System Dynamics Group
Sloan School of Management
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Introduction to System Dynamics, 15.871
System Dynamics for Business Policy, 15.874
Professor John Sterman

Assignment 1
Problem Definition and Model Conceptualization*

Assigned: Thursday 10 September 1998; Due: Tuesday 22 September 1998
This is an individual assignment.

The design and evaluation of high-leverage policies demand a long-term, dynamic perspective. The analyst or manager must be able to characterize the strategic problem, including its current symptoms and history. The time horizon should be explicit and must be long enough to include possible side effects, delayed responses to policies, and other feedbacks. In the first part of this assignment you are asked to develop a *reference mode* that characterizes graphically patterns of problem behavior over time in a business situation. In the second part you are asked to develop causal maps (or feedback loops) to portray the structure of the system and relate that structure to the problem behavior.

Problem definition in the system dynamics perspective involves both textual and graphical statements of problematic behavior. Conceptualization entails identifying feedback loops that are hypothesized to underlie observed patterns of system behavior. Model formulation is the process of moving from a theory of underlying structure to a fully specified mathematical model so that the theory can be tested. In this assignment, the skills involved in problem definition and model conceptualization are treated separately. Later assignments will bring these skills together with those of formulation and analysis to focus on a variety of strategic and operational problems.

A. Defining Problems Dynamically

In the past few years managers have increasingly focused on controlling costs, and eliminating jobs has become a very popular strategy to accomplish such reductions. "Downsizing," "rightsizing", and "re-purposing" are all popular euphemisms for reducing costs by separating people from their jobs. During the last few years, however, some companies have found that downsizing delivered less than it promised. As the US economy grew in the middle of the 1990s, and particularly as the labor market tightened, many companies that had slashed their workforce suddenly found that they could not fill all the positions they needed to keep up in a robust economy.

* Prepared by John Sterman, July 1986. Revised Jan. 88, Sept. 91, Jan. 92, Sept. 92, Sept. 93, Jan 95, Aug. 95, Aug. 96. Revised by Martin Großmann and Laura Black, Jul. 97; Nelson Repenning Jan. 97, Jan 98., John Sterman Sept. 98

❑ denotes a question for which you must hand in an answer, a model, or a plot.
• denotes a fact that you will want to include in the model under discussion.
☛ denotes a tip to help you build the model or answer the question.

What results did advocates of downsizing anticipate, and how did the actual results differ?

- ❑ A2. *2 points.* Make a list of the most important variables or concepts characterizing the problem described in the article. Your list should be comprehensive but as short as possible (ten or fewer). Aggregate similar concepts where possible (e.g., if you think the number of employees is important, can you lump together the different types?). Remember that you are attempting to communicate your ideas to a reader, not write "The Book of Lists." Strive to use names that have a clear sense of *direction*, that is, variables that can be larger or smaller, that can grow or shrink, increase or decrease. For example, "Happiness" is preferable to "Mental Attitude."

- ❑ A3. *1 point.* Use the verbal description and analysis in the article to graph the behavior of the key variables you identified in A2. First, identify the *time horizon* over which the dynamics unfold. Do not be constrained by the publication date of the article or the data given, but select a time period long enough to capture the dynamics of the critical variables, including their past development and enough of the future for the dynamics to play out. Next, sketch a graph showing the behavior for each variable over the time horizon you identified. If two or more variables have the same units of measure, plot them on the same scale (for example, show revenue and cost on the same graph so that the difference between them (profit) can be easily seen). Qualitative patterns are more important than numerical precision in the early stages of problem definition.

- ❑ A4. *1 point.* In a paragraph or two, define your variables clearly, explain your choice of time horizon, and briefly justify the dynamic patterns of behavior illustrated in your graphs.

- ❑ A5. *1 point.* Identify the variables or information, which you feel are crucial for understanding the problem but which are not discussed in the article. If you had a limited budget for additional data collection, how would you spend it? Remember that "data" does not mean only "numerical data" but also includes so-called "soft variables"—those concepts and variables that are important but for which numerical measures are not available. Focus on what is important, and worry about how to measure it later.

B. Conceptualization of Feedback Structure

- ❑ B1. *1 point.* Drawing on the article and your analysis above, create a causal-loop diagram that captures the important feedback loops underlying the dynamics you described (in A1) above. Your diagram should include the loops essential to explaining the dynamics, but should be simple enough to understand. Remember that your client will not understand a diagram that includes everything. Be sure to identify the polarity of each link and loop.
  - ☛ Before starting, be sure to do the assigned readings covering causal-loop diagrams.
  - ☛ If you are having difficulty getting started it may be useful to ask yourself the question "what were downsizing advocates trying to accomplish?". Having answered this question, can you then represent the decision to downsize and the *intended* outcome of such a decision using a feedback loop (what type of loops usually represent decision processes?). Having represented the intended outcomes, can you then capture some of those that were unintended

☛ A good explanation is one that links the behaviors in the reference model to the structure of the system represented in your causal map. It is not sufficient to just describe the reference mode. Instead you must describe how the loops interact to create the reference mode. A really good answer also explains how the structure causes the behavior to change from one type to another, for example from exponential growth to goal seeking behavior.

❑ B3. *1 point.* Using your diagram, identify what parts of the system structure you believe downsizing advocates understood (thus leading them to be advocates) and what parts they may have ignored (those creating the undesirable behavior).

☛ How much should you hand in? You must use your judgment. Some words of wisdom:

"Be careful that you write accurately rather than much." — Erasmus. We don't give higher grades for longer write-ups. Economy of presentation is a virtue.

"Often must you turn your stylus to erase, if you hope to write something worth a second reading." — Horace. Allow yourself time for revisions.

"What is written without effort is in general read without pleasure." — Samuel Johnson. And graded without pleasure, we might add.

☛ While your graphs and diagrams should be presented clearly and legibly, it is ***NOT*** necessary to create professional quality graphics. ***DO NOT*** spend your time creating artist-quality presentation graphics using fancy software. Use your time to think about the issues and develop your theory. Use software to create the diagrams ***ONLY*** if it will boost your productivity. A clear and legible handwritten diagram you had time to think about is preferable to a beautiful computer-generated diagram that took so much time to render that you didn't have time to think deeply about its content.

Neglecting Future Growth, They Shun Risks, Slight New Products and Selling

Needed: 'More Wild Ducks'

By BERNARD WYSOCKI JR.
Staff Reporter of THE WALL STREET JOURNAL

In corporate America, diet metaphors abound. Companies have trimmed the fat and become lean, fit and ready to compete. Now comes a more disturbing phrase about weight loss: corporate anorexia.

A shrinking corporation becomes anorexic when it gets so hooked on controlling expenses, closing plants, slashing inventories and eliminating jobs that it neglects the fact that a company should seek to grow, not fade away.

"I don't know who first coined the term 'corporate anorexia,' but it is a danger," says Jim Stanford, president of Petro-Canada, a Calgary-based oil and gas giant that has gone through numerous downsizings and restructurings over the past decade. Mr. Stanford doesn't believe that Petro-Canada has cut too deeply, but he recently announced that it would begin putting far more emphasis on revenue growth.

"You can't shrink to greatness," Mr. Stanford says.

Many Signs of Trouble

Indeed. After nearly a decade of frantic cost-cutting, the downside of downsizing is beginning to take its toll: Decimated sales staffs turn in lousy numbers. "Survivor syndrome" takes hold, and overburdened staffers just go through the motions of working. New-product ideas languish. Risk-taking dwindles because the culture of cost-cutting emphasizes the certainties of cutting costs over the uncertainties—and expense—of trying something new.

"There's a vicious cycle of downsizing," says Craig Schneier, a Princeton, N.J., management consultant. And in that cycle, a company can gradually lose its ability to grow.

On a more subtle level, excessive cost-cutting tends to strengthen the authority of financial and accounting departments, which see it as their mandate to control expenses rather than monitor and evaluate opportunities and investments. Top management can face a struggle to restore balance within the company and convince

chief financial officer. Management bonuses were geared to reward cash flow—net income plus depreciation—and profit.

Inventories were slashed. An entire layer of "group" management vanished. Research spending continued to increase, but risk-taking wasn't a priority. Operating profit was growing 15% a year, but revenue was increasing only 3% a year.

A Change in Tactics

By 1993, senior management realized that Bell & Howell couldn't keep saving its way into future prosperity. It had to ignite revenue growth. But the mentality of obsessive cost-cutting was habit-forming, and a tough habit to break.

"We're very serious that the culture has to change," Mr. Johansson says. "Our cultural bent is still not to spend. We almost have to encourage people to spend" — to invest in products and personnel that can speed growth.

Cost-Cutting Effects
The aftereffects on big companies that downsized between 1989 and 1994

	INCREASED	REMAINED CONSTANT	DECLINED
Operating Profits	50.6%	29.1%	20.4%
Worker Productivity	34.4	35.5	30.1
Employee Morale	1.9	12.1	86.0

Source: American Management Association

One change has been an infusion of growth-oriented executives. Of the five operating divisions, four have new top managers. "We needed more wild ducks, like me," says James Roemer, who ran one division that tripled in size during his watch. Mr. Roemer was recently promoted to president and chief operating officer.

In 1994, Bell & Howell changed executive-bonus formula by tying 30% of bonuses to sales growth and leaving 60% linked to operating profit and 10% to cash flow.

Already, the results are evident. Last year, revenue rose 7% to $720 million, and operating income surged 23% to $70.3 million. After restructuring and other charges, the company posted a net loss of $10 million, compared with a 1993 loss of $182.2 million. The company sold shares to the public early this year, partly to reduce its debt burden, which exceeded $450 million at the end of 1994.

At Bell & Howell, at least, the painful

Continued From First Page

ciation survey underscores the surprisingly mixed results of the decade of corporate budget-slashing. The study concludes that profits rose at only 51% of the companies that downsized between 1989 and 1994. Only 34% showed an increase in productivity. But employee morale slumped at 86%.

What went wrong? In the late 1980s and early 1990s, many companies trimmed payrolls with generous buyouts. And at many, some of the brightest stars — precisely the people the companies wanted to keep—took the money and ran.

Among those people were some with crucial knowledge. For instance, a Southeastern chemical company lost an engineer, the only employee who understood the design specifications of a certain compressor. The company scoured the Gulf Coast, by telephone, but never found him. He had been "downsized" and disappeared.

The rehiring of fired workers is perhaps the clearest sign that companies have cut too sharply. These "ghost workers" materialize as consultants, often at much higher pay, to handle engineering or other technical projects. When "companies cut too precipitously, either they hire again or they suffer from corporate anorexia," says John Challenger, executive vice president of Challenger, Gray & Christmas Inc., a Chicago outplacement concern.

Top executives tend to dismiss such concerns as excessively "touchy-feely," but evidence that staff cutbacks can be penny-wise and pound-foolish is growing.

"Downsizing is like a heat-seeking missile. It goes for where the biggest costs are," says Francis Gouillart, a senior vice president of Gemini Consulting in Cambridge, Mass. He says that at some insurance companies, management slashed payrolls in large benefit-claims departments, only to find out that when disasters such as hurricanes struck, the departments settled damage claims too quickly and paid out too much.

Sales Forces at Risk

Another fat target for downsizing is sales forces. But as companies focus on growth again, the often-decimated sales force comes under pressure. And with customer-service departments also whittled down, salespeople are doubling as customer-service reps. So, they have less time in the field, less time to sell new products or services.

"This is a death spiral," says Jerome Mr. Colletti's straightforward prescription: invest in people and buy companies that can expand your range of expertise. "This road takes guts, and it's the finance guys who have to get gutsy," he says. This tactic could rejuvenate sales departments overworked and still shellshocked from years of enduring on austere budgets.

"We have downsized considerably," says John Heffernan, director of sales administration at Westwood-Squibb Pharmaceuticals, a Buffalo, N.Y., division of Bristol-Myers Squibb Co. "At one point, we had 15 sales districts; today, we have 11. And the sales force has dropped from 145 to 122." The dermatological-products division has also slashed support staff.

"When you take away whole levels of management, the survivors have to take up the slack," Mr. Heffernan says. He adds that the staff reductions made him sensitive to signs of corporate anorexia. The most obvious: The work wasn't getting done. He also saw staff members doing a barely adequate job because they felt too overburdened to strive for excellence.

"Our challenge was to make people want to come to work," says Mr. Heffernan, who took a brief consulting-firm course on "mental toughness" and was so impressed that he persuaded the entire Buffalo facility to take it, too. The crucial insight: People need rest periods between periods of working flat out.

Training Often Slighted

One common symptom of corporate anorexia is the notion, within a company, that salespeople can just go out and sell and don't need much training. "Companies are willing to put people in sales, but they won't put the support behind them to make them successful," says Michael F. Iafolla, vice president for customer operations at Bristol-Myers Squibb's U.S. pharmaceuticals unit.

"This is a struggle within my own company," Mr. Iafolla recently told a conference of sales executives in Chicago. Today, a sales force, focusing on t[illegible] selling and highly specialized segme[illegible]tion of the market, requires heavy training. He says Bristol-Myers isn't "doing a good job there."

Ultimately at stake is the growth of the U.S. economy, as thousands of individual companies devise plans to increase their sales. Strip away big U.S. companies' growth through acquisitions, Gemini's Mr. Gouillart says, and you find that the internal annual growth rate, over the past decade, has ranged from 2% to zero.

But a sea change may be hitting big corporations. More of their executives are concluding that slashing costs can take a company only so far and that growth must be the paramount goal. Financial analysts and stock markets may still cheer when companies shrink costs, and stock prices may quickly surge, but over the longer haul, some studies find, shareholders don't hanker just for profit.

"The biggest driver of shareholder value is profitable growth," says Dwight Gertz of Mercer Management Consulting, of Boston. He adds that a study of 1,000 large U.S. companies' stocks shows that the key to a rising stock price is obvious: "The best way is to grow the business."