Design of Simulators to Enhance Learning: Examples from a Health Care Microworld[1]

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INTRODUCTION

Management simulators can be effective tools to improve strategic thinking in an organization and help its management and other staff respond to change.

Health care organizations were certainly facing major changes a few years ago along several different dimensions at once. These changes included:

1. A much higher level of competition than health care providers had experienced in the past, especially in terms of the prices of services and aggressive deal-making with large employers and insurers. This unprecedented price competition naturally produced extreme pressures to reduce costs and provide services in a less costly manner.

2. Anticipated shifts in the form of payment for care from the traditional fee-for-service system to capitated care where there would be a fixed payment per patient regardless of the services utilized.

3. Horizontal mergers of health care providers into larger entities that often combined organizations with very different cultures.

4. Vertical integration of different types of providers into delivery systems that, it was hoped, would provides "seamless" set of services to defined patient populations.

This paper describes a management flight simulator and learning experience (Micrworld) designed to help health care providers deal with these trends. This Microworld was developed with a consortium of 12 health care organizations put together by Innovation Associates and the New England Healthcare Assembly. These organizations realized that the extreme changes embodied in the emerging trends required their people to employ radically different ways of thinking about their work. A Microworld offered:

1. The potential for "trying out" new ways of thinking about health care without endangering their existing operations. People could learn by trial and error what would work and not work in this rapidly changing environment.

2. A "practice field" for strategic thinking that most people in health care, because of the industry's relatively stable history, had little experience with.

3. A framework for learning how to think systemically. Managers typically took action based on direct impacts that were expected. Yet health care delivery systems were becoming increasingly complex arrays of interconnected components. Any action was likely to have far-reaching implications. The Microworld was needed to help people understand that actions can have indirect as well as direct consequences and they need to think systemically when taking action.

4. An opportunity to develop skills for productive conversation. While there has been an intellectual appreciation for the need for collaboration to successfully achieve business and health outcomes, the pressures of change tend to promote a focus on self-interest. The Microworld offered an opportunity to understand surprisingly large differences in "mental models" among close co-workers, and arrive at a common understanding of how the world works.

Consortium members realized that simply telling people they needed to think differently was not enough. People had to experience the need for responding differently to the environment than they had in the past as well as the consequences of failing to do so. They also needed an opportunity to engage in this learning together with their colleagues in order to develop a shared understanding of what was required.

DESIGN CHALLENGES

Developing a Microworld that could meet these needs for all of the consortium members was a daunting task. To begin with, these organizations varied greatly in their relative sizes, the particular challenges they faced in their local markets, and where they were in making the various transitions required of health care organizations. Some were individual organizations that had long histories while others were newly merged and still going through a "shakedown" period. Some were operating networks that already had some degree of vertical integration while others were only discussing the possibility with potential partners. All were concerned with developing new strategies for health care delivery. However, some were also very concerned with improving the health status of the populations they served while others placed less emphasis on health improvement.

The consortium members also posed some common challenges:

1. The people with whom they wanted to use the Microworld represented a broad range in terms of experience with the health care issues, systems thinking, and familiarity with computers. Potential users included senior and middle managers, trustees, physicians, and other health professionals, and representatives of various community groups and constituencies.

2. Many of these people were already very busy dealing with the day-to-day pressures created by the changes going on in health care. They could not afford a great deal of time to be brought "up to speed". The learning experience had to be concentrated and allow a lot of learning to occur in a fairly short period of time. Learning of general skills such as systems thinking had to be woven into the learning experience rather than be assigned discrete blocks of time.

3. Despite the emphasis on learning quickly, there was also a need to slow people down and get them to be more thoughtful about what they are doing. A potential shortcoming of simulation games is that users may try to use them as "video games". It was important to structure the use of the learning environment so that people would think carefully about causes of behavior they encountered and about interventions to experiment with. People had to be encouraged to try one new thing at a time rather than everything at once (as they often did in the real world).

4. In order to be engaging, the learning environment had to be sufficiently realistic and detailed and respond to interventions in a plausible manner. This presented a problem since many people involved in the design process (some meetings involved close to 100 people) had ideas about "one more thing" to be added to make the simulations more realistic. The cumulative effect of these ideas was a simulation model that was very complex and sometimes difficult for users to understand.

5. People using the learning environment were likely to come to it with a range of different ideas about the right strategy for their organization. They had to feel that the environment was a neutral

reflection of the real world and not rigged to advance a particular viewpoint. Simulation results had to make sense to them, especially if they were counterintuitive.

DESIGN FEATURES[2]

These challenges required a highly complex, multi-layered learning environment with multiple entry points, levels of detail, and different sized "bites" for groups with different interests and amounts of time to spend on the learning experience. The following features emerged through a lengthy process of trial and error as we and our colleagues developed early versions of the learning environment, tried them with consortium members, encountered problems, and went back to the drawing board (often several times).

1. Generic Protocol for Users
2. Modular, Multi-Layered Design
3. Pre-configured Strategies
4. Role Assignments
5. Performance Objectives
6. Distilled Causal Structure
7. Iterative Process of Strategy Development
8. Multiple Levels of Results
9. Embedded Archetypes and Links to Real World
10. Robustness Testing of Strategies

1. Generic Protocol for Users

While many features we describe were driven by our objectives of increasing systemic thinking and improving the quality of conversation about complex policy issues in health care, the detailed design was determined by the structure of the learning experience. This design, arrived at through a series of beta tests, seemed to best achieve the result of **modeling a group process for approaching complex issues** for users in addition to facilitating their intellectual exploration of the structures and their implications. A sample agenda for a work session using Module 1 is detailed in Table 1. As much as possible, we encourage groups to integrate a session of this type into other organizational activities. For example, a regional university medical center had completed the legalities of integrating providers, but was now genuinely uncertain about how to think about re-balancing capacity and where to focus resources to improve community health. A session was positioned as a way to get insight about these specific issues and to generally develop skills that would help them address others. This type of user was our primary audience, and so the design focuses on learning through experience rather than a more didactic approach.

2. Modular, Multi-Layered Design

The "macro-structure" of the Micrworld enables users to focus on issues of health care delivery, improvement of the population's health status, or both depending on their interests. As shown in Figure 1, **Module 1** focuses on strategies for improving the performance of the "Acorn HealthNet". This network was formed from two independent physician groups, a hospital with 170 beds, a long-term care facility (nursing home), a home health agency, and an insurance entity and starts with a population of 100,000 for which it must provide care. Acorn operates in a competitive environment in which it can gain or lose patients and earn or lose money on its revenues. Users develop strategies for Acorn and implement them through four types of decisions: capacity, pricing, cost control and quality of care. Funds available for making investments change as a result of financial performance. Users evaluate the impact of their strategies by monitoring five performance objectives: the efficacy (quality) of care being provided, the average wait for care, and cost per capita as well as the size of the patient population and net income. They have the opportunity to revise their strategies every two years.

Pre-Work	• Learning Organization Framework • Microworlds • Module background reading • Module Users Guide • Own organization's strategy documents • Option: Case Study
8:00 - 8:15	WELCOME
8:15 - 9:15 Introduction	• Illustration: The value of thinking systemically in order to effectively select and implement strategies • Option: Use actual MW illustration • Overview: The Health Care Delivery System Module, Objectives of Session • Exercise: What are your critical success factors and how will you achieve them? (e.g. population served, cost per capita, net income, quality, waiting time) • Group Discussion: Do we have good ways to test whether these assumptions are valid? • Overview: Practice Fields and Simulations and Organizational Learning (5D's)
9:30 - 9:50 Oakville Overview	• Overview: Oakville (providers, summary statistics, performance objectives, decisions) • Overview: Key Causal Relationships for performance objectives (trees and loops)
9:50 - 10:15 Pre-Configured Strategies Overview	Demo of Pre-Configured (Compare 1 to 2, 3 to 1, 3 to 4) Pre-Configured Questions: 1. What results would an advocate for this strategy expect? 2. What results do you expect from this strategy? Why? 3. What were the actual results? 4. Were they different than expected? Why? 5. How can you improve on this strategy to produce the desired results? 6. To what assumptions is this strategy sensitive?
10:15 - 10:45 Small Group Exercise	Pre-Configured Strategies - Small Groups • Groups will be assigned Strategies 5-9
11:00 - 11:30 Reports	Small Group Reports • Summarize Strategy • Summarize Expected Results • Describe Actual Results
11:30 - 12:15 Debrief	Debrief - Intro Limits to Success • Overview: Limits to Success • Exercise: Limits you discovered in the pre-configured strategies. • Discussion: Are these limits (or others) relevant to your real issues?
1:15 - 1:45	EXERCISE: Network Meetings: How can we improve on our pre-configured strategy?
1:45 - 2:15 Demonstration	DEMONSTRATION: Walk-through on the Computer of How to Implement Strategies and view results (Use example of adding capacity to strategy #4)
2:15 - 3:30 Small Groups	EXERCISE: Implement Strategies and Analyze Results
3:45 - 4:30 Reports	DISCUSSION: Group Reports
4:30 - 5:00 Discussion	EXERCISE & DISCUSSION: • Should we modify our critical success factors how? • Will our strategies achieve these critical success factors? • What do we need to test?
5:00 - 5:15	Wrap-up Day; Feedback; Preview Day 2
DAY 2	Robustness testing of strategies Create Checklist for improving strategy Identify Next Steps

Table 1. Generic Agenda for Module 1

The **Module 2** has a very different emphasis. Users are told they are members of the Oakville "Health Improvement Authority" and have a set of interventions available to them that can affect the health status of a population of 100,000 people. Interventions for improving health status range from intensive medical management of people who are already chronically ill to programs that affect lifestyles and well-being of people who are kept from becoming ill as a result of reducing the population's social and behavioral risk factors. Successful performance helps to reduce health care costs and gives users a larger budget for expanding the scope and depth of these interventions. Users track six performance objectives: the percent of population in poorest health, per capita cost of illness care, standard public health measures of mortality rates and days lost due to illness or disability, and social and behavioral risks. They have the opportunity to revise their strategies every four years.

Module 3 combines these two policy areas by putting users in charge of the Acorn health network and giving them tools to both improve the delivery of health care for illness that presents itself and improve the health status of the population in order to reduce the prevalence and severity of illness. A single budget is available for allocation among these two types of interventions. Users monitor performance measures in both areas and can revise their strategies every two years.

This modular approach emerged early in the design process as a way of dealing with the very different interests of the consortium members regarding these topics. As shown in Figure 1, users can enter the simulation at any of three points and work with a single module or move through two or all three modules in the sequence that suits their needs and the amount of time they have available. This approach also enables users to get a gradual immersion since Module 3, the one that combines health care delivery *and* health improvement, presents a real challenge. Working with Module 1 and/or 2 first lets them master a more limited set of ideas and then build on what they have learned by moving to Module 3 and working with health care delivery and health improvement strategies together. A consistent approach to the structure of each module and screen design and "navigation" within each one helps users to move easily between modules without having to relearn basic operations.

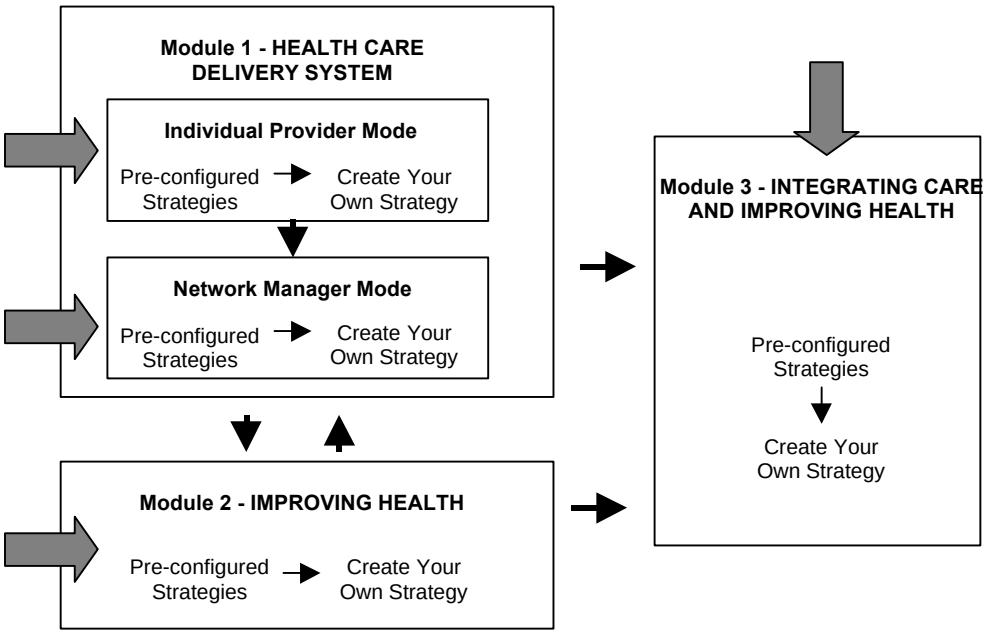

Figure 1. Overview of Modular Structure

Each module has at least two stages through which users can move. Simply confronting users with a number of decision screens proved to be intimidating for many and sometimes led to cognitive shutdown. Alternatively, it produced "video game" behavior in other users who would randomly throw levers in all directions to see what would happen. To deal with these hazards, we added a set of **pre-configured strategies** for each module that helps users get an initial idea of the impacts that various strategies might have.

Working with pre-configured strategies serves as an introduction to the module and helps users take a more thoughtful approach when they go to create their own strategies. These pre-configured strategies can be used as the starting point for the **create your own strategy** segment or users can simply start with a clean slate and create their own strategy "from scratch". In the create your own strategy segment, each module has a set of decision screens that enable users to fine tune a strategy in a great deal of detail as they try to create one that produces superior results.

Module 1 also has some additional modularity within it. As indicated earlier, the consortium members were at very different places in terms of creating integrated delivery systems. Some only contemplated doing so while others were well along in the process. Two "modes" were therefore developed for Module 1, as shown in Figure 1. The first one developed was the **individual provider mode** in which there are separate decision screens for each of the organizations that might come together to create an integrated delivery system (e.g., physicians groups, hospital, insurer). This mode represents an integrated delivery system at a very early stage of development in which separate providers have come together, but retain a large measure of autonomy. Each role can make its own decisions based on its own financial performance and funds available.

In this mode, users get to experience the real world tensions between organizations looking out for their own interests while also becoming part of a new entity whose success depends on collaboration. They get graphic evidence of the failures that can result when organizations focus on protecting their own turf and become "accidental adversaries" who undermine the delivery system's overall performance. Users then have an opportunity to craft collaborative strategies that work better by, among other things, reallocating financial resources among the delivery system's component organizations. A network decision screen enables the providers to pool resources and allocate them to achieve network objectives. Additional lessons come from managing growth in a shifting environment and getting into trouble by letting patient population get ahead of capacity or failing to implement and coordinate the multiple elements that a strategy requires to be successful.

Since some of the consortium members (and many other health care providers) already had vertically integrated networks under single ownership and management, this individual provider mode was no longer relevant for them. In addition, the number of decision screens made it difficult to introduce Module 1 to audiences that had a limited amount of time or limited tolerance for detail. We therefore developed a **network manager mode** in which users played members of the senior management team of a network that had already been formed. This mode has only two decision screens rather than seven. Decisions such as investments in information systems cause resources to be invested across the network's components. While the dynamics of individual vs. whole are no longer relevant, users playing the network manager role get to experience significant dynamic lessons such as the "limits to success" that are encountered when the network pursues growth without having created adequate capacity.

3. Pre-configured Strategies[3]

As indicated earlier, pre-configured strategies were added to provide users with an introduction to each module and the range of strategies that might be developed while working within that module. Pre-

configured strategies were selected to illustrate a range of likely approaches one might take to manage a new health plan through a challenging period. Figure 2 shows a list of pre-configured strategies available in the individual provider mode of Module 1. They range from a "do nothing" scenario (in which no changes in resources, premiums, and other parameters are made despite the fact that competitors are lowering their prices by 3% per year and 5% of available patients are shifting from fee-for-service to capitated payment each year) to scenarios in which component organizations take an adversarial approach to each other and the network to scenarios in which there is genuine collaboration and use of the new network to improve the delivery of patient care. Clicking on the question mark buttons gives users a more complete description of the strategies and the logic that might cause such a strategy to be adopted. Figure 3 shows a description for Strategy 3.

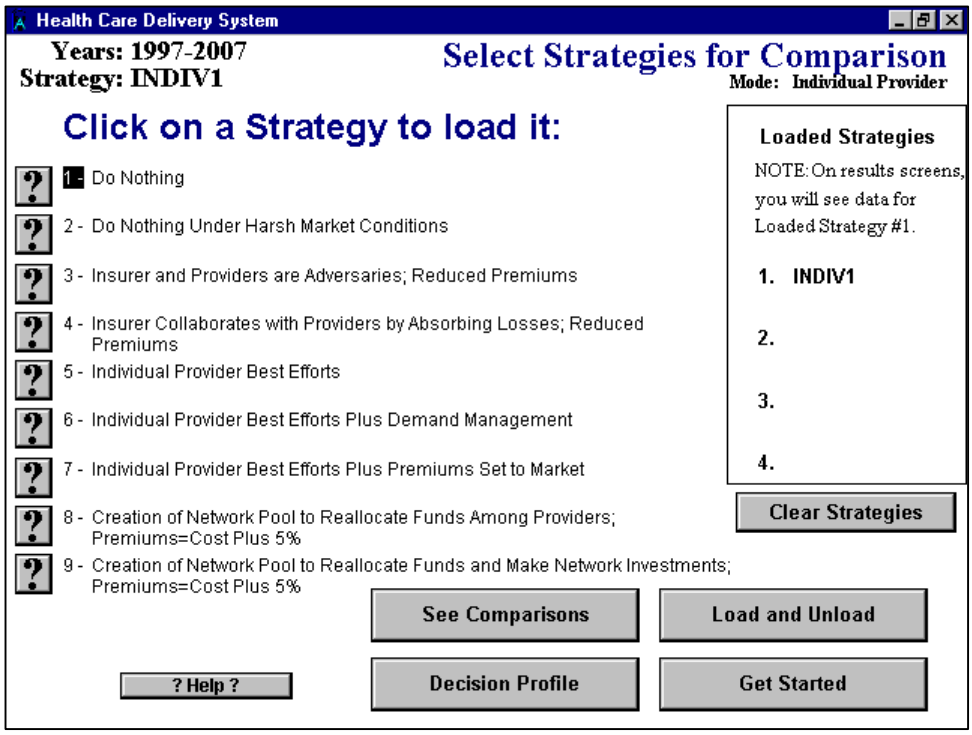

Figure 2. Pre-Configured Strategies, Module 1 Individual Provider Mode

Users can access the pre-configured strategies directly before having to learn about the decision screens or other aspects of the module. In a typical session, small groups are assigned specific pre-configured strategies for deeper investigation. (A typical session might have 30 people divided into ten groups of three.) The groups have the strategy described by a detailed "decision profile" as well as the sort of verbal description shown above. They are asked to understand and discuss the strategy, speculate on why someone might adopt such a strategy, plot the performance they expect from the strategy on several key measures, and anticipate limits the strategy might encounter and unintended consequences it might produce. After groups have plotted anticipated behavior for the five performance objectives, they examine the results actually produced by that strategy for a ten-year period.

Groups have access to graphs of the five performance objectives and, if they desire, a complete set of summary statistics and much more detailed data. Figure 4 is a graph of the performance objectives for pre-configured Strategy 3. Sometimes the results are predictable, but other times there are "ahas" as groups discover they failed to anticipate an unintended consequence of a strategy and the disastrous results it produced. Once users see the results, they are asked to explain what happened and answer some questions about the particular strategy. The questions for Strategy 3 appear in Figure 5.

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INDIV3  Insurer and Provider are Adversaries; Reduced Premiums - Organizations
often agree to work together in a general sense, but look after their own bottom
lines before worrying about their collaborators.  This sort of half-hearted
collaboration can lead organizations to become 'accidental adversaries' as actions
they take to protect their own interests undermine the success of their 'allies'.
The result can be a disaster for all involved.

In this scenario, the insurer is convinced that deep discounts are essential to
grab a large enough share of the market to be a player and survive the coming
shakeout.  It lowers premiums to $110 per person per month for the fee-for-service
package and
$80 for the capitated product (vs. $135 and $100 respectively in the do nothing
scenario).  It is equally certain that it must reduce reimbursements to providers
by a similar 20% in order to protect its reserves and remain solvent.  Providers
respond initially as best they can by reducing staff compensation by 10% and
investing in Process Redesign for cutting costs further.
These reductions are to no avail and the providers soon find themselves losing a
great deal of money.  As losses mount, providers shed capacity to further reduce
their costs.   What is likely to happen to waits for care, the efficacy of care
provided and patient satisfaction as a result?
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Figure 3. Help text for Strategy 3

They are encouraged to "drill down" and use more detailed data to help explain the more subtle aspects of observed performance. (See Section 7 for more on multiple levels of results data.) After the small groups have had a chance to do their work, they reassemble and report their findings to the larger group. A facilitator will prompt the group to bring out particular insights. The facilitator's notes are displayed in Figure 6. The result of the large group "debrief" will be a good deal of insight shared by everyone about the strengths and weaknesses of various elements of different strategies and some good starting points for the small groups as they move into the create your own strategy segment.

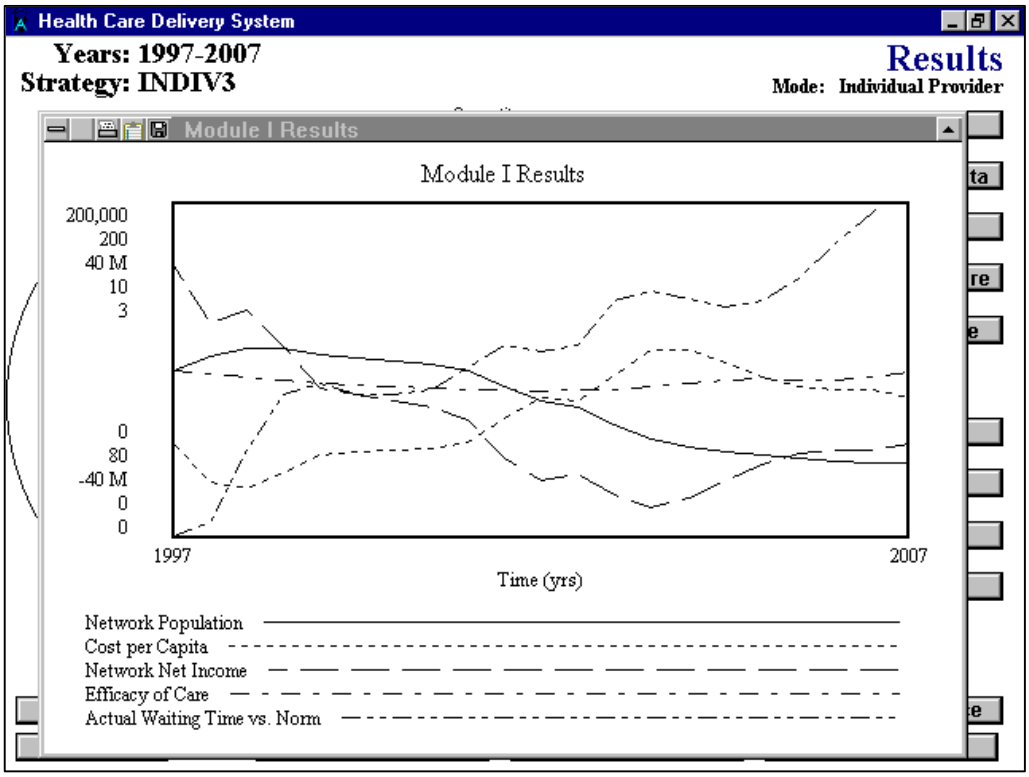

Figure 4. Results for Strategy 3: Insurer and Providers are Adversaries; Reduce Premiums

Discussion Questions

These reductions are to no avail and the providers soon find themselves losing a great deal of money. As losses mount, providers "shed capacity" to further reduce their costs.

- What is likely to happen to waits for care, the efficacy of care provided and patient satisfaction as a result?
- Why are waits for care longer than normal for most of the ten-year period even though the population is less than in the "do nothing" run?
- Why are costs per capita as high as in the "do nothing" run even though providers "shed capacity" and otherwise attempt to reduce costs?
- What approach might have been used to avoid this disastrous result?

Figure 5. Discussion Questions for Strategy 3

Facilitator Notes - Indiv 3

This scenario is a good illustration of what can happen when organizations create a network in name only and pursue network-building in a half-hearted manner with most attention focused on their own well-being rather than the network's.

After a futile attempt to cut costs, providers respond to growing losses by reducing staff and related overhead expenses. Reduced staff leads to chronically high waiting times that drive down network attractiveness and patient population, lower net income even further, and result in further staff reductions. (Trace this reinforcing loop on the overview diagram or draw it on a flipchart.) After an initial increase in response to the lower premiums, this reinforcing process produces a lower network population than the "do nothing" strategy. The lower population results in high costs per capita because network patient population drops as fast as capacity is being cut back (but not fast enough to reduce waiting times). Financial difficulties faced by providers kept them from making investments in process redesign that would have helped to reduce cost per capita. Net income is lower in this simulation than the "do nothing" scenario both because cost per capita is high and premiums were set low with the intention of attracting more people.

Figure 6. Facilitator Notes for Strategy 3

4. Role Assignments: Taking a Job with the Acorn HealthNet

After an introduction to the structure of the simulation, usually through an exploration of pre-configured strategies, the task users face is to design strategies for the Acorn HealthNet that meet ambitious objectives. Simulation participants are either assigned or choose specific roles (i.e. primary care, insurance, etc.) and health care systems to join. Participants first meet briefly with their peers playing the same role (like a professional association meeting) to exchange ideas about how to get what they want from their health care system. After this meeting, the health care system teams meet and complete the rest of the process.

A health care system team can always take the Mt. Olympus approach and fantasize that the entire system will comply with their choices. However, especially from our experience with the previous simulation, *Mastering the Transition to Capitation*, we observed that even when teams created winning strategies, they found the experience unsatisfying because they felt the solutions they had reached were academic.[4] While the strategies might be analytically sound, they suspected the strategies were politically impossible. Put another way, "the docs would never go along with this".

Incorporating role playing into a simulation of this type serves a few purposes. First, we know that in most real systems, even when global policy decisions are made such as "minimize costs", specific implementation decisions are in the hands of local policy makers subject to their interpretation about how to best meet the goal. *The Beer Game* is the classic illustration of this point in a simulated environment.[5] Second, the number and/or complexity of decisions required to capture dynamics of interest makes a division of labor necessary to complete the task within the few hours most managers are willing to devote to using the simulation. Finally, when players take on roles outside of their immediate experience, they report that their intellectual and emotional understanding of the role and the functioning of the larger system increase significantly.

In one session, a participant fondly referred to as "Dr. Quality" became a hospital administrator for a day. It's hard to say whether the physician himself or his team was more surprised when he said at one point: "Quality is important, but we can't do that. We'll run out of money. We've got to look for some other ways to cut costs." When the team returned to their real life roles, they seemed to recognize that their previous habit of establishing certain "sacred cows" to make decisions around probably undermined the overall results they were achieving.

5. Setting Objectives

Left to their own devices, most users will immediately begin crafting "better" strategies. But what really are better results? We have observed that achievement-oriented users will work hard to win the game. We are impressed with the creative approaches that teams discover to maximize certain measures, particularly ones that are snap shot measures calculated at the end of the run. Some users of *Mastering the Transition to Capitation* seemed to hang up their stethoscopes and become masters of arbitrage. Clearly this was not our intent as designers of a learning experience, but the result is certainly consistent with the behavior many organizations observe as a consequence of what they choose to measure and reward.

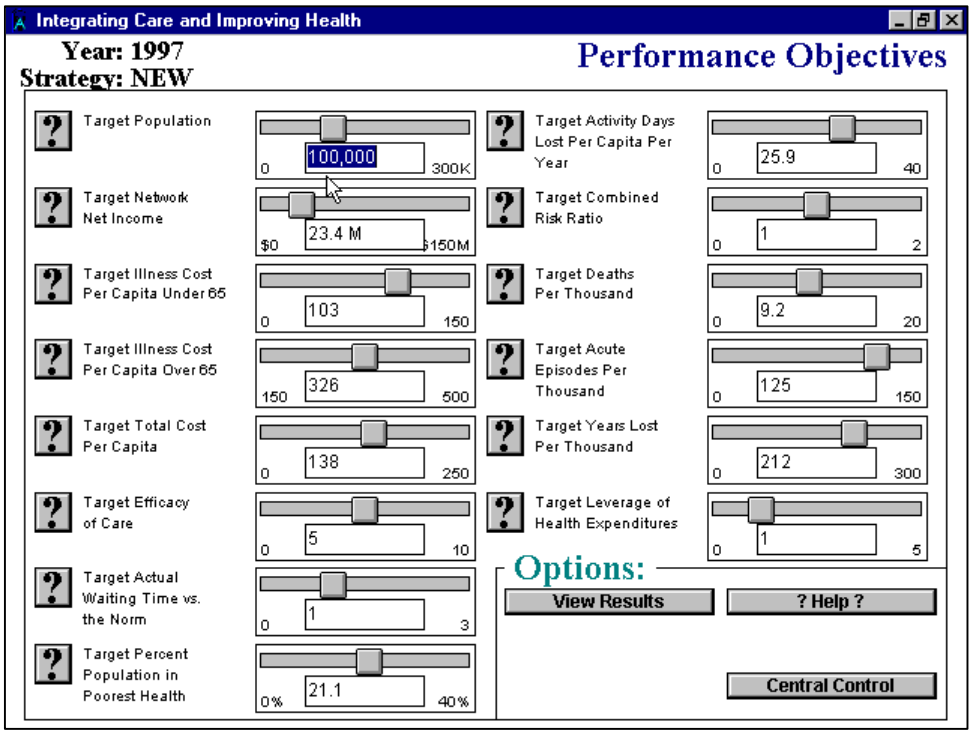

Figure 7. Performance Objectives for Module 3 (Integrating Care and Improving Health)

Users are encouraged to set "Performance Objectives" to declare for themselves how they will measure their success. Each module has at least five possible objectives. The performance objectives for Module 3 (*Integrating Care and Improving Health*) appear in Figure 7. During the simulation, users can return to this feature and get graphical feedback about how their current performance compares to their objective. Figure 8 illustrates the consequences of pre-configured Strategy 3 described in Section 3 if the target population had been 130,000. We also encourage teams to consider other measures that we may not have chosen but are available on other reports and graphs if they better capture the results the team wants to create.

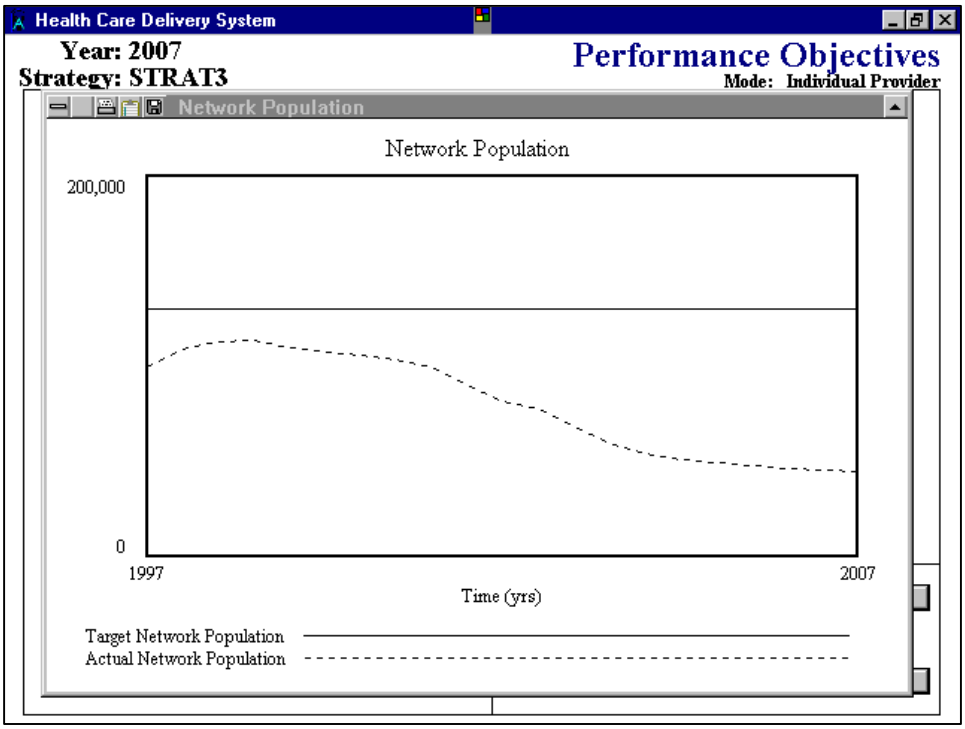

Figure 8. Comparison of Actual Results to the objective of a 30% increase in Network Patient Population for a reduce premiums strategy.

When time is short, or users are unfamiliar with the subject matter, we will propose challenging, multi-dimensional performance objectives on behalf of a mythical Board of Directors, however groups report significant value in setting their own objectives. The conversation is the first opportunity for the Acorn HealthNet to meet. The players learn something about what those in each role are interested in accomplishing. When some agreement can be reached, these objectives provide structure for the following discussions about policy decisions. For many groups, this assignment stands in striking contrast to their typical debates about the pros and cons of more minute decisions. They realize that many of these debates, often a catalyst for elaborate meeting-avoidance strategies, would be unnecessary if they had clear objectives.

Second, a discussion of objectives can highlight genuine confusion about specific measures for success. In the *Improving Health Module*, users must agree on how they will know that health has improved. Differences are usually significant. Users frequently report that they now suspect that people in their home organizations have vastly different definitions of what it means to improve health even though almost every organization states that this is part of their mission. Finally, declaring objectives and revisiting them over the course of a simulation can highlight the value of feedback and its absence in real world systems. Even experienced health care providers and administrators find the task of managing the

Acorn HealthNet challenging. When they notice how seriously they take the performance information they receive as an indicator about whether changes in their behavior are required, they inevitably ask whether timely information about important measures is readily available within their systems. Without it, it becomes easier to understand why the tyranny of the urgent prevails.

Within the context of certain desired results, we also encourage teams to take a structured "what would happen if" approach to strategy development. The discipline of developing and testing hypotheses underlies the overall design of the simulation. For example, if a team is clear that their primary goal is to increase market share, they could explore various pricing strategies. If we assume that buyers are price sensitive, then we would expect that if we price under the market, our share should increase. What would happen if we price 5% below the market? 10% below? Would we expect these strategies to have any other consequences that might affect our market share? These types of questions seem to provide more understanding of the underlying structure than "let's reduce prices by 10% and see what happens". One purpose of the pre-configured strategies is to illustrate some basic "what if" scenarios so that users can shift their focus to more results-oriented inquiries.

Setting clear objectives also helps users test the robustness of their best strategies. When teams have successfully achieved their performance objectives, they can see what assumptions drive these results. Robustness testing is described in a later section.

6. Iterative Process of Strategy Development

The Microworld is designed to support an iterative process of strategy development. Users of early versions complained that it was tedious and a waste of time to input the decisions in a complex strategy all over again just to make a small change. This difficulty got in the way of the careful, incremental process of strategy development that we were trying to foster.

Each simulation is now given a name and all of the decisions made during the simulation are saved under that name. Users can then retrieve the decisions saved under that name and use them as the starting point for new simulations. In such a new simulation, the decisions from the earlier one that has been selected appear as defaults on the decision screens. These decisions can be changed as users modify the strategy to improve the performance it produces. This feature makes it easy and convenient to go through a process of incremental improvement where changes are made one at a time without having to input all of the decisions each time. This ability supports a more thoughtful process of strategy development and, at the same time, enables users to progress quickly through a set of incremental changes in a limited amount of time.

The following example will illustrate how this incremental process would work. Imagine a group working with Module 1 in the "network manager" mode who are managing the Acorn network. They have high hopes for a strategy that attempts to cut costs and then drive down price to increase market share. They reason that this will create a reinforcing effect in which lower premiums attract more patients which drives down cost per capita leading to lower premiums and so on. Instead, they find that this strategy, labeled FIRST on the graph in Figure 9, produces a disastrous result, even worse than the "do nothing" scenario. Looking more closely, they discover that a lack of capacity thwarts growth through longer waiting times and patient growth and premiums "hit the wall". Competitor premiums gradually fall below Acorn's. The reinforcing effect then works against Acorn as higher relative premiums drive away patients which raises cost per capita and leads to even higher premiums.

Group members think carefully about what might be missing from this strategy. One person suggests that competing on cost and price alone will not work. Improving clinical information systems, however, would increase efficacy of care (quality) which would attract additional patients and have the added benefit of expanding capacity by allowing episodes of illness to be treated with fewer visits. To test this idea, the group would load FIRST as a starting point and add investments in information systems to create a new strategy, SECOND. They would find that, as shown in Figure 9, the additional investments enable Acorn to attract enough new patients to set off the reinforcing effect and achieve substantial growth in patient population.

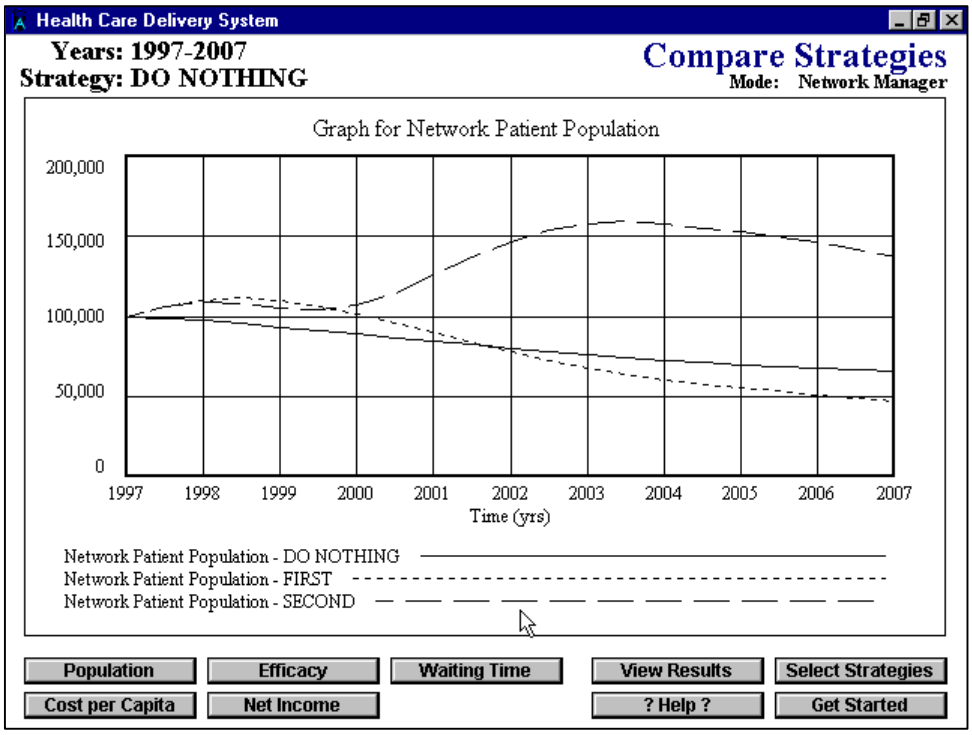

Figure 9. Comparison of two user strategies to Do Nothing (Module 1)

7. Distilling Causal Structure

We are aware of the debate around whether simulation models should be black boxes, transparent, or something in between for their users. Since each module contains hundreds of variables, we deemed it inappropriate to make the actual model visible. By contrast, to reveal very little of the structure created two difficulties: one is simply skepticism about whether the model assumptions were close enough to real life to merit further investigation. The second issue is that the complexity of the underlying model makes it difficult to discover through experimentation, and the resulting debate about the true nature of the structure seemed unproductive.

After experimenting with various approaches, we settled on five approaches to distilling the structure: causal trees, summary diagrams, detailed diagrams, descriptions of decisions, and graphical presentations of results based on causal trees. In addition, users are encouraged to look for archetypal patterns in these structures, described in Table 1 and discussed in Section 9.

Causal Trees: From the starting point of performance objectives, the introduction to each module includes a simple causal tree for each of these measures. The diagrams name the primary causal factors and consequences of each objective. When users work with the pre-configured strategies, they are asked to anticipate the results of the run. These causal trees provide guidance in helping users predict behavior, but also provide a roadmap for inquiry when performance does not meet expectations. Cost per Capita is illustrated in Figure 10.

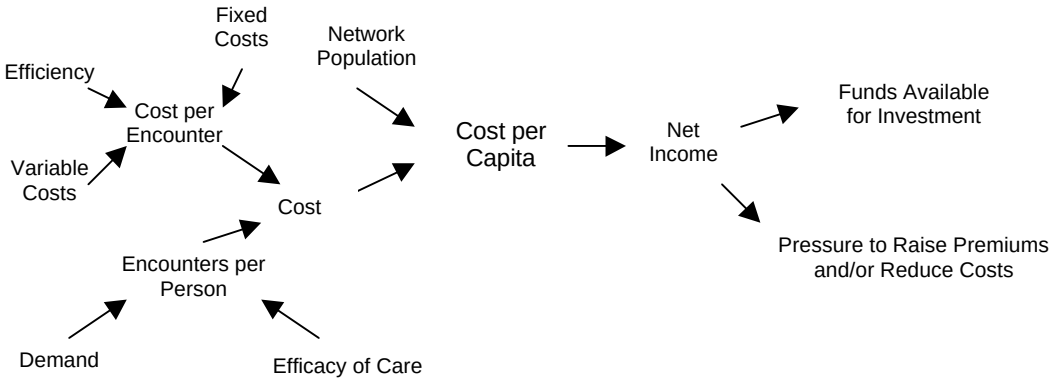

Figure 10. Simplified Causal Tree for the performance objective COST PER CAPITA

Summary Diagrams: Also referred to as "pasta-grams", a summary set of loops is also available to users at all time. The diagrams include: all performance measures, all decision categories and many

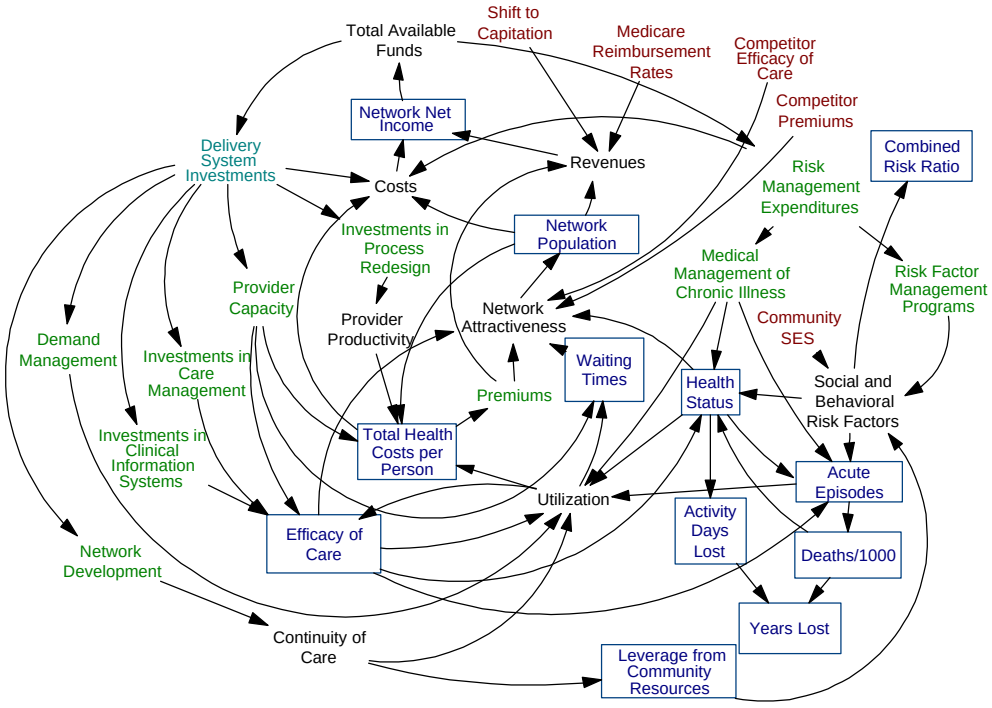

Figure 11. Summary Diagram for Module 3 (Integrating Care and Improving Health)

specific decisions, and all scenario variables. These variables are color-coded by category. These loops summarize the basic structure of the model, but they aggregate provider groups and population segments. In order to fine tune a strategy, users need to be able to break out these segments and to have an understanding of the dynamics they are addressing with their strategy. Figure 11 is the summary diagram for Module 3.

Detailed Diagrams: Structural diagrams are also provided for each provider group or population risk category. Figure 12 shows the diagram for the specialty care provider. These diagrams are still summaries of model dynamics, but can help users develop more targeted strategies.

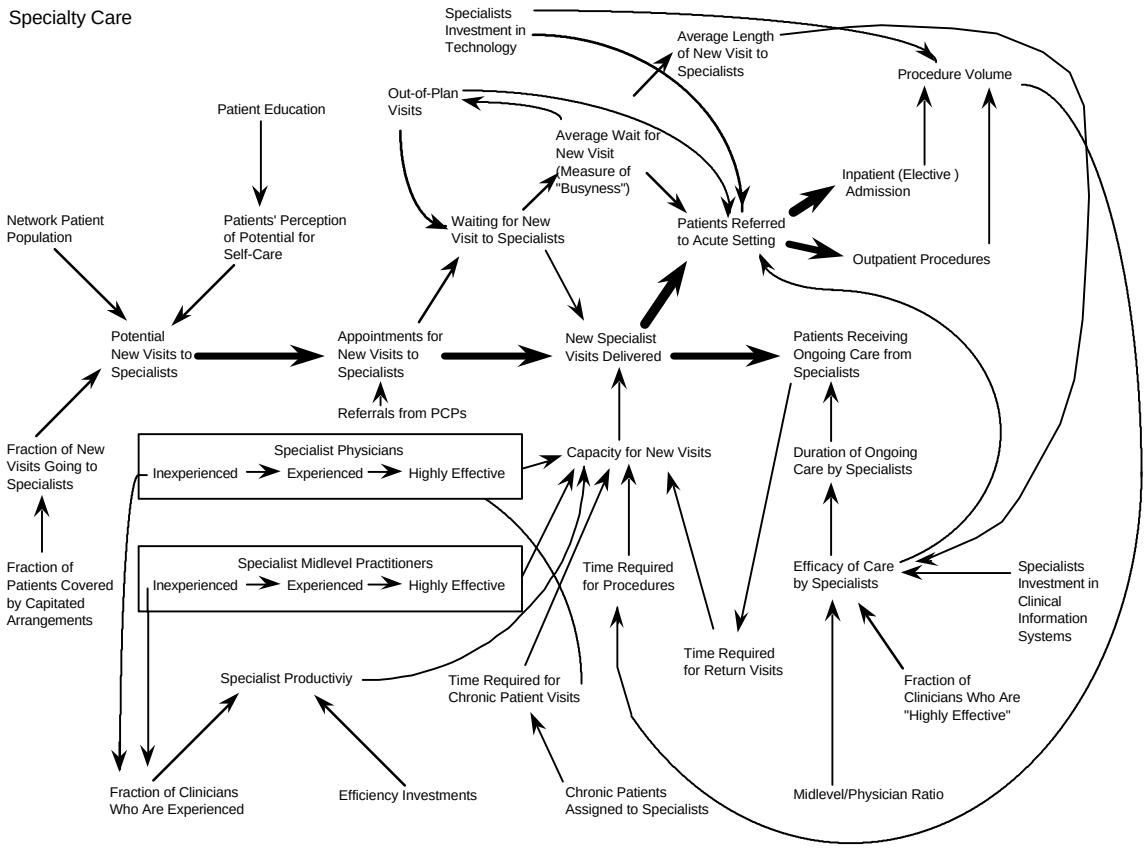

Figure 12. Description of the Specialty Care Provider

Descriptions of Decision Categories and Decisions: Prose descriptions of decision categories and decisions, provide a final degree of detail about the structure of Oakville. The parameters of each decision are defined, as well as the links to performance objectives. Figure 13 provides an example.

Add/Subtract Acute Care In-patient Bed Capacity (0-100) Adding or subtracting up to 100 beds over a two-year period. Adding beds requires an investment of $100,000 per bed. Additional beds will have staff costs associated with them (2 staff per bed) and fixed costs of $126,000 per bed per year. There is an additional investment of $82,000 per bed required for the necessary inpatient procedure capacity to support each bed. Inpatient procedure capacity is automatically increased or decreased by the same fraction as beds.

Starting number of beds = 170.

Figure 13. Description of the decision Add/subtract acute care beds

Causal Tree Graphs: The preceding information is available prior to the completion of any runs. When a run has been completed (or for pre-configured strategies) users have access to two types of data. The central results screen for Module 1 appears in Figure 14. Buttons on the lower part of the screen provide detailed data. This feature is discussed in Section 8. The buttons on the right hand side are graphical portrayals of causal trees associated with the performance objectives. Figure 15 uses the results for pre-configured strategy 3 discussed in Section 3 and shows the results related to Cost per Capita.

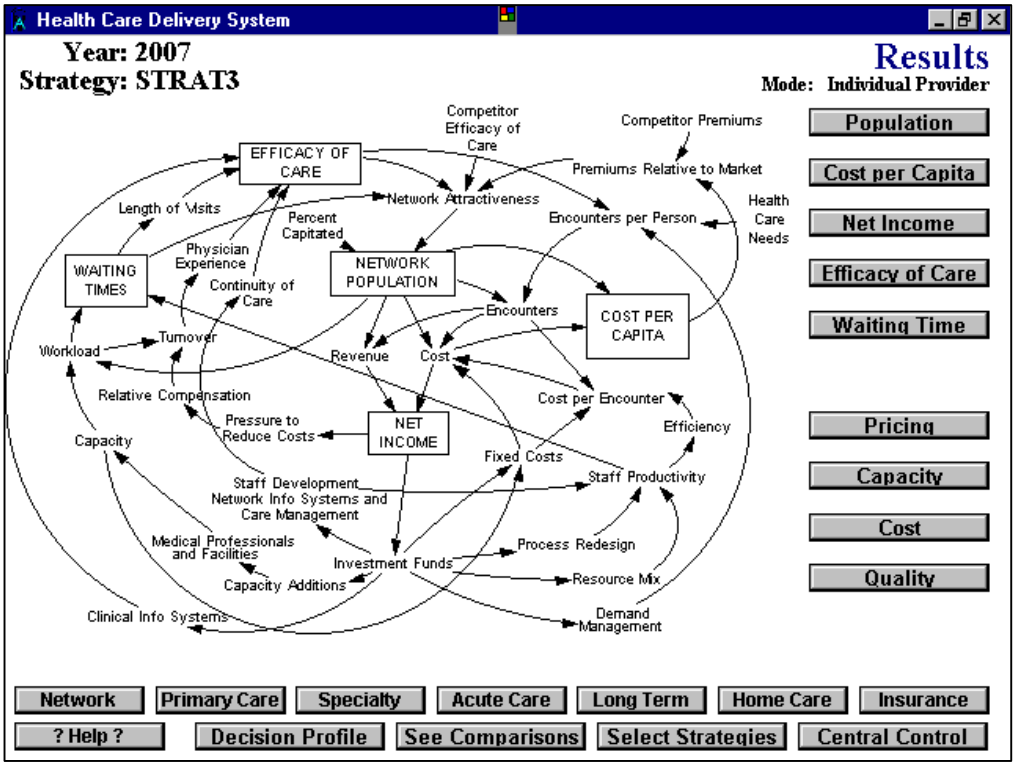

Figure 14. Central Results Screen for Module 1

The summary diagrams, prose descriptions and results are available to users on line. Paper versions of all causal structure features are provided to every user in a workbook.[6]

8. Multiple Levels of Results

As mentioned in Section 7, detailed results are available for all providers. As an illustration, a common hidden issue in Module 1 is that physicians may leave the system even though it is management's intention to retain or increase capacity. Primary Care and Specialty Care Results can help users determine the patterns of physician behavior, and adjust their strategies accordingly. One of four reports available for primary care physicians is displayed in Figure 16. The feature of successive levels of detail helps users truly test their hypotheses about what's happening rather than simply asserting them. Facilitators will help users see if the data supports their conclusions, and if not, where they might look to understand this discrepancy. On-line help also guides users to related results screens.

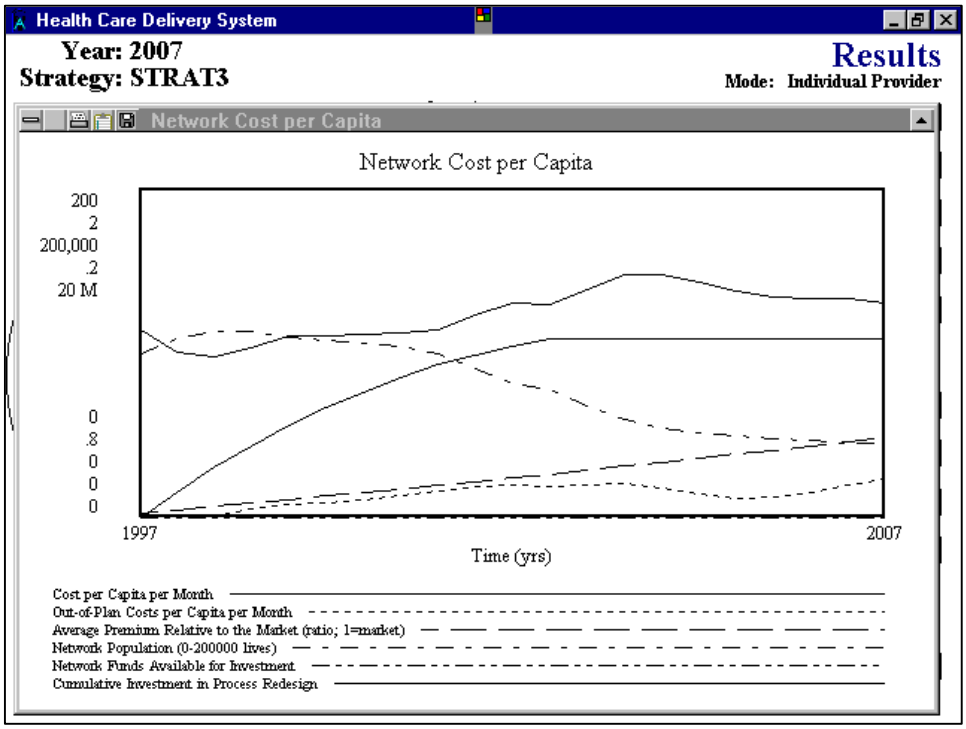

Figure 15. Cost per Capita Causal Tree Graph

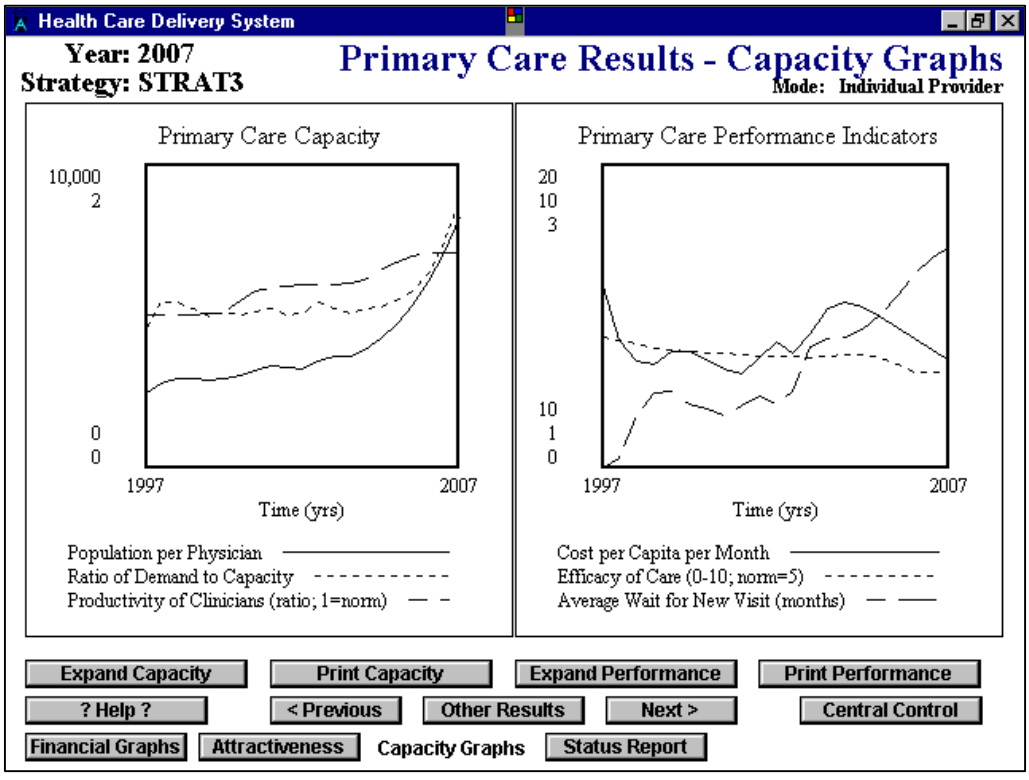

Figure 16. Primary Care Capacity Results for Strategy 3

9. **Making Archetypal Strategies Explicit**[7]

This simulation offers users a hands-on way to experience a number of archetypal phenomena. An early observation is that some well-intentioned strategies produce worse results than doing nothing. In some cases, this is an introduction to **fixes that backfire**, and encourages people to consider how their strategies to fix problems might make things worse. Cost reduction policies are a typical area where fixes can fail – directly because of loss of staff and decreased efficacy of care, and indirectly when these problems cause loss of patient population and overall higher per capita costs. In Module 1, we focus users on questions around **limits to success**. (See Table 1.) They note that even the best pre-configured strategies do not produce the results they would hope, and it seems common for results to peak and decline. We ask users to identify the limits these strategies have encountered and ask them to consider their options. We also encourage conversations around how the limits present in Oakville are similar and different from the limits in their own communities.

A specific variant of limits to success is the structure of **balancing two boats**. While there are a number of ways to define the boats, the traditional payment system in health care makes higher health care utilization better for providers. As noted in the introduction, new payment schemes reward providers for lowering per capita utilization. Issues around managing the transition from one system to another are complex enough, but current trends suggest that many providers will be subject to both systems for quite some time to come. Identifying the limits that each scheme places on the success of the other is another structure that we may note. Finally, there are **accidental adversaries** throughout the system. This is perhaps the most useful structure for users to explore because it so dominates their real world experience. Unlike the classic story where friends become foes, most relationships in health care started out as enemies. Disabling competitive or defensive policies, practices and beliefs becomes a little easier when they are made visible. While we begin by asking team members to identify how their "partners" are undermining their success, we also follow-up by asking people to consider how their strategies might be affecting their partners. These insights are the ones users often report as most valuable – they really didn't know THAT their actions affected others, or how.

Introduction of the archetypes helps users structure their strategy development conversations, improve their strategies for Oakville and apply this technique to other real issues they are facing.

10. **Testing Robustness of Strategies**

Sensitivity testing provides an important way that users can make changes in the underlying model structure. We have found it helpful to distinguish the behavior of exogenous factors from endogenous relationships. We refer to exogenous factors as "scenario variables". For all practical purposes, these are taken as givens. Users are encouraged to test the sensitivity of their strategy to changes in these conditions.

In addition, relationships internal to the model are called "assumptions". The assumptions that users can change in Module 1 are shown in Figure 17. Generally the assumptions we have singled out are relationships (usually table functions in the model) of two sorts. One type includes the basic physics of the system, for example, the effect of efficacy of care on network attractiveness (see Figure 17), or the effect of behavioral risk on health status. The other is the effect of expenditures on the target variables, for example the effect of investment in clinical information systems on efficacy of care or the effect of expenditures on behavioral risk reduction on behavioral risk.

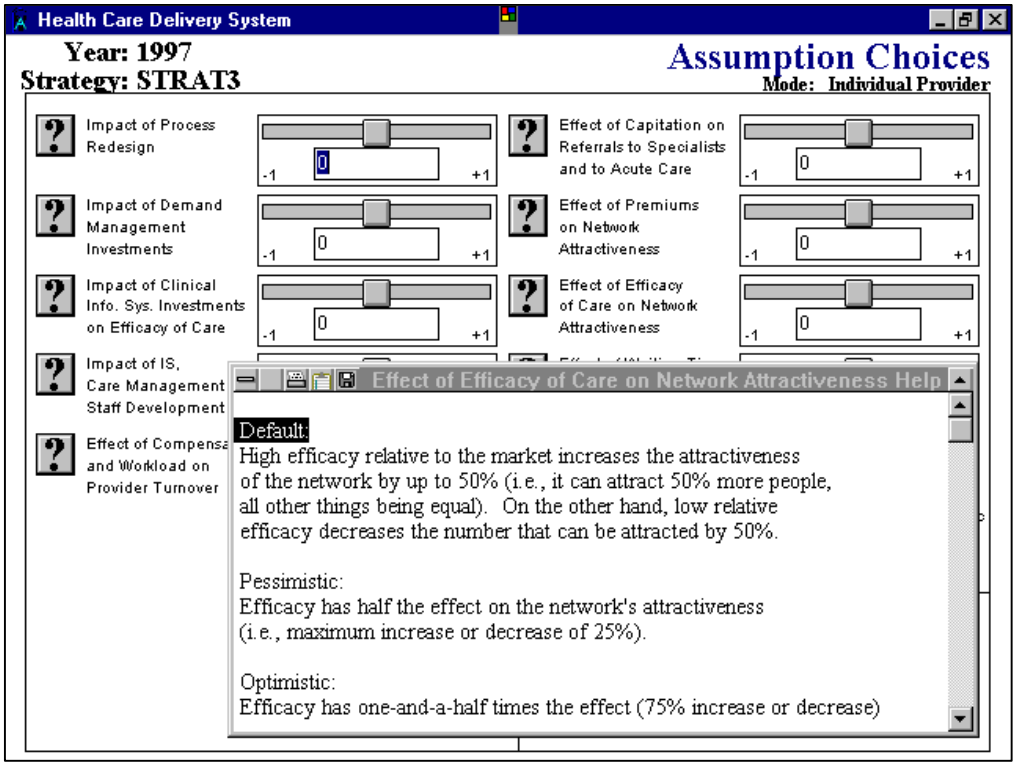

Figure 17. Assumptions Module 1 with a Description of the Effect of Efficacy on Attractiveness

Robustness testing is also an opportunity for users to explicitly consider how the scenarios they expect to face in real life affect their strategies.

Reported Learnings by Users

Here is a sample of the learnings that users have reported:

- Even in the best circumstances, traditional favorite strategies won't accomplish what we want.
- In many circumstances, strategies have unintended consequences which undermine their effectiveness.
- Undesirable results normally attributed to outside forces (e.g., aggressive competitors, unfavorable economic conditions, fickle customers) are often the result of our own decisions.
- The measurement systems used in most of our organizations serve to reinforce our assumptions rather than to question and improve them.
- There are real limits to success in remaining an autonomous provider.
- Calling yourself an integrated delivery system doesn't necessarily make you one.
- Short-term thinking produces long-term costs.
- Many critical assumptions are never clearly stated.
- Testing critical assumptions helps resolve conflicts about strategic direction.
- "Good" strategies do not necessarily produce great results under all scenarios. Some strategies are more robust than others.
- Collaboration is aided by understanding the issues and dilemmas of the other parties.

What We Learned

If we had it to do again, most the prominent lessons for us fall under the heading of group model building. This is a topic of general interest in the System Dynamics community, and better the subject of a separate paper. For purposes of this discussion, we should note that we began the process with model building, then turned our attention to the interface, and finally constructed the learning experience. We iterated between learning experience designs and the interface. In retrospect, it might have been better to start with some idea of the size and complexity of models and interface needed to produce a valuable learning experience. We do want to emphasize the value of sitting with users as they explore the simulation. We do not believe that we would have designed most of these features in this manner without our attention to their needs and preferences.

Other Learnings:

1. Don't let mechanics be impediment. Only describe the mechanics when users are at a computer. Provide roving help (sometimes permanent) to help with mechanics.
2. Let folks get hands-on as soon as possible.
3. The Microworld is an inefficient way to educate an unsophisticated participant about the dynamics of the industry. The Microworld needs to be paired with more conventional lectures about marketplace trends, etc.
4. It is important to diffuse concerns that Oakville isn't like Anytown USA. We stress the value of practice field, and learning to discern structure in changing environments.
5. Process facilitation is very important. Inherently, practice fields surface organizational dynamics and these can be useful to name and learn from. This is not a typical feature of simulator design.
6. There is value in distinguishing between model, interface and learning experience development. We think it is best to start with agreement about what needs to happen in the learning experience/intervention.

While we believe that there are still improvements to be made in simulator design, we suspect that the largest leverage might come from better understanding this work as an organizational intervention. If our goals go beyond simple awareness, use of simulators requires attention to the larger context and linkage to specific organizational issues and processes. We hope to encourage further inquiry in this area.

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[1] The subject of this paper is the microworld *Creating Integrated Care and Healthier Communities*. Gary Hirsch, Sherry Immediato, and Jenny Kemeny created this simulation for Innovation Associates and the New England Healthcare Assembly. It is available from Innovation Associates, Waltham, MA.

[2] We would like to thank Bob Eberlein, Tom Fiddaman, and Zach Woods for their help in working with us to use Vensim to implement these features.

[3] The 13 scenarios described in *Beyond the Limits* by Donella Meadows, Dennis Meadows and Jørgen Randers (White River Junction, VT: Chelsea Green Publishing Company, 1992), and their portrayal in the standard release of *Vensim*, inspired us to create some strategies/scenarios that would introduce users to the complexity of Oakville.

[4] *Mastering the Transition to Capitation* was created by Gary Hirsch and Jenny Kemeny for Innovation Associates and the Healthcare Forum. The microworld is available from the Healthcare Forum, San Francisco, CA.

[5] The structure of "the Beer Game" and the experience of participants is described by Peter Senge in Chapter 3 of *The Fifth Discipline*. (NY: Doubleday, 1990) Versions of the Beer Game are available with most system dynamics software packages; the board game is available from the System Dynamics Society.

[6] Normally, causal trees would also be available on-line using Vensim as the simulation software, however this feature was not available on the software we used when most of the model was written. We chose not to do the edits necessary to make the model user friendly when we switched over to Vensim.

[7] We are referring to the archetypes or templates popularized in *The Fifth Discipline*, *The Fifth Discipline Fieldbook* (NY: Doubleday, 1994) and various publications by Pegasus Communications (Waltham, MA).