WORKING PAPER
ALFRED P. SLOAN SCHOOL OF MANAGEMENT

DESIGNING CORPORATE GROWTH STRATEGIES:
AN INDUSTRIAL DYNAMICS IMPLEMENTATION

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540-71                          May 1971

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#### Abstract

An Industrial Dynamics model was developed for an East Coast trucking company to investigate factors thought to dominate potential growth. The study suggested changes in the firm's operating policies and these were implemented. Implementation was successful. Resultant growth in sales and profit, changes in service, capacity utilization and measures of marketing effort indicate that new policies have been useful and validate the model's predications.

### Introduction.

Strategies for profitable growth are a major concern of most businesses. The size and intricacy of management systems, the complex interaction of the components within the organization, the multiple conflicting goals within the enterprise, and the interface between firm and market all work to make successful policy design difficult. The firm's own strategies for controlling resources, marketing, and trading off immediate expense for long-term results may interact to define growth in spite of potential market demand.

This paper reports a simple and inexpensive Industrial Dynamics study that suggested profitable policy changes for a real firm. A management group with limited exposure to Industrial Dynamics used this methodology to design successful policies and to monitor an effective implementation.

Methodology.

The management of a trucking company had been interested in uncovering new strategies to improve growth. Several techniques (multivariate statistical methods, dynamic programming) had been used to try to isolate key issues for profitable growth. None of these efforts showed clear cut, useful results; all were too complicated to be accepted with confidence by the firm's operating management.

Discovering effective management controls requires understanding of the causal mechanisms which underlie corporate system behavior.[10] The Industrial Dynamics methodology has the view that complex, non-linear feedback processes form the important structure of socio-economic systems. To design control policies to address dynamic socio-economic problems, an Industrial Dynamics practitioner builds a model that explicates this essential structure. The field is grounded in the state-space approach of modern control theory; its techniques include feedback systems analysis and computer simulation of complex models.[4,1,3,10] Applications of Industrial Dynamics are directed toward enterprise design--the development of control policies for continuous monitoring of corporate activity.[2,7,10,11,12]

The Industrial Dynamics approach was selected for three reasons.

1. Suitability to problem: the processes believed to encourage or constrain growth were part of a non-linear closed-loop feedback system.

2. Available theory: a substantial body of theory of corporate

growth had been developed by the Industrial Dynamics Group at M.I.T.[5,6,  8,9,10,13,14,15]  Some of the research was directly applicable.

3.  Simplicity:  the Industrial Dynamics approach was sufficiently straightforward so that management could take active part in the course of the project.

Model Formulation.

To build an Industrial Dynamics model it is necessary to focus on specific questions, to find a system boundary that encompasses the important causal mechanisms needed to answer the questions, to specify the feedback loops within the system boundary, and to estimate the values of system constants.

The model was built to investigate these three topics:

1.  The buy-off between the results of long-term efforts to maintain customer satisfaction and the company's immediate out-of-pocket cost for good service.  Was the firm's traditional policy optimal?

2.  Mechanisms for capacity control.  How does the firm's resource acquisition strategy affect growth?

3.  Company response to sales uncertainty.  To what extent do company policies control for sales fluctuations?

The company studied was a medium-sized trucking firm that carried general freight between Worcester-Boston, Massachusetts and the Washington-Baltimore area. This firm had two major terminals, forty competitors, and three million dollars in yearly revenues.

Many significant constraints on the operation and profitability of a trucking firm lay beyond the control of management. These factors such as general economic conditions, total area freight, Interstate Commerce Commission and Teamsters' Union work rules, most freight rates, and wage levels are not affected by the firm's operations. They enter the model as fixed parameters.

Management has effective control on intracity freight collection and distribution, intercity line-hauling, and administrative functions. The firm's operations are straightforward. Small "city trucks" pick up freight shipments during daily rounds in the metropolitan areas. At the originating terminal, the freight is batched into large (60 foot) over-the-road van loads for night shipment to the destination city by special intercity tractor-trailers.

At the other end, van loads are sorted into deliveries to consignees and sent out during the day. Intercity drivers, arriving at the destination terminal, sleep during the day and drive a tractor-trailer back to their home city the next night. The origin terminal is responsible for generating bills and records. The central office handles billing, damage claims, salesmen, staffing and accounting.

Capacity utilization and customer satisfaction are key issues in the list of problems the model is to investigate. Customer satisfaction has many facets. Potential customers do not all have the same needs and criteria. Some are

worried about thefts and damaged freight; others want special schedules for pick-ups and deliveries; a few want to use trailers for temporary warehouse space. But the essential competitive variable was found to be the speed of delivery. The firm promised its customers one-day door-to-door service between Boston and Baltimore; meeting this schedule dominated all other service criteria.

It appeared that once freight was received at the destination terminal, delivery the same day to the consignee could be assumed. Loss of one-day service would result only from holding freight at its originating terminal. Given the random nature of customer freight inputs and a limited intercity fleet, a terminal manager must expect that sometimes he will have more filled vans ready to ship than tractors to pull them. Maintaining a superior service level depends on rapidly clearing such freight backlogs. The measure of service used was smoothed percentage of freight held overnight (or longer) at its originating terminal before being sent over the road. This measure is generated by the over-the-road sector.

While intercity tractors are limited and expensive, small "city trucks" and tractor vans are relatively inexpensive and easy to procure. It was assumed that terminal capacity would not be a constraint. The important capacity measure is average-use of over-the-road tractors.

As dominant factors for customer service, resource control, and sales fluctuations effects occurred only in the over-the-road sector, the model boundary included that sector alone.
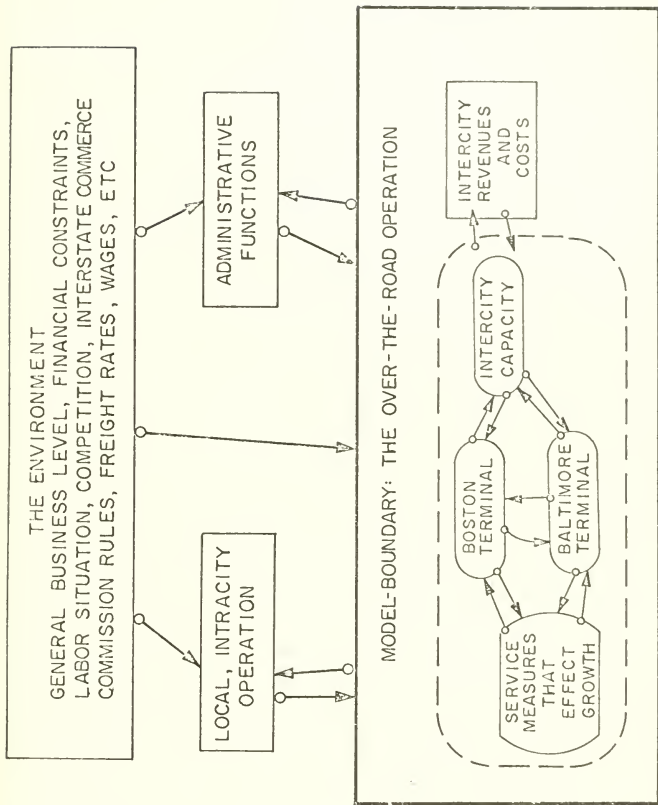
Figure 1 here.

Figure I: System Boundary

The Feedback Loops.

Within the system boundary four interacting feedback mechanisms were identified. They are:

1. Reputation-sales loops: the effect of the firm's service record on its sales rate.

2. Policies for capacity acquisition.

3. A special sales effort mechanism to smooth the effect of sales fluctuations.

4. Over-the-road loops: the basic daily shipment of men, trucks, and freight between the terminals.

Figure 2 here.

1. Reputation Loops. The sales rates at each terminal can be affected by market perception of the firm's service--its reputation, which is a result of over-the-road operations.

The measure of reputation is the average ratio of           delayed delivery freight  to orders. Averaging the daily service measure makes sense; it takes time for the market to perceive changes in the firm's service pattern. One day's good or bad service would directly affect only a small subset of the potential market.
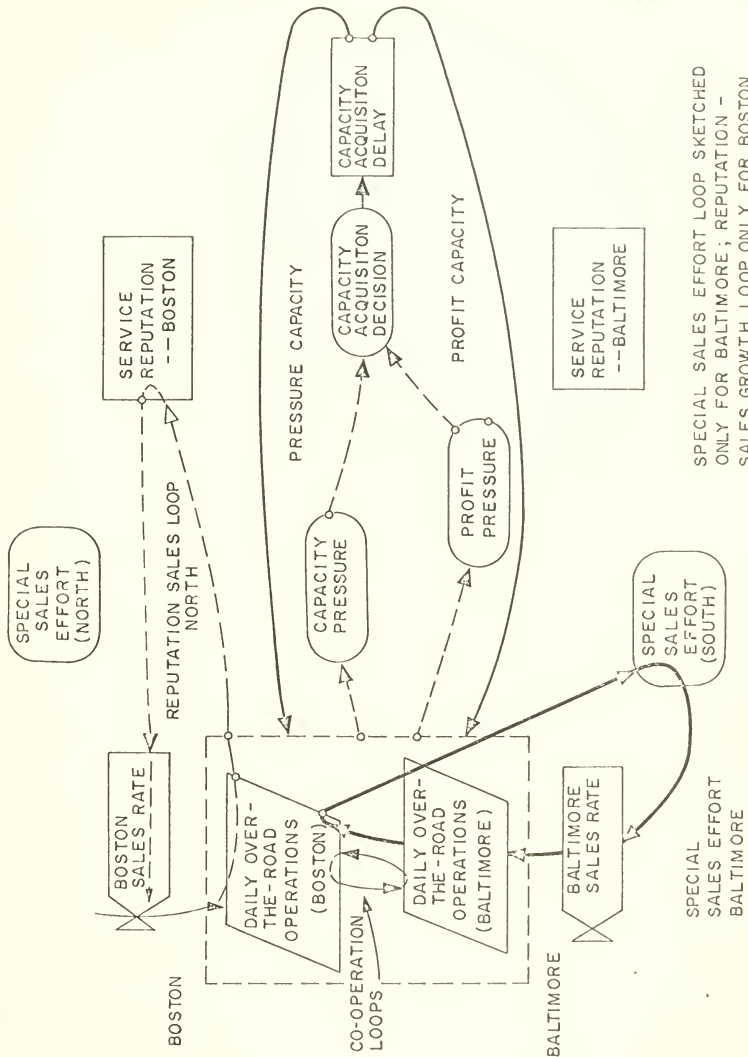
Figure 2: System Macro Elements

2. <u>Capacity Acquisition Loops</u>. (Figure 2.) Purchasing new trucks is a decision made by top management. Tractors are almost always bought in pairs, one to be based at each terminal. Purchasing pairs follows from the firm's expectation of long-run balance between mean sales rate in Boston and mean sales rate in Baltimore.

The firm was highly levered; there were no direct cash constraints on purchasing trucks. When profits are satisfactory, acceptable chattel mortgages can be easily negotiated.

Capacity pressure is defined by smoothed tractor utilization. A percentage utilization beyond a desired level signals the need for new equipment. There is a substantial delay between the indication that new trucks are needed and the delivery of the trucks.


3. <u>Special Sales Effort Loops</u>. (Figure 2.) Sales fluctuations cause occasional freight backlogs at one or another terminal. A short-term, expensive sales effort at the city without the freight backlog was suggested to help control these backlogs. This extra business would result in more trucks being sent to the clogged terminal; with an increased number of available trucks the backlog could be reduced.

The special sales effort might include calls and visits by salesmen to inactive customers, soliciting and accepting marginal freight, and gifts to customer shipping managers. For a short time, order rate would be increased, but resultant sales would not be profitable. As these loads would be used to fill trucks which might otherwise be sent empty, we thought that this

process might be a useful mechanism for balancing the system. All these assumptions, it turned out, were wrong.

4. <u>Daily Operations</u>. The rectangles marked "daily over-the-road operation" in Figure 2 are the core of the system. Measures of customer satisfaction and capacity use are generated by these loops and all other feedback loops are connected to them. Figure 3 below shows the detail of the over-the-road operation.

Figure 3 here.

Shipments from individual customers are brought to the origin terminal and grouped into loads--a load is one long-haul trailer filled with freight. "Holds" are filled trailers which were not shipped the day received, but held overnight in the terminal yard. Men and tractors are a single unit. In either terminal there are two groups of men and trucks: men whose home base is that terminal, and men based in the opposite city.

The shipping policy in the model contains these restrictions:

a. No Boston men can be kept in Baltimore over the weekend, nor Baltimore men in Boston.

b. Layovers--the holding of out-of-town men an extra night--are expensive and bad for morale; freight is first assigned to out-out-town men and trucks.

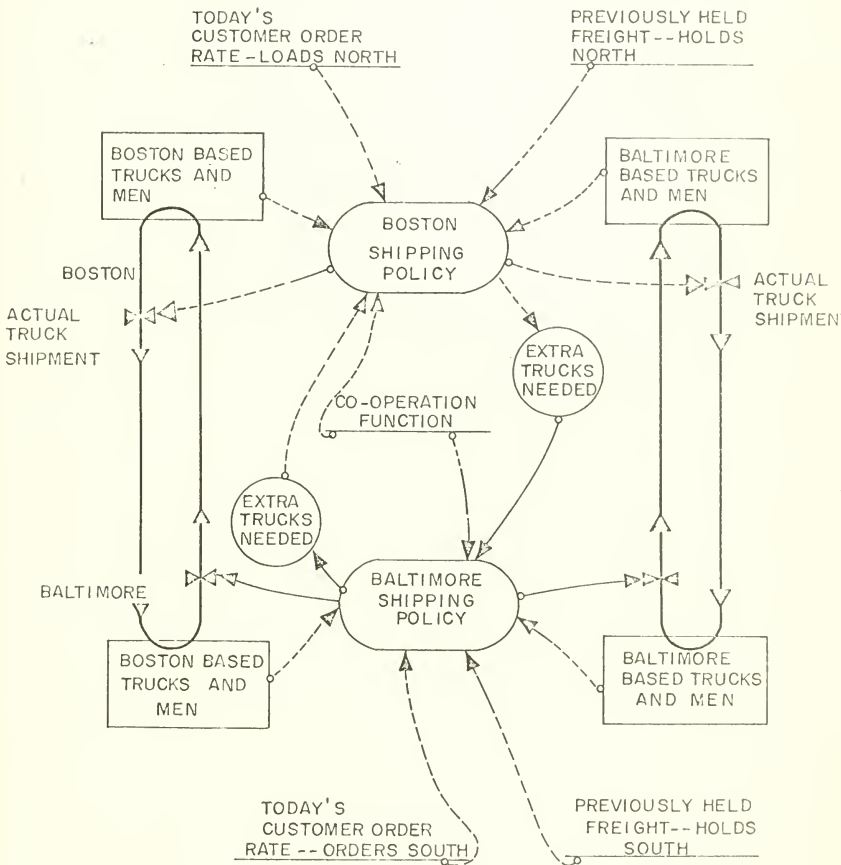c. Loads which have already been held one night ("holds") are given

Figure 3: The Over-The-Road Sector

priority for shipment.

d.  Traditional industry and company policy is "never" send empty trucks.

With this traditional policy, there is no real feedback between the Northern and the Southern terminals.  There is no mechanism by which one city can help the other when an abnormal backlog of freight has developed.  Despite the claims of management, it is clear that "no empties" cannot be a policy maintained in all circumstances.  With a variance on sales rate and a limited tractor supply, eventually there is certain to be a large number of delayed shipment loads clogging one of the two terminals.

It is important to ask what is done in extreme situations;  the model formulation must be accurate for the complete range of expected activity.

After pressing company personnel on the "no empties" policy, it was found that serious backlogs do develop;  top management then accedes to the terminal managers' request for help by authorizing shipment of empty trucks. There are, in fact, "cooperation loops" which connect the shipping policies in Figure 3.

Estimating Parameters.

Having focused on problem areas, justified a model boundary, and defined feedback loops, the next step is to estimate values for constants in the model. With company data and estimates published by the Interstate Commerce Commission

and the American Trucking Association, selecting values for most model parameters was straightforward. But finding the constants for cooperating loops, the reputation sales effect, and capacity acquisition delays required some investigation. The cooperation loops describe the willingness of the terminals to revise their normal shipping policies. A simple way to quantify this policy is to construct a function that relates need for trucks in excess of those to be sent by the normal shipping policy and response to that need.

The company's traditional cooperation function is graphed in Figure 4. For the traditional policy, as long as a small or moderate number of trailer loads are backlogged in a terminal, no special action is taken to clear them out; that is, empty trucks are not sent from the opposite terminal. The shape of this function is a management policy; examining alternative formulations was an important part of the study.

Figure 4 here.

There were two issues in specifying the reputation effect on sales rate: how long does it take the market to perceive a change in the firm's service, and how powerful is the effect of good or bad service on growth of sales rate?

To estimate these factors, three sources were used. The first was the firm's personnel: top management, salesmen and terminal managers. Active customers were a source; 20 major customers were asked their opinion of the effect of service on potential growth in sales. Finally, at an American Management Association distribution meeting, estimates were solicited from logistics executives of many large national firms. Evaluating these opinions, we estimated that the market's perception of service followed a three to six month smoothing of the firm's daily holds to orders ratio. The range of
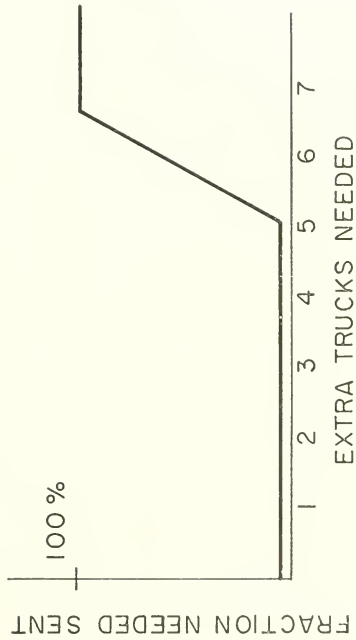
Figure 4: Traditional Co-Operation Function

realistic estimates for the service level-sales rate relationship are shown on the graph below (Figure 5). While we were not certain where the true line lies, we were confident that it is bounded by the optimistic and pessimistic estimates.

Figure 5 here.

It was generally agreed that a perfect service record--no freight held-- would result in 10 to 12 percent yearly growth. Very poor service, on the other hand, might cause the firm to lose a third of its business in a year.

## Capacity Acquisition.

Capacity acquisition is controlled by profit and capacity utilization pressure. Were the firm's operating ratio (yearly expenses/revenue) greater than 96 percent, no new trucks could be purchased. Otherwise there are no financial constraints on obtaining new trucks.

When the firm's smoothed (over a 3-4 month averaging time) capacity utilization ratio reached 70-75 percent, new trucks would be ordered. The firm had experienced a four- to six-month delay (a two- to three-month delay in placing the order and a two- to three-month wait for actual delivery), between seeing a need for new capacity and putting the new tractors into service.
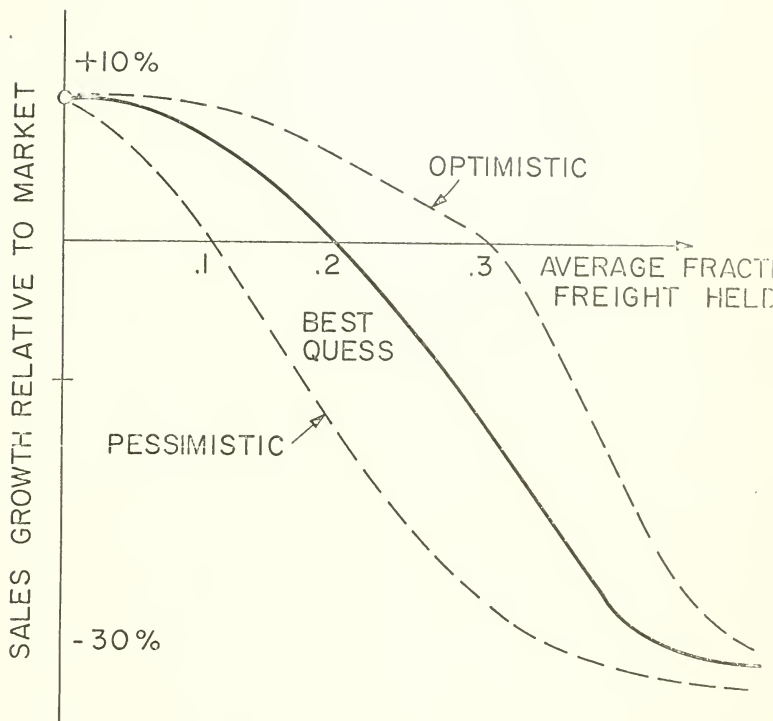
Figure 5: Service-Reputation Effect on Sales Growth

Validation.

    With a model boundary, feedback loops, and parameter values all carefully
chosen and justified, the model was coded and debugged.[1]  A test run was used
to check the reasonableness of the complete model.  This validation test used
initial values from company records, historical policies for sending empty
trucks, and the best (median) estimate of the service reputation sales rela-
tionship.

    The result of that test is shown below (Figure 6).  The trend line for
sales growth for the six year simulation was consistent with the firm's
experience.

                        Figure 6 here.

    Although a poor point estimator, the validation run does generate a time
series that reflects important patterns in real data.  The growth trend and
the long period cycles in sales rate can be seen in real data and in the
simulation graphs.

    An interesting point is the low frequency oscillations on sales rates.
The model shows a pattern of shifting terminal sales rate dominance, with
thirty-two week cycles.  Although not noticed before building the model, the
same phenomenon was found in company records.  The vertical, dashed lines
super-imposed on Figure 6 show the node of company record order rate oscil-
lations.  Having the model point up an unsuspected pattern in real data did
a great deal to build confidence in the formulation.

    Since we had carefully defined and justified the micro-elements of the
model and since the gross behavior with traditional policies accurately reflected
the important components of the firm's real experience, we could claim with
clear conscience that we had formulated a valid model.[2]

COMPUTER OUTPUT: HEAVY LINE FOR BATIMORE SALES RATE
LIGHT LINE FOR BOSTON SALES RATE

COMPANY RECORDS SHOW SALES RATE OSCILLATION'S WITH INTERSECTION
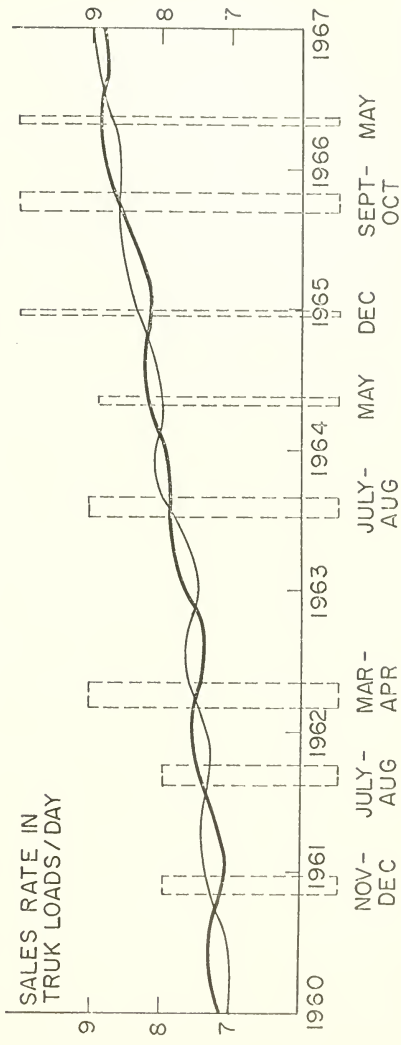POINTS OCCURRING IN TIMES MARKED BY VERTICAL DOTTED LINES

SALES RATE IN
TRUK LOADS/DAY

Figure 6: Validation Test

## Policy Change Analysis.

By examining system structure and model behavior and by testing alternative suggestions, new operating policies were developed for reputation induced growth, capacity acquisition, control of balance and control of variance. The special sales effort policy was found to be impractical.

## Reputation Induced Growth.

Management must trade-off two alternatives: the first is to increase the use of empty trucks and encourage long-term growth with good service, but degrade immediate profits. The second restricts the use of empty trucks, improves or maintains present profits, but reduces long-term growth potential. Increasingly larger costs are caused by increasing inter-terminal cooperation. The optimal trade-off point is not obvious.

The control policy here is the cooperation function. System behavior was examined for a broad range of possible cooperation policies (Figure 4) while at the same time varying assumptions about the values of the reputation-growth multiplier (Figure 5).

The simulation runs showed that over the whole range of assumptions of the power of service on sales rate, increasing the gain of the cooperation function would result in increased profitable growth. Shipping empties would pay back immediate cost in long-term growth.

Table I summarizes the results of the runs. Indices for ten years' growth in profits are shown for nine simulations.

The "ship half needed" option clearly dominated the traditional company policy.

## TABLE I

| Reputation Growth Assumption | Co-operation Policy | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Optimistic | 130 | 210 | 140 |
| Best Estimate | 100 | 160 | 80 |
| Pessimistic | 96 | 120 | 20 |

Policy 1:  Traditional rule--ship no empty trucks.
Policy 2:  Ship half needed extra trucks.
Policy 3:  Ship all needed extra trucks.

The reputation growth assumption estimates are plotted on Figure 5. The profit indices are normalized by results of the firm's original co-operation policy, assuming our best estimate of the reputation-sales growth effect. Profit measures are generated considering only cost from the over-the-road sector and revenue accruing to that operation.

Capacity Acquisition.

Model behavior was insensitive to reasonable choices for utilization fraction to signal new truck acquisition. But in a period of rapid growth, the long delay in the firm's original acquisition policy could temporarily constrain growth. Reducing the acquisition delay was practical; management had never seen a need for expediting the ordering process.

Special Sales Effort:  Balance and Variance

The simulation runs for a special, short-term sales effort showed poor results. This is not surprising. By the time a small surge in sales appeared, a week or so after initiating the policy, the problem of unbalance sales rates may have corrected itself or even reversed. Investigating this mechanism was not wasted effort; it drew us into analysis of the effect of order rate patterns on total system performance.

Imbalance is the difference between the mean daily order rate at Boston and the mean at Baltimore. Variance is the standard deviation on the order rates.

Questions of balance and variance dominate behavior. In a period of differing mean terminal order rates, profit is destroyed and growth inhibited. A 10% difference in terminal order rates for four months could cost the firm 30-50% of the year's potential profits. Growth is precluded; it is impossible to maintain a good service pattern.

Variance is an important issue. Substantial noise on the order rates at

either terminal causes a large reduction in profits. A 10% variance in order rates will cost 15-25% of annual potential profits. High daily sales variance makes it difficult to ship enough empties to maintain a superior service record.

Seeing their key effect on company performance, it became clear that a well-designed system should control for imbalance and high variance. Everyone knew that imbalance and large noise on sales were unprofitable. But no one had seen exactly how balance and variance impacted on profits or how they were tied to growth and customer satisfaction.

Management ought to try to anticipate developing imbalance. If such a situation is indicated, the firm should add business, profitable or not, at the light terminal and delete customers at the heavy terminal.

To control variance, the firm should seek out shippers who are not concerned with one-day service, even if their freight provides only enough revenue to cover out-of-pocket costs. Such freight would be used as an inventory for smoothing daily operations.[3]

Implementation.

The new control policies described above were presented to management. The initial effort to sell results failed. Three factors prevented implementation: operating managers thought the author an academic without interest in "real" problem solving; the study had not involved inhouse personnel; and Industrial Dynamics seemed arcane.

A good deal of time was spent in cultivating support from operating managers for the suggested changes, especially for increased effort for high customer satisfaction. We reminded the executive vice-president, subtly we thought, that pleasing the customers was important and that it would be very nice if promised one-day service were always provided.

The executive vice-president finally responded to our service campaign with, "I know what you're trying to get me to say. You want me to say we should ship empties. I'll never ship empties."

This statement epitomized the failure of the first implementation attempt. Selling results proved not to be enough. It was necessary to provide operating people with a conceptual framework for judging the work for themselves and confidently accepting proposals.

A great virtue of Industrial Dynamics is its simplicity. It was possible to sit down with operating executives who were high school graduates and explain enough about feedback systems to teach them the model and to sell the model's suggestions. It is fair to point out that the second pass short-circuited the misconceptions and dead ends that we followed in the initial model formulation. In any case, management bought the model. Convincing the prospective users of policy suggestions that the model structure and behavior were reasonable was the real validation test.

Implementing Specific Policies.

Management was prepared to adopt new policies in four important areas.

1. Balance Control.  The weekly computer-generated accounting reports were expanded to include listings of smoothed sales rates and estimates of potential imbalance.  The sales force and terminal managers now aware of the importance of maintaining system balance agreed to try to predict major changes in their areas' sales patterns.

To correct imbalance, marginally profitable customers were to be solicited at the low mean terminal and marginally profitable business at the heavy end would be eliminated. There was resistance to the idea of turning away sales, but it was clear that unless the firm itself took this step, the market inevitably would do so.  There was no real choice.

2.  Variance.  It was agreed to solicit more freight, even if only marginally profitable, from customers indifferent to one-day service.  A major source of this buffer stock is the federal, state, and local governments; rates (prices) for this material are set by bids and not by law.  Other possibilities are certain large shippers for whom special rates might be established with Interstate Commerce Commission permission, and freight-shipped rail-road piggyback.

3.  Co-operation Function.  To increase growth, management agreed to change its cooperation function.  The terminal managers were instructed to send one-half the needed empty trucks to the opposite terminal.  If an "empty" could be filled with marginal smoothing freight, so much the better.  The firm kept careful count of empties, holds, and average revenue per truckload.  The bonus

compensation program for terminal managers and salesmen were revised to take account of soliciting and using marginal smoothing freight.

    4.  Capacity Acquisition.  The simulation runs showed that reducing delay in acquiring new tractors meant average utilization could be increased without constraining service and growth.  The ordering decision could be easily expedited given up-to-date information and management's realization that it was important to do so.


Results and Evaluation.

    The Industrial Dynamics implementation generated successful policy changes in five areas:  balance control, variance control, service induced growth, capacity acquisition, and corporate expansion.

    Inbalance was reduced.  Twice during the implementation period the firm took action to mitigate developing inbalance.  In both cases, forecasts were timely and accurate.  In fact, in the first instance, the firm over-reacted. The computer-generated estimate of balance change was not useful as a warning signal.  Instead, informal information sources--salesmen, terminal managers, information from the business press and trucking industry meetings and publications--turned out to be a better forecasting device.

    The new policy appears to have caused a small improvement in system balance.  In the two and a half years of active implementation, the balance measure has averaged 3.5 unmatched loads per week;  before the study, the statistic averaged 4.4 loads per week.  After adjusting this number for the reduction in

daily order variance, a small improvement remains.

The most successful new policy was variance reduction. The firm has used marginally profitable service-insensitive freight to help smooth noise on daily sales rates. Variance was reduced by twenty-five percent. Before the Industrial Dynamics implementation, average variance on daily orders was 12 percent; afterward, the ratio averaged 9 percent.

New policies for balance and variance control have reduced over-the-road costs. During the implementation period, the fraction of total expense in the over-the-road sector fell from .115 to .105--a ten percent reduction. Expenses were cut despite a policy of sending empties when needed. There has been, in fact, sufficient smoothing freight to reduce the number of physical empties. On the other hand, the number of cooperation shipments and marginal smoothing freight loads has strongly increased.

The combination of policies to increase customer service caused substantially improved growth. The firm improved its service measure by reducing the held freight ratio from 20 percent to 8 percent (not counting deliberate holding of smoothing freight). Growth in sales increased from 2 percent to 8 percent.

The policy for increased cooperation and service and resulting growth was not maintained. Recall that the model boundary was justified with the argument that the intracity operation would never constrain the ability to give good service. A year and a half after implementation, this assumption was invalidated. When the project began, a new terminal was under construction for Baltimore-Washington. Zoning, labor, and financing problems delayed completion.

In the meantime, rapid growth was taxing the capacity of the old terminal. Terminal freight handling capacity began to dominate the ability to give good service.

The Industrial Dynamics approach and the model were clear and simple enough to be easily adopted for this new circumstance. Revised simulations showed that steep rising overtime expenses would absorb any further growth in revenue.

As maintaining good service and growth would require substantial, costly overtime operation, the growth strategy was inactivated. The intention was that growth inducing strategies would be re-started as soon as the new terminal came on line. Unfortunately, the combination of long construction delays and serious management personnel and labor discipline problems precluded re-establishing an aggressive growth strategy for the Baltimore-Boston route.

The major impact of the project was helping to evaluate a proposed merger and developing control policies for an enlarged operation. When the firm had an opportunity to purchase a small, unprofitable carrier with complementary routes--between Boston-Buffalo, the model was adopted for policy design for the proposed three-terminal firm.

While the basic ideas of the original model could be directly extended, examining this purchase required revisions in several places.

1.  Shipping policy: two interesting constraints had to be considered. First, the expanded firm could not carry freight between Buffalo-Baltimore; the new route pattern would be two legs of a triange, but not a closed loop. Second, for the original Boston-Baltimore

route, state laws restricted the firm to using a tractor with sixty-foot trailers. But for the Boston-Buffalo route, a single truck is allowed to haul two forty-five foot trailers. While the driver of such a "double bottom" leviathan does receive premium pay, it is still profitable to haul double loads. There were different opportunity costs, risks and payoffs for variance smoothing and service strategies.

2. Reputation growth effect: the competition on the Buffalo-Boston route was less keen than between Boston-Baltimore. Industry service standards were lower. It turned out that the potential for service induced growth was greater on the new route than for the original operation.

New scheduling algorithms and shipping policies were developed; the extended model indicated that the smaller carrier could be profitably integrated into the firm. The acquisition was made.

Revenues for the Buffalo-Boston operation more than doubled in two and a half years; the subsidiary operation showed a substantial profit in place of loss. While part of the growth is due to increased capitalization and general economies of scale, objective measures of capacity utilization (nearly 90 percent), smoothing (variance 8-9 percent), and high service (holds of prime freight less than 7 percent), and low road sector costs—suggest that operating strategies suggested by the model were an important factor in this substantial, profitable growth.

The new capacity control policies generated modestly useful results. With the addition of the new route and integrating the subsidiary's tractor fleet, it is difficult to point an unambiguous application of reducing truck purchase lead time. On the other hand, average utilization of the long haul fleet did increase from 78 percent to 87 percent.

Conclusion.

As was noted, labor discipline and start-up problems plagued the new Baltimore terminal. The most serious was an eightfold increase in claims (theft and breakage) from $30,000 to $250,000 per year. This situation, together with a downward spiral in labor efficiency in the city operation, put the Baltimore-Boston link into the red. (The over-the-road costs remained under effective control.) The morale of management and of the owners was undermined, and the family that held the firm decided to find a less aggravating business. The success of the Boston-Buffalo route was the saving grace for arranging a sale. The initial investment in this Boston-Buffalo carrier was nearly tripled.

This Industrial Dynamics application provided a substantial return to the clients for whom it was done. It suggested successful policies for the problems to which it was addressed. Direct benefits, even for the Boston-Baltimore operation, far outweighed total project expenses. Industrial Dynamics can work in the field.

Designing Corporate Growth Strategies:

An Industrial Dynamics Implementation

Footnotes

1.  The DYNAMO language was used to code the 70 equations of the model.
    For details of model formulation, see (17).

2.  The verification of dynamic models is a problem that has generated
    much confusion.  The ability of a model to give point by point pre-
    dictions is not an appropriate criterion.  For a discussion of the
    verification problem, see (16).

3.  Several other alternatives for variable control were tested and re-
    jected.  These included increasing fleet size and renting trucks.
    Devices to control for sales uncertainty are discussed in (15).

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