WORKING PAPER
ALFRED P. SLOAN SCHOOL OF MANAGEMENT

A BEHAVIORAL SIMULATION MODEL OF SALES PLANNING AND CONTROL IN A DATACOMMUNICATIONS COMPANY

by

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WP-1761-86

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March 1986
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Abstract

The paper describes a behavioral simulation model which represents the policies and procedures for sales planning and control in datacommunications companies. The model allows you to think about the different 'players' whose actions and choices regulate sales. There are quite a few of them -- account executives, customers, sales executives, business planners and compensation planners. You step into their shoes. You examine their responsibilities, their goals and incentives and the sources of information that attract their attention -- all with the intention of understanding the logic behind their choices and actions. Then you stand back from the detail of the individual players and, with the help of diagrams and computer simulations, you explore how the players interact and cooperate, and how the system as a whole balances the sales goals of the company, the efforts of the salesforce and the needs of customers.
INSIDE THE SALES ORGANIZATION

Imagine you are the vice-president of sales in a growing datacommunications company, with revenue responsibility for several major product lines. Included in your product portfolio are telephones, key systems, medium-sized PBXs, personal computers and workstations. Due to advancing technology and increasing competition the products are frequently changing -- new models are introduced and existing models are offered with enhanced features.

You have at your command a professional salesforce presently comprising sixty high-calibre account executives, each one assisted by a staff of three or four people that provides technical and clerical support. The salesforce sells mostly to business customers, medium to large firms with annual sales revenue between $500 million and $10 billion.

As you think about the problems of managing the sales organization, several questions come to mind. Given the company's wide range of products, how do you ensure balanced growth of the different product lines? How do you know that account executives will allocate their selling time so that you meet your negotiated sales quota, so the firm meets its sales objectives and so the factories can satisfy customer orders? How do you know that account executives are pushing the products customers most want to buy? How do you know that your salesforce is the right size and growing at the right rate?
To get another perspective on these questions you try to put yourself in the position of one of the account executives. You know most of them well. They are a talented group of individuals, extrovert, knowledgeable of the company's products and persuasive in selling them. They are well-paid for their talents. Most earn at least $60,000 per year and the 'stars' sometimes as much as $250,000 per year. What motivates them? How do they decide which products to sell? Money, prestige, and competition with colleagues are doubtless important influences. But, when you come to think of it, they are obviously not motivated by the firm's overall sales goals (how many account executives actually know these goals), and less still by your own negotiated sales quota or the factories' production commitments! So how can you plan and control the sales of your own sales organization?

To help explore these questions a simulation model of a sales organization has been developed which represents sales planning and control in datacommunications companies. The model allows you to think about the different 'players' whose actions and choices regulate sales. There are quite a few of them -- account executives, customers, sales executives, business planners and compensation planners. You step into their shoes. You examine their responsibilities, their goals and incentives and the sources of information that attract their attention -- all with the intention of understanding the logic behind their choices and actions. Then
you stand back from the detail of individual players and, with the help of diagrams and simulations, you explore how the players interact and cooperate, and how the system as a whole balances the sales goals of the company, the efforts of the salesforce and the needs of customers.

**Account Executives' Time Allocation**

Let's begin with the account executives. To keep things simple imagine they have to choose between selling just two product lines -- a large system like a PBX selling for perhaps $100,000 and a small system like a personal business computer/workstation selling for $20,000. (We'll base the whole model on just two product lines. It's simpler than reality of course, but even so can teach us a great deal). Naturally they're interested in the 'payoff'. What is their compensation for selling a large system, and what for a small system?

To make a choice they have to know the terms of the compensation scheme. These schemes come in many varieties. Some companies use a straight commission (account executives are paid a fixed proportion of the selling price), some use a combination of base 'guaranteed' salary and commission. In this case a points scheme is used. Account executives are awarded 25,000 points for the sale of a PBX and 5,000 points for the sale of a workstation. They keep a tally of points and convert their points to real dollars at a rate of say $1000 per 5000 points, which is added to their base, guaranteed pay. The terms of the compensation scheme can, and do,
change from month-to-month. So account executives must keep up-to-date and watch for announcements of changes in the points value of products, or the points to dollars conversion rate. The details of any given points scheme can be quite complex, but the basic principle (from the account executives' perspective) is quite simple and similar to a commission scheme. The more points they earn, the bigger their sales bonus.

Account executives know they'll earn 20,000 points for each PBX they sell and only 5,000 for each workstation. But points alone don't dictate their time allocation. They also take account of the number of hours it takes to sell a PBX versus a workstation. There are several reasons why a PBX sale is more time consuming. The PBX is much more expensive and more complex than the workstation, so it takes account executives a long time to explain its features to a customer. It may take the customer a long time to win his company's approval for a large expenditure on a PBX. Finally, the chances of winning an order may be low because, given the expense, customers look closely at competitor's products too.

Figure 1 summarizes the factors that influence account executives' time allocation. They keep abreast of the points system. From their field experience they estimate the time per sale of large systems and small systems. Knowing points and time per sale they can judge, roughly, the payoff, in terms of points per hour, to selling either a large system or a small system. For example, suppose it takes, on average, 60 hours to sell a
Figure 1: Account Executives' Time Allocation
PBX (the total time spent with a customer from first contact to final delivery and installation -- including time lost with those customers who choose not to buy) and 15 hours to sell a workstation. Given the terms of the compensation scheme, the payoff for selling PBXs is 25,000/60 or 416 points per hour and the payoff for selling workstations is 5000/15 or 333 points per hour. Therefore, in this case, account executives will want to devote more of their time to selling PBXs.

But account executives don't switch in a single day to selling PBX's exclusively. They have a variety of contracts already underway which they are obliged to complete. Their time allocation changes only gradually, depending on the new selling opportunities available, existing commitments and the current payoff for large and small systems. The process is dynamic. Conditions change from day to day and week to week. The compensation scheme may be modified. The time to sell a system will change as the relative prices and delivery intervals of each product line vary. New products may be introduced whose selling time one can only guess. Despite these complexities, salesforce time allocation is logical and quite predictable, once the points and time per sale are specified. Account executives will gradually shift more and more of their time to the product line which, in their judgement, gives the biggest payoff.

Compensation Planning
Compensation planners design the compensation scheme. They are the
interface between sales objectives and the salesforce. As figure 2 shows, they look at performance against objective (in this case for small and large systems) and decide how to adjust product points to encourage account executives to sell products in the quantity called for by the objective. So, if sales of a particular product line are below objective, compensation planners will increase the points value of the product, making it more attractive to sell. On the other hand, if sales of a product line exceed the sales objective, planners will maintain or possibly even decrease it's points value. In practice it is much easier to increase points than reduce them, because account executives strongly resist any attempt to lower their compensation.

**Sales Objective**

The sales objective comes from a complex business planning procedure that consolidates information and judgement from market analysts, account executives, product managers, product schedulers and manufacturing planners. The business plan starts from an estimate of total industry volume for all classes of datacommunications equipment. From historical data and various business assumptions (new product introductions, price changes, competitor actions, expected delivery intervals) market analysts compute the company's expected share of industry sales. By applying the share to industry volume, the business plan generates the company's sales forecast by product line over a two year planning horizon.
Figure 2: Compensation Planning
Although a great deal of information enters the planning process, a most important input is the recent history of customer orders, as shown in figure 3. Planners compute a base estimate of demand using last year's volume of customer orders. Then, during the sales commitment process, executives increase the base estimate by a 'stretch margin' to arrive at the corporate sales objective. For example, suppose the salesforce sold 1000 PBXs last year. If the stretch margin is 10 percent, then the corporate sales objective for the coming year is 1100 PBXs. The stretch margin is a simple but powerful way for executives to set challenging sales objectives for sales managers, in an environment of great uncertainty about customer demand. The objective requires sales managers to strive for higher sales volume, by holding them accountable for an objective that is greater than last year's (or last quarter's) sales. Performance against sales objective (which compensation planners use in adjusting points) is obtained by comparing customer orders to date, with the sales objective pro-rated to the same date.
Figure 3: Business Sales Objective
Customer Ordering

It's common to think that customer orders are completely determined by factors such as price/performance, availability and quality. Certainly these factors are important, but they're not the whole story. Put yourself in the position of a business customer buying a PBX or a workstation. Think about your knowledge of the product and your information sources as you begin the purchase.

A principal influence is sales effort, as shown in figure 4. Few customers for office systems will spontaneously place an order without first having a demonstration and talking with account executives. Very often it is the account executive who initiates the customers' interest and makes them aware of the existence of the product and its features. Only when the customer is aware of the product do factors such as price/performance, availability and quality become important. Each customer has his own perception of these factors and sensitivity to them. But in general, if availability of the product is low (or, put another way, if delivery interval is long, say 12 months), or if price is high, account executives will take a long time to find willing customers. Conversely, if the product is readily available, or the price is low, account executives will soon find willing customers.
Customer Orders for Large (or Small) Systems

Customer Ordering (Large or Small Systems)

Availability

Quality

Time to Make a Sale

Price/Performance

Sales Effort to Large (or Small) Systems

Figure 4: Customer Ordering
Force Hiring, Layoff and Budgeting

A description of sales planning and control would be incomplete if it ignored force hiring and layoff. How do companies regulate the size of their salesforce, which people are responsible for hiring and what motivates their decisions? In broad terms, force planning is driven by the budget, as shown in figure 5. Given the salesforce budget and knowledge of average salesforce compensation, planners can estimate the number of account executives the budget can support -- the authorized salesforce. If the authorized force exceeds the current force then hiring takes place and the salesforce grows. Conversely, if the current force exceeds the authorized force then layoffs take place and the salesforce contracts. (alternatively the company may rely on attrition, or some combination of attrition and layoff to reduce the salesforce).

The company's budgeting policy is a complex process which the model only outlines. The important point is to capture the inertia and myopia that characterize budgeting in most large organizations. Major budget items (such as advertising expense, R&D expense, sales and service expense) rarely change dramatically from year to year as a proportion of the total budget. New budgets are often just incremental adjustments to old budgets, because organizational politics cannot cope with radical change and because it is complicated and time consuming to justify every budget item from scratch each year. The budgeting policy captures these incremental, inertial adjustments, as shown in figure 6. The budget for the
Figure 5: Force Hiring and Layoff
salesforce is represented as a fraction of total sales revenue (revenue itself is the product of price and customer orders for both large and small systems). The fraction is 'sticky' (slow to change) though not rigidly fixed. For example, it slowly increases if total salesforce compensation repeatedly exceeds budget.

Figure 6: Budget for Salesforce
DYNAMICS OF SALES PLANNING AND CONTROL

Scenario 1 -- "Test Drive" Balanced Product Portfolio

Up to now we have described the way sales are planned and controlled in a datacommunications company. Now we want to understand the dynamics of sales planning and control -- how customer orders, sales objectives, compensation and number of account executives change over time. To begin, let's try a 'test drive' of the model, a simulation of a special, easy-to-interpret product scenario. The scenario assumes four conditions. First, large and small systems yield the same revenue per sales hour, so the salesforce generates the same total revenue no matter how account executives allocate their time. Second, large and small systems are equally attractive to account executives -- in other words, the points payoff to selling either large or small systems is identical. Third, orders for large and small systems are exactly equal to the sales objective. Finally, products are priced to generate a profit and there are many potential customers for both large and small systems. Given these conditions, imagine how the business units' sales and revenue will evolve over time? Will revenue grow and if so why? How will account executives allocate their time?

Figure 7 shows a simulation of the scenario made by running the sales organization model (documented in the appendix) for a period of 24 months. Orders for small systems (-1-) begin at 60 units per month and orders for large systems (-2-) begin at 108 units per month. Both grow smoothly and
Figure 7: Customer Orders When Products Are Equally Attractive to Salesforce
exponentially over the 24 month simulation at a rate of approximately 30 percent per year. Figure 8 shows that the salesforce (-1-) is growing at the same 30 percent rate, starting with 60 account executives and ending with 90 in month 24. Meanwhile the attractiveness of small systems (shown as (-2-) in the lower half of figure 8) remains constant at a value of 1 (meaning that the points payoff for small and large systems is identical throughout the simulation). So account executives stick with their initial time allocation (in this case 10 percent for small systems and 90 percent for large systems) throughout the simulation, because there is no incentive to change.

The growth of orders, revenue and salesforce results from a positive feedback loop, shown in figure 9, that couples budgeting, salesforce hiring and customer ordering. To understand the figure imagine what happens if the salesforce, on the right-hand side, is increased. First, sales effort will rise because there are more account executives. Then customer orders will rise, because more customers are informed of the company's products and persuaded to buy them. More customer orders generate more sales revenue which in turn expands the budget for the salesforce and therefore allows more hiring. As long as there are plenty of potential customers who, once informed, will consider buying the company's products (in other words, as long as the market isn't saturated) then the reinforcing positive cycle will continue, leading to more and more orders and steady
Figure 8: Salesforce (top) and Product Attractiveness (bottom) When Products Are Equally Attractive
Figure 9: Positive Feedback Loop Connecting Budgeting and Salesforce Hiring
Scenario 2 -- Introduction of an Attractive New Small System

Imagine now a more complex scenario in which the company introduces an attractive new workstation to complement its small system product line. Market analysts expect the workstation to be well received by customers and to yield more revenue per sales hour than large systems (PBXs). Moreover, because company executives are anxious to boost sales of the new workstation, it is offered with an attractive compensation package. As before, all systems are priced to produce a profit and there are many potential customers for both PBXs and the new workstations. Given these new product and incentive conditions, how will revenues and customer orders evolve over time and how will account executives allocate their time?

Figure 10 shows a six-month simulation. Orders for small systems (-1-, top) start at 70 units per month, quickly grow to a peak of almost 100 units per month by month 4, and then gradually decline. Meanwhile, orders for large systems (-1-, bottom) remain static at about 110 units per month. What's happening, and why? Figures 10 and 11 together provide an explanation. The top half of figure 11 shows the changing terms of the compensation scheme that drives salesforce time allocation. At the start of the simulation, compensation per hour (shown here as dollars per hour
Figure 10: Customer Orders and Business Sales Objectives
When Attractive New Small System is Introduced
per account executive, including indirect sales support expense) is higher for small systems (-2-, top) than for large systems (-1-, top). The imbalance occurs for two reasons. First, the compensation scheme is deliberately designed to encourage sales of small systems (workstations). Moreover, workstations are assumed to be easier to sell than PBXs -- they generate more revenue per sales hour. Not surprisingly then, account executives allocate more and more of their time to selling workstations and less to selling PBXs. The time re-allocation doesn't happen instantly though, as the lower half of figure 11 shows. The salesforce starts by allocating 10 percent of its effort to small systems (-1-, bottom) and gradually increases to 12.5 percent by month 4. This small re-allocation is sufficient to cause small system orders to increase 30 percent in only four months!

However, even as the salesforce is putting more effort into selling small systems, compensation planners are changing the terms of the compensation scheme to halt the trend. But why? The answer lies in figure 10. Orders for small systems (-1-, top) exceed the sales objective, (-2-, top) but orders for large systems are below objective. Under these conditions there is pressure for planners to increase the points awarded for the sale of large systems and decrease the points for small systems. The result is shown in figure 11. Compensation per hour for large systems (-1-, top) slowly increases while compensation per hour for small systems (-2-, top) falls. Shortly after month 4, compensation is identical
Figure 11: Compensation and Time Allocation When Attractive New Small System is Introduced
for large and small systems, so account executives are now indifferent which product they sell -- workstation or PBX! Accordingly they cease re-allocating their time, so the fraction of effort devoted to small systems (-1-, bottom) stabilizes at about 12.5 percent.

A longer, 24 month, simulation reveals some more interesting features in the new product scenario, as figure 12 shows. Orders for small systems (-1-, top) start at 70 units per month and grow rapidly to more than 100 units per month. In month 5 orders begin to decline, and fall to a minimum of 75 units per month by month 10. Then orders recover and go through another (diminished) cycle of growth and decline between months 10 and 20. By the end of the 24 month simulation, orders for small systems (-1-, top) are still fluctuating slightly, but are clearly settling at about 90 units per month, almost 30 percent higher than at the start of the simulation. The sales objective for small systems (-2-, top) rises, but only gradually because it is an average of recent customer orders. As a result of this inertia, orders for small systems exceed the sales objective during (and immediately following) any period of rapid growth in orders, as in months 0-7, and again in months 12-19.

The lower half of figure 12 shows orders (-1-, bottom) and the sales objective for large systems (-2-, bottom). One can see a very slight
Figure 12: Customer Orders and Business Sales Objectives

When Attractive New Small System is Introduced
fluctuation in orders for large systems. But the most striking feature of the simulation is that orders are almost constant at 110 units per month. Remember that in scenario 1 (balanced product portfolio) orders for large systems grew steadily from 110 units per month to 170 units per month over 24 months. The only change between scenario 1 and 2 is the introduction of a successful new workstation. The PBX system is the same as before, selling at the same price, to the same customers. Why then should the new workstation halt the growth in PBX sales?

A close look at the system's feedback structure and the conditions surrounding salespeople's time allocation gives insight into the puzzle. Figure 13 shows two feedback loops that interconnect procedures for business planning, compensation planning, salesforce time allocation and customer ordering. Together these procedures produce dysfunctional competition for sales time. The reader can trace around the feedback loops in figure 13 to understand how the competition for time occurs. Look first at the attractiveness of large systems which, at the start of the scenario, is low. Compensation per hour for small systems exceeds compensation per hour for large systems, causing account executives to shift more sales effort to small systems. As a result, orders for small systems increase unexpectedly, above the sales objective, while orders for large systems are depressed, below the sales objective. In order to correct the sales variance, compensation planners increase the points on large systems and reduce the points on small systems. The result of the points adjustment
Figure 13: Feedback Loops Connecting Compensation Planning, Time Allocation and Customer Ordering
is shown in figure 14. Compensation per hour for large systems (-1-, top) rises during months 0 through 6 while compensation per hour for small systems (-2-, top) falls. Shortly after month 4, large systems begin to look more attractive to the salesforce than small systems. Between months 4 and 9 account executives reallocate their time increasingly in favor of large systems. Orders for small systems decline while orders for large systems increase. By month 10 the sales variance situation is entirely reversed -- small system sales are now below objective (the variance problem is compounded because the business sales objective for small systems has been revised upward in light of the initial sales success) and large system sales are below objective. Compensation planners then engage in another round of points adjustment in their quest to bring orders in line with objective.

The competition for sales time has two dysfunctional effects on business performance. First, sales effort allocated to large and small systems fluctuates, playing havoc with manufacturing schedules (these effects are addressed specifically in a report D-3807 dealing with the dynamics of production scheduling). Second, the average compensation of the salesforce rises. Each round of points adjustment bids up the firm's selling expense, because compensation planners are more willing to increase points than they are to decrease them. The increase in selling expense stifles growth, by reducing the growth rate of the salesforce, as shown in figure 15. As salespeople's compensation rises, the existing
Figure 14: Compensation and Time Allocation When Attractive New System is Introduced
Figure 15: Salesforce and Budget When Attractive New Small System is Introduced
force absorbs an increasing proportion of the sales budget, leaving less for force expansion. The process reinforces itself. With lower force expansion, revenue growth is suppressed and the sales budget itself grows less quickly.

POLICIES TO IMPROVE SALES PLANNING AND CONTROL:
The net result of the system's adjustment is quite curious. The company introduces an attractive new product line that has the potential to earn more revenue per sales hour than existing products. But the product's success creates competition for salesforce time that causes an inflation of selling expense, which in turn slows sales and revenue growth. Particularly severe competition for salesforce time, stemming from the introduction of an extraordinarily successful product line, can cause such an inflation of selling expense that the company is forced to reduce the size of the salesforce, setting in motion a spiral of decline in sales effort, orders, revenue and salesforce budget!

It is useful to reflect on the policy arrangements most likely to encourage growth of orders for both large and small systems. It is obviously important to avoid excessive competition for salesforce time. One idea is to curb the rate at which compensation planners increase the points value of a product whose sales are below objective. Another idea is to adopt an aggressive hiring policy. The company should hire account executives quickly enough to allow sales of small systems to grow without cutting
into the time available for selling large systems.

Figure 16 shows a simulation that incorporates these two ideas. There is a dramatic change in behavior, which the reader can see by comparing figure 16 with figure 12 (note the scale change -- in figure 12 orders are plotted on a scale that runs from 40 to 120 units per month, whereas in figure 16 the scale runs from 0 to 320 units per month, four times the range of figure 12). The fluctuations in orders for small systems are entirely eliminated. Orders begin at 70 units per month and grow quickly and smoothly to 240 units per month in the first year of the simulation. In the second year, orders continue to grow, but at a slower rate. Meanwhile, orders for large systems decline slightly until month 15, and then begin to grow slowly.

Figure 17 shows why orders for small systems grow so much more than before. Compensation per hour for small systems starts higher than for large systems. So account executives begin to allocate more of their time to small systems. The new compensation policy allows this re-allocation to continue, because compensation planners are slower to increase the points awarded to large systems, even though large systems sales are below objective and falling. The net result is that the salesforce spends much more time selling small systems, in fact more than 30 percent of its time by the end of the run, compared with only 12 percent under the original compensation policy. From a corporate perspective this result
Figure 16: Customer Orders and Business Sales Objectives With Improved Sales Planning and Control Policies
Figure 17: Compensation and Time Allocation with Improved Sales Planning and Control Policies
makes sense. Since small systems generate more revenue per sales hour than large systems (by assumption), the company earns more revenue the more time its salesforce spends selling small systems.

Of course, large system sales are depressed, but two factors are at work to limit the decline. First, because total revenue (from both large and small systems) is more than before, the salesforce budget is therefore larger. This factor, by itself, allows more account executives to be hired. So, even though the proportion of time allocated to selling large systems is smaller than before, there are more total sales hours available. Second, because the new hiring policy is more aggressive, the salesforce is expanded more rapidly than before and so again, more total sales hours are available. The reader can see the boost in salesforce growth clearly by comparing figure 18 with figure 15 (the figures use the same scales for budget and for salesforce). In figure 18, the budget for the salesforce grows from $2.45 million to almost $2.8 million in the first year of the simulation. The salesforce grows steadily from 60 to 70 people over the same period. By contrast in figure 15, under the old compensation and hiring policies, the budget grows from $2.45 million to only $2.5 million and the salesforce stays almost constant at 60 people in the first year of the simulation.

Several general policy lessons emerge from the model. First, in businesses that rely on a direct sales force to generate orders, the success of a given
Figure 18: Salesforce and Budget with Improved Sales Planning and Control Policies
product line depends not only on customers' preferences, but also on account executives' preferences. Customers of course choose between the products of several competing companies -- a choice based on an external market comparison of factors such as price, quality and availability. Account executives however choose between the product lines of their own company, a choice based on an internal, non-market comparison of the payoff from selling different product lines. The distinction is crucial. A company must manage not only the external attractiveness of its products, but also their internal attractiveness to the salesforce. Even with competitive prices, a product line may fail to sell if the compensation scheme deters account executives from showing the product to customers.

The design of the compensation scheme therefore deserves close attention. All compensation schemes tend to equalize the payoff to account executives of the company's different product lines -- if they didn't then eventually account executives would allocate 100 percent of their time to the product line with the highest payoff. This tendency to equalize payoff must be understood and managed. One doesn't want the equalization to occur too quickly, otherwise the growth of promising new product lines may be stifled and sales expense may escalate. On the other hand, one doesn't want the equalization to occur too slowly, otherwise the factories may be flooded with orders for the product with the highest payoff, and salestime for the company's staple product lines may be cut excessively. The simulations show two policy parameters that should receive
management attention -- the speed at which compensation planners adjust points when sales are below (or above) objective, and the speed with which new account executives are hired when the budget authorizes a salesforce expansion. When a company's product lines are changing frequently, then points should adjust slowly and account executives should be hired aggressively to encourage sales and revenue growth.

The discussion so far is indicative of how the model can be used for policy design. There are undoubtedly further simulation experiments that can be carried out to explore other aspects of sales planning and control policy. For example, one might explore the effect of increasing or reducing the rigidity of corporate sales objectives and of increasing or reducing the size of the 'stretch' objective. One might explore the effect of strict budget controls on compensation planning. The model should be viewed as a laboratory for testing new policy proposals and comparing the simulated outcome with management intuition.
BACKGROUND READINGS IN SYSTEM DYNAMICS


DOCUMENTATION OF THE SALESFORCE
TIME ALLOCATION MODEL

Policy Structure of Salesforce Time Allocation Model
STELLA Diagram of Sales Planning and Control for Large Systems
STELLA Diagram of Revenue Procedures
STELLA Diagram of Sales Planning and Control for Small Systems
STELLA Diagram of Budgeting and Hiring (Also Showing Performance Indicators)
STELLA Equation Listing
Description of Parameter Changes for Simulation Scenarios
Figure 19: Policy Structure of Salesforce Time Allocation Model
Figure 20: STELLA Diagram of Sales Planning and Control for Large Systems
Figure 21: STELLA Diagram of Revenue Procedures
Figure 22: STELLA Diagram of Sales Planning and Control for Small Systems
Figure 23: STELLA Diagram of Budgeting and Hiring
(Also Showing Performance Indicators)
STEELA Equation Listing of Salesforce Time Allocation Model
D-3806

- \( \text{cpl} = (\text{ipl} - \text{pls})/\text{tcp} \)
- \( \text{cpps} = (\text{ipss} - \text{pss})/\text{tcp} \)
- \( \text{csf} = (\text{esf} - \text{sf})/\text{tasf} \)
- \( \text{dvp} = \text{INIT}(\text{bsf})/((\text{INIT}(\text{coss}) \ast \text{INIT}(\text{pss})) + (\text{INIT}(\text{cols}) \ast \text{INIT}(\text{pls})) \ast (1 + \text{igb})) \)
- \( \text{etsls} = \text{tsls} \)
- \( \text{etsss} = \text{tsss} \ast \text{wts} + \text{xtsss} \ast (1 - \text{wts}) \)
- \( \text{igb} = 0.1 \)
- \( \text{ipl} = \text{pls} \ast \text{mppls} \)
- \( \text{ipss} = \text{pss} \ast \text{mppss} \)
- \( \text{pass} = (\text{pss} / \text{etsss}) / (\text{pls} / \text{etsls}) \)
- \( \text{phls} = \text{pls} / \text{etsls} \)
- \( \text{phss} = \text{pss} / \text{etsss} \)
- \( \text{pols} = \text{cols} / \text{bsols} \)
- \( \text{poss} = \text{coss} / \text{bsoss} \)
- \( \text{rcrls} = \text{rhls} / \text{chls} \)
- \( \text{rcrss} = \text{rhss} / \text{chss} \)
- \( \text{rfrs} = \text{tsc} / \text{sr} \)
- \( \text{rhls} = \text{mpls} / \text{etsls} \)
- \( \text{rhss} = \text{mpss} / \text{etsss} \)
- \( \text{sels} = \text{tse} \ast (1 - \text{fsess}) \)
- \( \text{sess} = \text{tse} \ast \text{fsess} \)
- \( \text{shsm} = 150 \)
- \( \text{sm} = 0 \)
- \( \text{sr} = (\text{coss} \ast \text{apss}) + (\text{cols} \ast \text{apls}) \)
- \( \text{tasf} = 3 \)
- \( \text{tasr} = 6 \)
- \( \text{tcp} = 3 \)
- \( \text{tebf} = 24 \)
- \( \text{tecso} = 6 \)
- \( \text{tsc} = (\text{coss} \ast \text{pss}) + (\text{cols} \ast \text{pls}) \ast \text{dvp} \)
- \( \text{tse} = \text{sf} \ast \text{shsm} \)
- \( \text{tsls} = 75 \)
- \( \text{tsss} = 13 \)
- \( \text{xtsss} = 13 \)

STELLA Equation Listing Continued
\(\text{cfpa} = \text{graph(pass)}\)
\[
\begin{array}{l}
0.0 \rightarrow -2.500 \\
0.200 \rightarrow -1.700 \\
0.400 \rightarrow -1.100 \\
0.600 \rightarrow -0.600 \\
0.800 \rightarrow -0.250 \\
1.000 \rightarrow 0.0 \\
1.200 \rightarrow 0.250 \\
1.400 \rightarrow 0.600 \\
1.600 \rightarrow 1.100 \\
1.800 \rightarrow 1.700 \\
2.000 \rightarrow 2.500 \\
\end{array}
\]

\(\text{mppls} = \text{graph(pols)}\)
\[
\begin{array}{l}
0.500 \rightarrow 1.500 \\
0.600 \rightarrow 1.450 \\
0.700 \rightarrow 1.400 \\
0.800 \rightarrow 1.250 \\
0.900 \rightarrow 1.100 \\
1.000 \rightarrow 1.000 \\
1.100 \rightarrow 0.960 \\
1.200 \rightarrow 0.930 \\
1.300 \rightarrow 0.910 \\
1.400 \rightarrow 0.900 \\
1.500 \rightarrow 0.900 \\
\end{array}
\]

\(\text{mppss} = \text{graph(poss)}\)
\[
\begin{array}{l}
0.500 \rightarrow 1.500 \\
0.600 \rightarrow 1.450 \\
0.700 \rightarrow 1.400 \\
0.800 \rightarrow 1.250 \\
0.900 \rightarrow 1.100 \\
1.000 \rightarrow 1.000 \\
1.100 \rightarrow 0.960 \\
1.200 \rightarrow 0.930 \\
1.300 \rightarrow 0.910 \\
1.400 \rightarrow 0.900 \\
1.500 \rightarrow 0.900 \\
\end{array}
\]

\(\text{wts} = \text{graph(acoss)}\)
\[
\begin{array}{l}
0.0 \rightarrow 0.0 \\
100.000 \rightarrow 0.095 \\
200.000 \rightarrow 0.200 \\
300.000 \rightarrow 0.335 \\
400.000 \rightarrow 0.500 \\
500.000 \rightarrow 0.800 \\
600.000 \rightarrow 0.970 \\
700.000 \rightarrow 1.000 \\
800.000 \rightarrow 1.000 \\
900.000 \rightarrow 1.000 \\
1000.000 \rightarrow 1.000 \\
\end{array}
\]

STELLA Equation Listing Continued
Definitions

ACOSS  Accumulated Orders for Small Systems (Orders)
ASR    Average Sales Revenue (Dollars/Month)
BOLS   Base Orders for Large Systems (Orders/Month)
BOSS   Base Orders for Small Systems (Orders/Month)
FRS    Fraction of Revenue to Sales (Dimensionless)
FSESS  Fraction of Sales Effort to Small Systems (Dimensionless)
PLS    Points for Large Systems (Points/System)
PSS    Points for Small Systems (Points/System)
SF     Salesforce (Account Executives)
ACS    Average Compensation Per Salesperson (Dollars/Account Executive/Month)
APLS   Average Price of Large Systems (Dollars/System)
APSS   Average Price of Small Systems (Dollars/System)
ASF    Authorized Salesforce (Account Executives)
BSF    Budget for Salesforce (Dollars/Month)
BSOLS  Business Sales Objective for Large Systems (Orders/Month)
BSOSS  Business Sales Objective for Small Systems (Orders/Month)
CASR   Change in Average Sales Revenue (Dollars/Month/Month)
CBOLS  Change in Base Orders for Large Systems (Orders/Month/Month)
CBOSS  Change in Base Orders for Small Systems (Orders/Month/Month)
CFRS   Change in Fraction of Revenues to Sales (Fraction/Month)
CFSESS Change in Fraction of Sales Effort to Small Systems (Fraction/Month)
CHLS   Compensation Per Hour for Large Systems (Dollars/Hour)
CHSS   Compensation Per Hour for Small Systems (Dollars/Hour)
COLS   Customer Orders for Large Systems (Orders/Month)
COSS   Customer Orders for Small Systems (Orders/Month)
CPLS   Change in Points for Large Systems (Points/System/Month)
CPSS   Change in Points for Small Systems (Points/System/Month)
CSF    Change in Salesforce (Account Executives/Month)
DVP    Dollar Value of Points (Dollars/Point)
ETLS   Estimated Time to Sell Large Systems (Hours/System)
ETSS   Estimated Time to Sell Small Systems (Hours/System)
IGB    Initial Growth Bias (Dimensionless)
IPLS   Indicated Points for Large Systems (Points/System)
IPSS   Indicated Points for Small Systems (Points/System)
PASS   Perceived Attractiveness of Small Systems (Dimensionless)
PHLS   Points Per Hour for Large Systems (Points/Hour)
PHSS   Points Per Hour for Small Systems (Points/Hour)
POLS   Performance Against Objective for Large Systems (Dimensionless)
POSS   Performance Against Objective for Small Systems (Dimensionless)
RCRLS  Revenue to Compensation Ratio for Large Systems (Dimensionless)
RCRSS  Revenue to Compensation Ratio for Small Systems (Dimensionless)
RFRS   Reported Fraction of Revenue to Sales (Fraction/Month)

Definition of Variable Names
<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RHLS</td>
<td>Revenue Per Hour for Large Systems (Dollars/Hour)</td>
</tr>
<tr>
<td>RHSS</td>
<td>Revenue Per Hour for Small Systems (Dollars/Hour)</td>
</tr>
<tr>
<td>SELS</td>
<td>Sales Effort for Large Systems (Hours/Month)</td>
</tr>
<tr>
<td>SESS</td>
<td>Sales Effort for Small Systems (Hours/Month)</td>
</tr>
<tr>
<td>SHSM</td>
<td>Standard Hours Per Salesperson Month (Hours/Account Executive/Month)</td>
</tr>
<tr>
<td>SM</td>
<td>Stretch Margin (Dimensionless)</td>
</tr>
<tr>
<td>SR</td>
<td>Sales Revenue (Dollars/Month)</td>
</tr>
<tr>
<td>TASF</td>
<td>Time to Adjust Salesforce (Months)</td>
</tr>
<tr>
<td>TASR</td>
<td>Time to Adjust Sales Revenue (Months)</td>
</tr>
<tr>
<td>TCP</td>
<td>Time to Change Points (Months)</td>
</tr>
<tr>
<td>TEBF</td>
<td>Time to Establish Budget Fraction (Months)</td>
</tr>
<tr>
<td>TECSEO</td>
<td>Time to Establish Corporate Sales Objective (Months)</td>
</tr>
<tr>
<td>TSC</td>
<td>Total Salesforce Compensation (Dollars/Month)</td>
</tr>
<tr>
<td>TSE</td>
<td>Total Sales Effort (Hours/Month)</td>
</tr>
<tr>
<td>TSLS</td>
<td>Time per Sale of Large Systems (Hours/System)</td>
</tr>
<tr>
<td>TSSS</td>
<td>Time Per Sale of Small Systems (Hours/System)</td>
</tr>
<tr>
<td>XTSS</td>
<td>Expected Time Per Sale of Small Systems (Hours/System)</td>
</tr>
<tr>
<td>CFPA</td>
<td>Change in Fraction from Perceived Attractiveness (1/Month)</td>
</tr>
<tr>
<td>MPPLS</td>
<td>Multiplier from Performance on Points for Large Systems (Dimensionless)</td>
</tr>
<tr>
<td>MPPSS</td>
<td>Multiplier from Performance on Points for Small Systems (Dimensionless)</td>
</tr>
<tr>
<td>WTS</td>
<td>Weight for Time Per Sale (Dimensionless)</td>
</tr>
</tbody>
</table>

Definition of Variable Names -- continued
DESCRIPTION OF PARAMETER CHANGES FOR SIMULATION SCENARIOS

Scenario 1 -- "Test Drive" Balanced Product Portfolio (Model stam_scen1)

Four conditions are required to produce the test drive scenario:

1. Large and small systems yield the same revenue per sales hour.

Revenue per sales hour for a given product line is computed by dividing the product's price by the time per sale. So in order to set up condition 1, one must arrange the following equality:

\[
\frac{\text{average price of large systems}}{\text{time per sale of large systems}} = \frac{\text{average price of small systems}}{\text{time per sale of small systems}}
\]

or

\[\text{apl}_s/\text{ts}_s = \text{apss/tss}
\]

The parameter values used in the paper were:

- \(\text{apl}_s = \$100,000\) per large system, \(\text{ts}_s = 75\) hours per large system
- \(\text{apss} = \$20,000\) per small system, \(\text{tss} = 15\) hours per small system

With these parameter values, revenue per sales hour is \$1333\) for both large and small systems.

2. Large and Small Systems are Equally Attractive to Account Executives

For condition 2, account executives must earn equal points per hour for selling large or small systems.

The parameters one must set to generate this condition are:

- Initial value of points for large systems \(\text{INIT}(\text{pl}_s)\)
- Initial value of points for small systems \(\text{INIT}(\text{pss})\)
- Time per sale of large systems \(\text{ts}_s\)
- Time per sale of small systems \(\text{tss}\)
The parameter values chosen were:
INIT(pls) = 25,000 points per large system
INIT(pss) = 5,000 points per small system
tsls = 75 hours per large system
tsss = 15 hours per small system
With these parameters, account executives receive 333 points per hour for selling either large or small systems (e.g. INIT(pls)/tsls = 25,000/75)

3. Orders for Large and Small Systems Equal to the Sales Objective
Consider first the case of large systems. For condition 3 to apply to large systems then customer orders for large systems cols must equal the business sales objective for large systems bsols. One can trace through the model's algebra to find the initial parameter values that generate this equality.
cols = sels/tsls and bsols = bols *(1+sm) where:
cols - customer orders for large systems
sels - sales effort to large systems
tsls - time per sale for large systems
bsols - business sales objective for large systems
bols - base orders for large systems
sm - stretch margin
So for condition 3,
bols = sels*(1+sm)/tsls and INIT(bols) = sels*(1+sm)/tsls
If the stretch margin sm is set to zero, which it is in all the runs
described in the report, then condition 3 is satisfied when the initial value of base orders for large systems is:

\[ \text{INIT(bols)} = \frac{\text{sels}}{\text{etsls}} \]

4. Products Priced to Generate a Profit and Many Potential Customers

Condition 4 is really two separate sub-conditions. First, products are priced to generate a profit. This means that the price of both large and small systems is set so that each additional account executive adds more revenue to the sales budget than he takes from the budget in compensation. This sub-condition is guaranteed by the equation for dollar value of points, \( dvp \)

\[ dvp = \frac{\text{INIT(bsf)}}{\left(\text{INIT(coss)} \times \text{INIT(pss)}\right) + \left(\text{INIT(cols)} \times \text{INIT(pls)}\right) \times (1 + \text{igb})} \]

where:

- \( dvp \) - dollar value of points
- \( bsf \) - budget for salesforce
- \( coss \) - customer orders for small systems
- \( pss \) - points for small systems
- \( cols \) - customer orders for large systems
- \( pls \) - points for large systems
- \( igb \) - initial growth bias

When the initial growth bias \( igb \) is greater than zero (it is set at a value of .1 in all the simulations shown in the report), then the dollar value of points \( dvp \) takes a value which ensures that account executives'
compensation is less than the revenue contribution they make to the sales budget. This sub-condition ensures that the salesforce will grow initially, because the sales budget is greater than the salesforce expense, so more account executives are hired, leading to more customer orders, more revenue, a larger salesforce budget and more hiring.

The second sub-condition, many potential customers, is generated automatically if the time per sale of large and small systems is fixed and if the first sub-condition is true. When time per sale is fixed and the salesforce is growing, then customer orders will also grow -- in other words, there are many potential customers.

**Scenario 2 -- Introduction of an Attractive New Small System**_(Model stam_scen2a and stam_scen2b)_

Scenario 2 is generated by lowering both the expected time per sale of small systems xtssss and the time per sale of small systems tssss and also by re-initializing base orders for large systems bols INIT(bols). The new parameters are shown below.

expected time per sale of small systems xtssss = 13 hours per system  
(15 hours per system in scenario 1)
time per sale of small systems tssss = 13 hours per system  
(15 hours per system in scenario 1)
INIT(bols) = ((tse*.5) + (sels*.5))/etsls  
(sels/etsls in scenario 1)
The reduction of time per sale of small systems has two principal effects. First, revenue per sales hour of small systems is $1538 (20,000/13) instead of $1333. So small systems now generate more revenue per sales hour than large (large systems still generate $1333 per hour). Second, account executives initially receive 385 points per hour (5000/13) for selling small systems instead of 333 points per hour. So they now find small systems more attractive to sell than large (large systems still yield 333 points per hour).

The new initial value of base orders for large systems INIT(bols) causes the initial business sales objective for large systems to exceed customer orders for large systems. The new initial value of base orders is a weighted average of the orders that would be expected if 100 percent of sales effort (in other words if the total sales effort tse) were devoted to large systems and the orders that would be expected from the current sales effort devoted to large systems (sels). The idea is to capture the inertia in the sales objective for large systems. When the new small system is introduced, it will absorb sales time, but the sales objective for large systems will not decline to account for the fact that correspondingly less time is being spent selling large systems. The result is a 'tension' in the company’s sales objectives.

Policies to Improve Sales Planning and Control (Model stam_pol)
Three parameter changes are used to represent the policies to improve
sales planning and control. The changes are shown below and contrasted with the values used in scenario 2.

time to adjust salesforce \( tasf = 2 \text{ months} \) (3 months in scenario 2)
time to correct points \( tcp = 12 \text{ months} \) (3 months in scenario 2)
time to establish corporate sales objective \( tecso = 3 \text{ months} \) (6 months in scenario 2)

The reduction in the time to adjust the salesforce (tasf) from 3 months to 2 months represents a more aggressive hiring policy. The increase in time to correct points (tcp) from 3 months to 12 months represents a less responsive compensation planning procedure that only gradually increases product points when sales are below objective. The reduction of time to establish corporate sales objective (tecso) from 6 months to 3 months represents a procedure for more frequent review and adjustment of sales objectives.

**Scenarios for Unexpectedly Good or Unexpectedly Bad New Products**

It is possible to use the model to examine the introduction of new products which are unexpectedly good (they are easier to sell than expected) or unexpectedly bad (they are more difficult to sell than expected). To do so one needs to set the parameter for expected time per sale of small systems \( xtsss \) at a value that differs from the time per sale of small systems \( tsss \). Consider first an "Edsel" scenario -- a new product is introduced which many people in the company expect to be a success in the market, but which turns out to be a flop.
xtsss = 13 hours per system -- people expect the product to be easy/quick to sell

tsss = 17 hours per system -- the product turns out to take longer to sell than expected

Note that a small system is 'neutral' (neither a success or failure) when it takes 15 hours to sell, because then the new system generates the same revenue per sales hour and the same number of points per sales hour as large systems, as in scenario 1.

Consider next a new small system which turns out to be a surprising success.

xtsss = 15 hours per system -- people expect the product to be 'neutral'

tsss = 13 hours per system -- the product turns out to sell quicker than expected.