Mental Models Fall Short?
  – Laundry List Thinking; Lack of Systemic Context
  – Poor Sense of Second Order Effects
  – Perils That Need to Surface--Where Can Strategies Make Things Worse
  – “We vs. They” Thinking--Accidental Adversaries
  – Failure to See That Multiple Interventions Are Required for Effective Strategy; Emphasis on Single “Magic Bullet”
  – Potential Conflicts Among Objectives
  – Focus on Fire-fighting Instead of Long-Term
Design from the Ground Up (2)

- Develop Clear Learning Objectives

- Model Boundary and Structure Should Focus on the Elements Needed to Produce These Lessons; Not Try to Capture All the Detail in Real World

- Have Client Help Identify Structure--Part of Their Learning Process

- Be Open to What Might Be Learned from Modeling as Well as Original Learning Objectives

- Process with Multiple Checkpoints and Mid-Course Corrections

- Anticipate Ongoing Uses--e.g., Strategic Planning, Staff Development, Links to MIS, Detailed Planning and Budgeting Tools--and Build Into Design
Design from the Ground Up (3)

• Design and Development Should Have Multiple Rounds of Interaction with Client(s) and Range of Stakeholders

• Early Opportunities for Model Builder to Feed Back and Test Impressions, Group Model Building Techniques May Help

• Early Testing of Prototypes
  – Realistic?
  – Useful?
  – Does Interface Design Support or Get in the Way of Learning?

• Design Team
  – Include Range of Experience and Points-of-View
  – Workable Size
  – Draw on Wider Range of Inputs at Selected Points
Design from the Ground Up (4)

• Provide Sufficient On Screen and Written Documentation; Guidelines for Facilitators

• Build In Evaluation
  – Questionnaires
  – Focus Groups
  – Debrief Pre- and Post- Mental Models, Can Participants Articulate What They’ve Learned?

• Periodic Revisions to Incorporate Lessons Learned
Watch Outs!

- Pressure for More Detail--Until the Model is Too Complex to Be Useful

- Event Rather Than Policy Orientation (e.g. short-term crisis) Based on Client’s Past Experience with Simulation

- Where Did You Get Your Data? How Do You Know the Model is Right?

- Interesting, but Not Our Company, Agency, Hospital, etc.

- Great Off-site Exercise, but Same Monday Morning Behavior

- Pet Ideas That People Want Reflected in the Model
Summary

• Who Are the Client(s), Decision Maker(s), Stakeholder(s)?

• What Are Their
  – Problems?
  – Needs for Deeper Understanding?
  – Options for Taking Action?

• What is the Minimal Model for:
  – Addressing Their Concerns
  – Asking “What If?” Questions About the Range of Options Open to Them?

• What Kind of Learning Experience Will Let Them Explore Their Options and, In the Process, Understand the System They Are Managing?