

Investigating the Effect of Account Receivable & Delivery Delay on the Profitability of a Medical Department -Siemens Case-

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Abstract

This study focuses on the problem of getting Account Receivables and delivering products/ systems on time for the Medical Department of Siemens Turkey. The Balanced Scorecard approach was used as a base platform which served as a decomplexifying element for the initial modeling tangle. In the department, there are salespeople who does the sales via monthly visits to customers. After collecting the orders, they follow some processes. When the order is delivered, the payment does not occur immediately, especially for the state customers and there exists an oscillating delivery time. This simulation model achieves giving the knowledge and ability to the managers to make plans accordingly. Having seen the outputs, they organize their plans pre-active, but not reactive in the long term. The project had one more tenet which is launching the system dynamics approach internally and making managers use it as their regular thinking style.

1. System Dynamics Methodology

Despite the growth and acceptance of System Dynamics, it is far from being well-known as a field itself or as a contribution to the fields in which it is used.

When we look at a group of individual parts, as well as the connections or interactions among those parts, we are viewing a “system”. A system is a collection of parts that work together in order to function as a whole. In all systems the relationship between the parts determine what the system does and how it functions as a whole. Therefore the relationships are often more important than the individual parts.

Many of the systems we are part of are *dynamic* rather than *static*. They tend to change throughout the passage of time. It is referred to the way a system changes over time as the systems *behavior*. And when a system’s development follows a typical pattern, we say the system has a behavior pattern. Effective decision making and learning in a world of growing *dynamic complexity* requires us to become systems thinkers. Whether a system is dynamic or static depends on which *time horizon* you choose and which *variables* you concentrate on. The time horizon is the time period over which you study the system and a variable is a changeable value in a system. [9]

1.1 Application Areas of System Dynamics

The field of system dynamics is thriving. Over the past decade, many top companies, consulting firms or NGOs have used system dynamics to address critical issues. Tools and methods of it and the library of applications and insights into the effective use of the tools with senior executives and organizations are all expanding rapidly.

Since its publication, the span of applications has grown extensively ranging in a very large spectrum. To name some of them:

- Business
- Biological problems
- Corporate and business planning and policy design
- Medical modelling
- Strategic quality management
- Long-term water planning
- Strategic insurance management
- Education

2. Balanced Scorecard Approach

The Balanced Scorecard is a popular concept which focuses on management' attention to few measures and bridges between different functional areas. [8] In other words the Balanced Scorecard (BSC) is a proven approach to strategic management that imbeds long-term strategy into the management system through the mechanism of measurement. For years, senior leaders have struggled to use financial-driven performance management systems to achieve operational and strategic goals such as adjusting the workforce level, reducing the delivery delay or increasing/decreasing the capacity.

In essence, a corporate scorecard is a sophisticated business model that helps a company or a department understand what's really driving its success. We can only get success on the drives that we can actually measure. Unfortunately, the things most companies measure (short-term financial performance and local productivity) don't determine long-term success in a competitive marketplace, in other words sustainable success on the metrics.

BSC structure is chosen as it is among the most famous performance management systems and tried to be the main thinking base of the model that we have created and shown in the next sections. In Fig.1 lies the general framework for Balanced Scorecard (BSC).



Figure.1 Business Scorecard View [1]

In order to achieve and sustain strategic success via operational excellence, the corporate /department performance management system must balance on the basis of the following measures:

- **Customer metrics**
How the customers view the corporate (for e.g. in terms of satisfaction and loyalty)
- **Business process metrics**
How well the core processes of the corporate produce value
- **Internal development metrics**

How your company learns and grows

- **Financial metrics**

How well your company meets shareholder needs

The performance management systems follow an approach as described in Figure.2

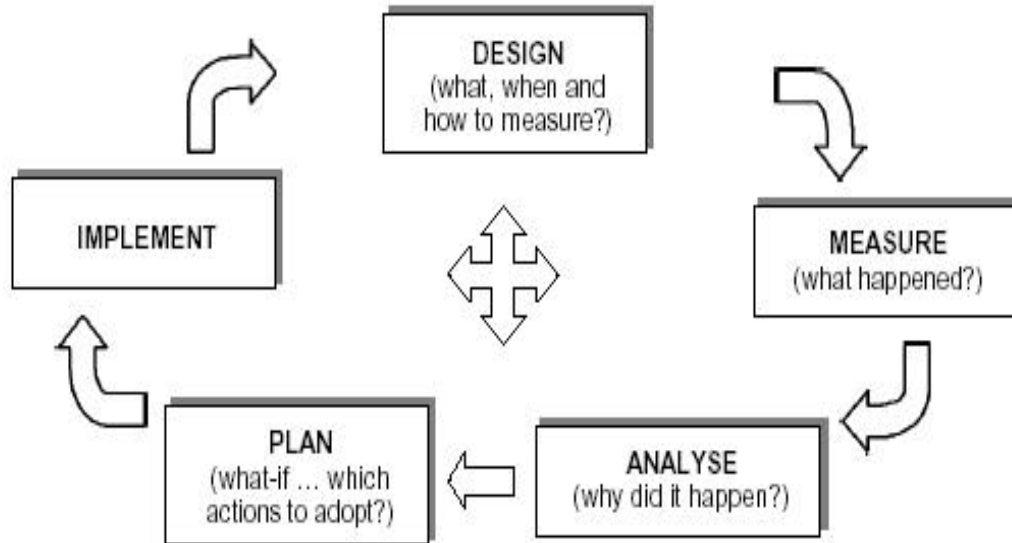


Figure.2 DMAPI Cycle [10]

What is actually desired to achieve In this project is to use BSC as a basis platform for the model.

The model comprises of three main compartments:

- Employees
- Market and Finance
- Internal Processes

By the help of these segments, we come up with a model that is formed on basic business

As the Figure.2 shows, the model had basic 5 phases. We designed the relations and internal structure that gives the dynamic behavior of the system. We have carried out base runs to see what goes on with the current structure and validated the model with the real life. Then we have analysed what to change and how to change. After the model has been completed, implementation has been activated by launching the model to the senior managers' PCs.

3. Problem Environment & Definition

Siemens Turkey provides complete health care solutions and support diagnoses and therapy in hospitals. Today, Siemens Turkey Medical Solutions (MED) is considered to be the market leader in the domestic market. The department offers the medical profession and its patients, the medical systems, devices and services in Turkey and all over the world. They have a wide range of products from x-ray, angiography and ultrasound systems to computerised tomography, magnetic resonance, nuclear medicine, echocardiography and radiotherapy. The field of expertise is in imaging techniques, elaborate artificial respiration, anaesthesia equipment and patient monitors.

Among all, Ultrasound (US) is the most common diagnostic procedure in medical industry and most innovative modality/product. Ultrasound is a very fast business and has a 5bn \$ total worldwide market.

Siemens TR-MED constitutes of several departments which serve different needs of the market on the basis of both product and service. MED-US is one of them and they handle the product business of Ultrasound section. They just do the sales transactions and service part is carried on with the help of another department.

Roughly speaking, MED-US have sales people who handle the sales of the product. They have monthly on-call visits to customers and take the orders. Then these orders are transferred to the department's ordering section and they order the product from Siemens-Germany. There is no domestic production of US machines and there is very little inventory. The receiving time of the product from Germany has some time periods. The product's coming to the customs, waiting in the customs and receiving of the product to the department. Having got the order, MED-US starts installing the machine locally. After that, the order is fulfilled and sent to the customer. After some start-up procedures and tests carried out in the customer's place, it is claimed to be ready for use.

After getting the order, they sign up a contract with the customer which says that the payment would be done within a specified time length. They have a various type of customer structure. Briefly, we can separate them as private and public customers. They have different contract options for the customers based on private or public. Public customers do not make agreements on foreign currency which is described by the law. They just sign up Turkish Lira figures and this creates currency costs. However, the private customers can have agreements on €

Their customers are mainly the hospitals which can be classified as:

1. University Hospitals
2. Private Hospitals
3. Military Hospitals
4. Social Security Hospitals (SSK)

5. Ministry of Health Hospitals

They have 3 or 4 big competitors in the market and MED-US thinks that they would create value added by their pre-defined processes which covers technology, marketing, cost/ price, services and time/ logistics.

In order to sustain and even enlarge their market share, they think they have to overcome their basic two problems. They complain about their long receiving time of the Account Receivables and current long delivery delays which reveal problems in managing cash flow and sustaining **EVA** for the profitability of the department. This requires continuous monitoring of the account receivables and delivery delays. As they owe debt to the firm's cash for their all kinds of costs, they desire to be profitable throughout the fiscal year. As a matter of fact, they need to make strategic plans for the upcoming years and for these plans they need to monitor their future *Account Receivable* and *delivery delay* figures. Delivery delay is also the second most important criteria evaluated in the "Customer Satisfaction" questionnaire which dictates that it is among the differentiating factors of competitiveness.

By making plans, they would be able to arrange their sales employment levels, contract options and fulfilling capacity. Having seen the outputs, we plan to make their plans pre-active, but not reactive.

4. Conceptual Model

After having carried out 2 interviews with MED-US, the general structure of the department has been explained in details. The conceptual model has been drawn after arranging these interviews and synthesizing the articles that are listed in the references part. These papers helped much in forming a mental model for us. (Please see Fig.3)

The deliver delay affects the incoming order efficiency which is in fact the sales efficiency of the sales people. Orders in Process (OIP) is the current amount of orders that is in process and it is affected by the order fulfilling and order entering. Delivery delay is also used in finding Perceived delivery delay which in turn affects order efficiency.

We have also Possible target delivery rate which affects the fulfilling capacity. Fulfilling capacity is thought to be an importing and fulfilling capacity. It is different than a production capacity.

Account Receivables' (AR) outflow is affected by Deliver delay (the receiving rate of AR) and orders fulfilling affects the incoming rate of AR. AR and monthly interest rates give feedback to the profitability which gives us an insight about hiring decision of Sales Experts.

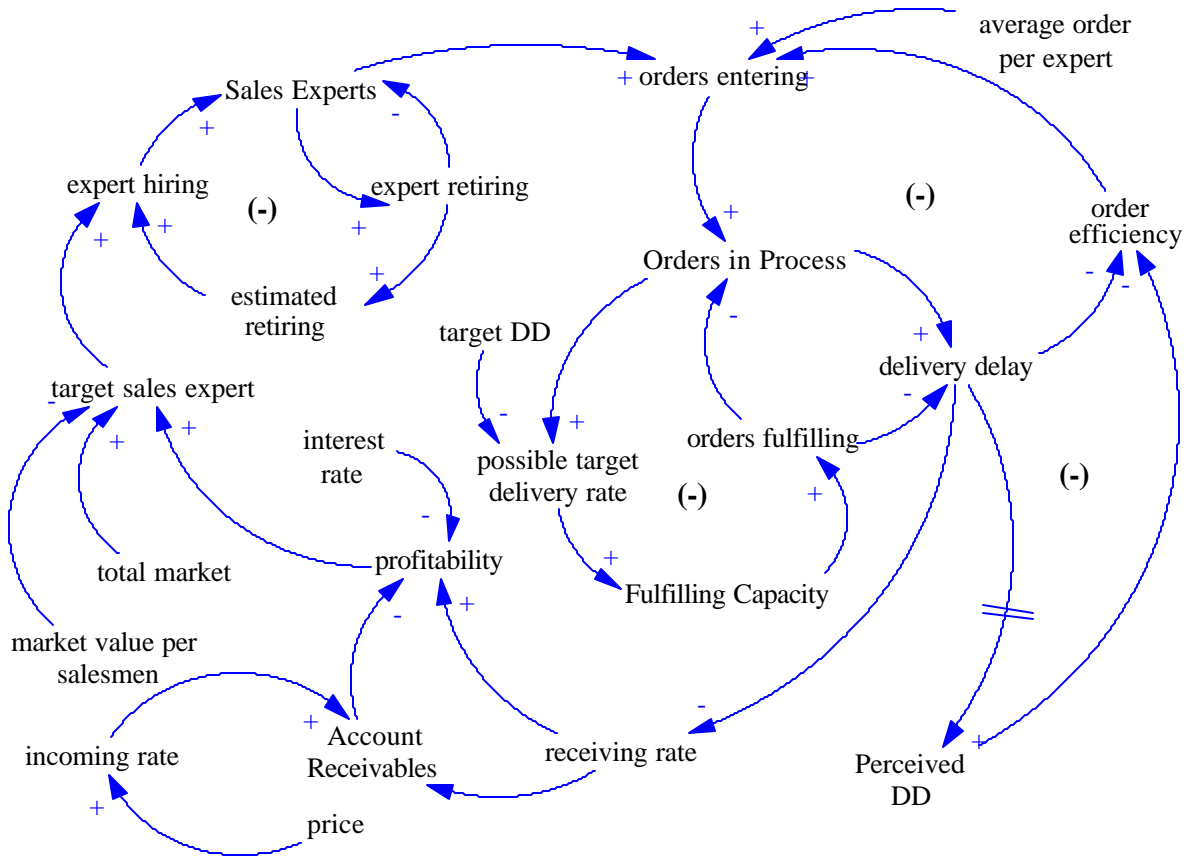


Figure.3 Model Causal Loop Diagram [2],[3],[4],[5],[6],[7],[8],[9],[10],[11],[12],[13],[14],

Throughout the modeling process, Balanced Scorecard (BSC) approach has been applied as the basic constructing material. The main 4 compartments of BSC constituted the content of the model. You can see the conceptual model in Figure.3 with the articles I have benefited from.

5. Stock & Flow Structure

Having completed the conceptual model, we completed the stock flow structure of the model. You may find the stock-flow definitions below.

5.1 Stock Variables

Account Receivables: This variable represents the amount of account receivables of company (department). It is obvious that this variable must be a stock variable. Related flow variables are incoming rate and receiving rate.

Unit: Euros (€)

Fulfilling Capacity: This is the order fulfilling capacity of the department. It has the unit "piece per time", Related flow variable is capacity change rate.

Unit: piece/month

Orders In Process: This variable represents the number of orders received but not fulfilled yet. Related flow variables are orders coming and orders fulfilling.

Unit: Item

Perceived DelDel: This is the perceived delivery delay of the company. It was added in order to represent an information delay between the actual and perceived values of delivery delay. Related flow variable is adjustment flow.

Unit: months

Sales Experts: This variable represents the number of sales person working for the department. Note that it can have non-integer values. One may think that this is unrealistic, since number of sales experts hardly exceeds 10. However at Siemens, when a personnel assists more than one task, his/her is shared among these tasks. For example, 2.35 sales persons means that in addition to 2 employees who spent full of their time on the sales, another person spends 35% of his time assisting sales. So, such non-integer values of employees are completely realistic. Related flow variables are expectedly hiring and retiring.

Unit: Persons

Ultrasound machines are not domestically manufactured. They are imported from Germany. In a way we can say that, TR-MED department works import-to-order. There is very little or negligible side product inventory. In this model, we assumed no inventory.

5.2 Flow Variables

Hiring: Number of sales persons hired per month (person/month)

Retiring: Number of sales persons retired per month (person/month)

Incoming rate : Receivables are expanded by the *fulfilled* orders in the month. (Euro/month)

Receiving rate: Amount of receivables collected in the month. (Euro/month)

Orders coming: Amount of orders taken in the month (piece/month)

Orders fulfilling: Amount of orders fulfilled in the month. (piece/month)

Capacity change rate: Amount of capacity change in the month. (piece/month)

Adjustment flow: Change in perceived delivery delay in the month. (1/month*month)

5.3 Some Important Auxiliary Variables

Prof = prof margin* receiving rate – monthly interest rate* Account Receivables.

This is a measure for efficiency of the department. Note that it does not reflect the exact profit of the department. First term represents the cash generated by the sales activity and the second term represents the opportunity cost of not receiving the money on time. (Euro/month)

Order Fulfilling Time: This is the average time needed for an order to be fulfilled.

One can see the details of the equations and input functions in the Appendix.

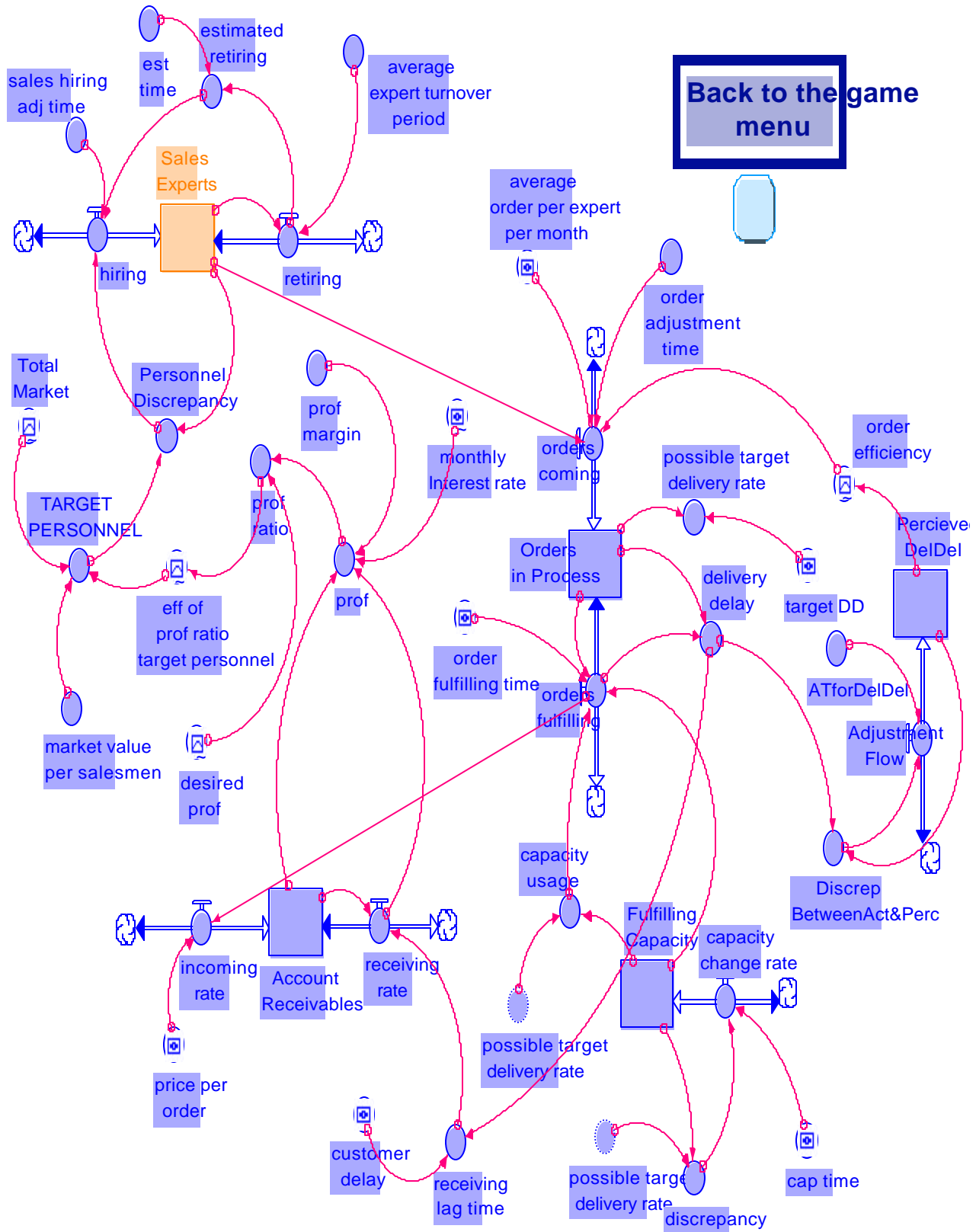


Figure.4 Stock Flow Diagram

6. Simulation and Validation

Simulations are done for 10 years of which 7 years are to the future. In other words the simulation ends up on 2010. In addition simulations are done on a monthly basis. Here are the most relevant results:

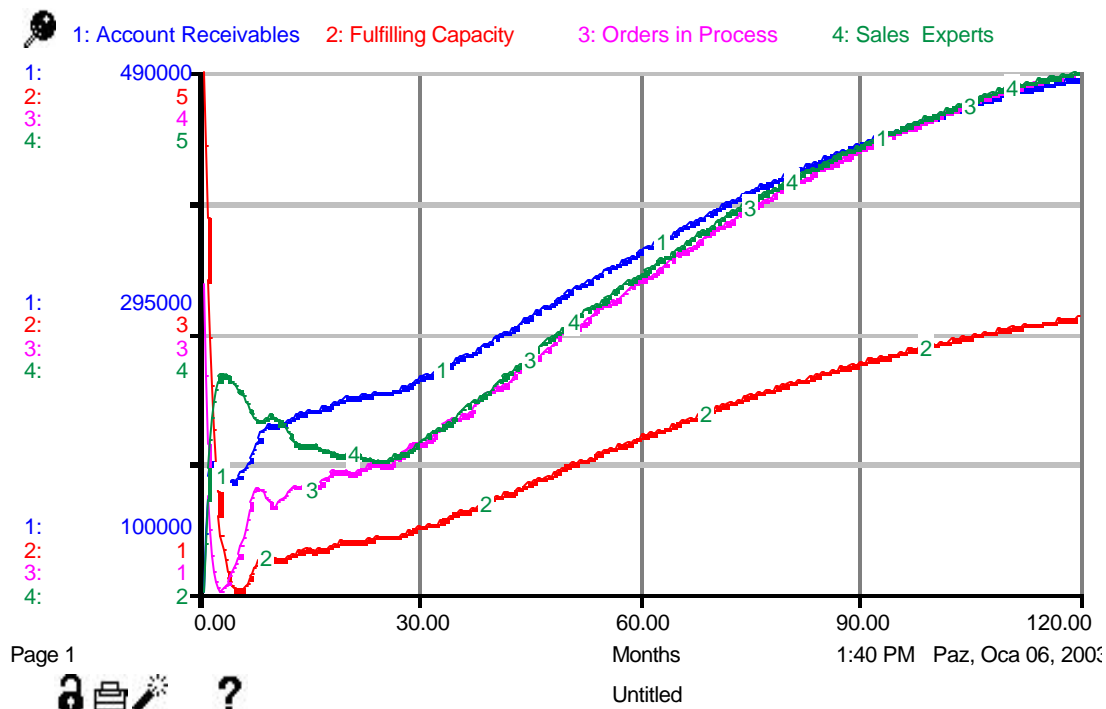


Figure.5 Account Receivables, Capacity, Orders (OIP) and Sales Experts

Expectedly fulfilling capacity gets enlarged because of the enlargement of the sales expert. And the market for Ultrasound seems to be growing in real life. This is reflected to the model and Account Receivables enlarge accordingly due to the enlargement of the market. OIP also gets high at the end of the 10th year. Delivery delay shows a damping oscillatory behaviour after the 30th month.

Delivery delay seems to be oscillating much in the first 60 months. Perceived Delivery Delay follows delivery delay with a lag which was designed to get this result. The simulation results in fact coincide with the real observations because delivery suspends somewhere among 1-1.5 month. As the graph shows below, it mostly oscillates in the range of 1.25-1.31 month. In other words the oscillation in fact does not indicate that much significance because the range is 1 or 1.5 days which can be tolerated.

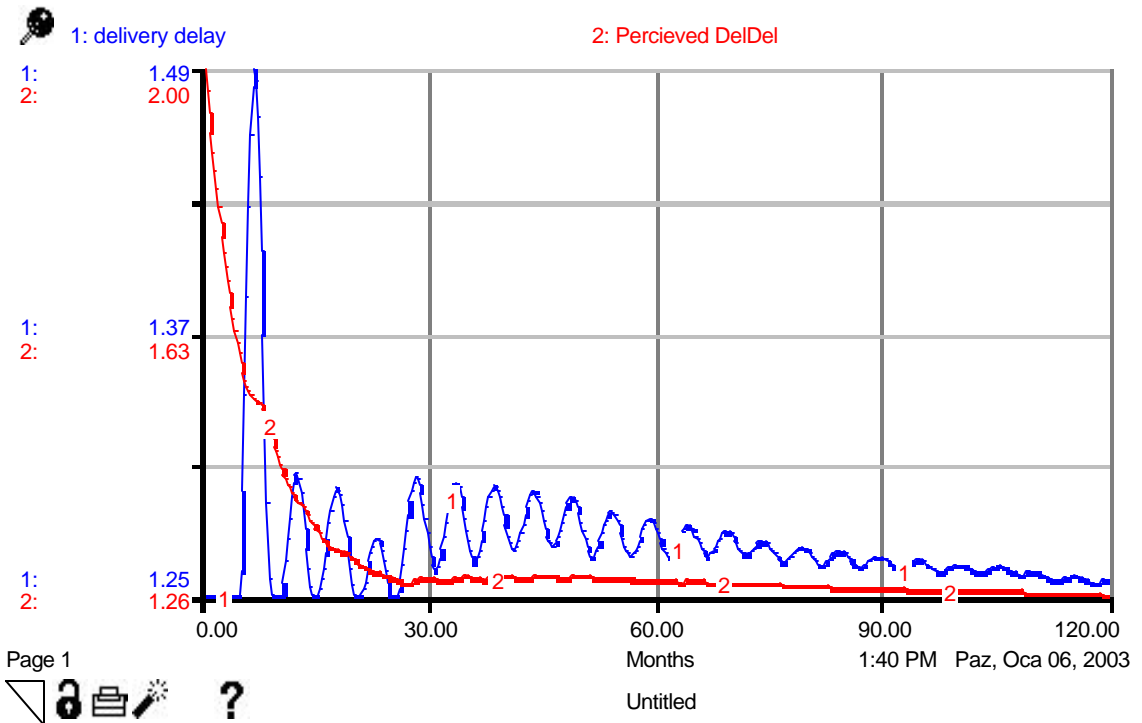


Figure.6 Delivery delay & Perceived delivery delay

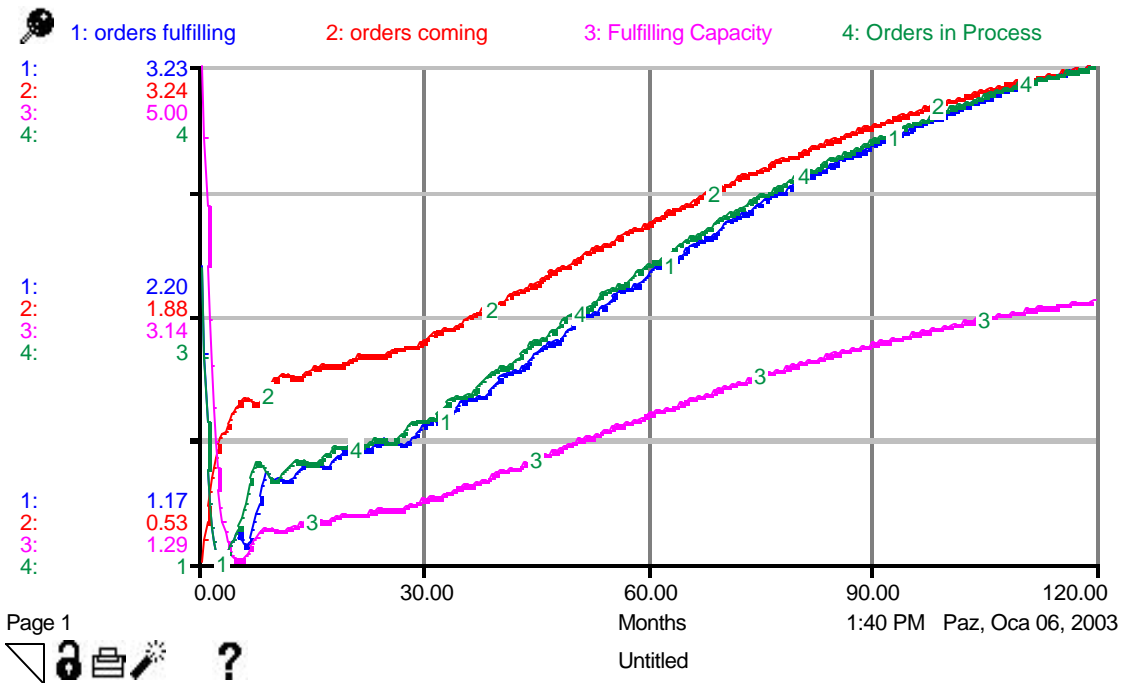


Figure.7 Orders fulfilling and coming, capacity and orders in process

Orders coming and orders fulfilling are also increasing through time which depends on the sales experts and internal business processes like setup and start up.

Perceived deliver delay follows a goal seeking behaviour whereas the deliver delay follows an damping oscillatory type of behaviour. Likewise the OIP, Experts, Capacity and Account Receivables follow goal-seeking behaviour with little oscillatory movements. Profitability and prof ratio also tries to reach a value and stay there.

One should keep in mind that validation was done mostly on a **structural basis** because the department does not have archival data for the model's parameters to validate. They have been using SAP since 1995 and from that time SAP did not keep record of every thing that we desired to find. Two years' data were on hand and with this amount of real data we could not carry out a behavioural validation.

One will be able to find the structural validity tests carried out for specially chosen variables:

1) Monthly interest rate: Sensivity runs for a range of monthly interest rate are performed.

Run:	Monthly Interest Rate
1	0.01
2	0.06
3	0.11
4	0.16

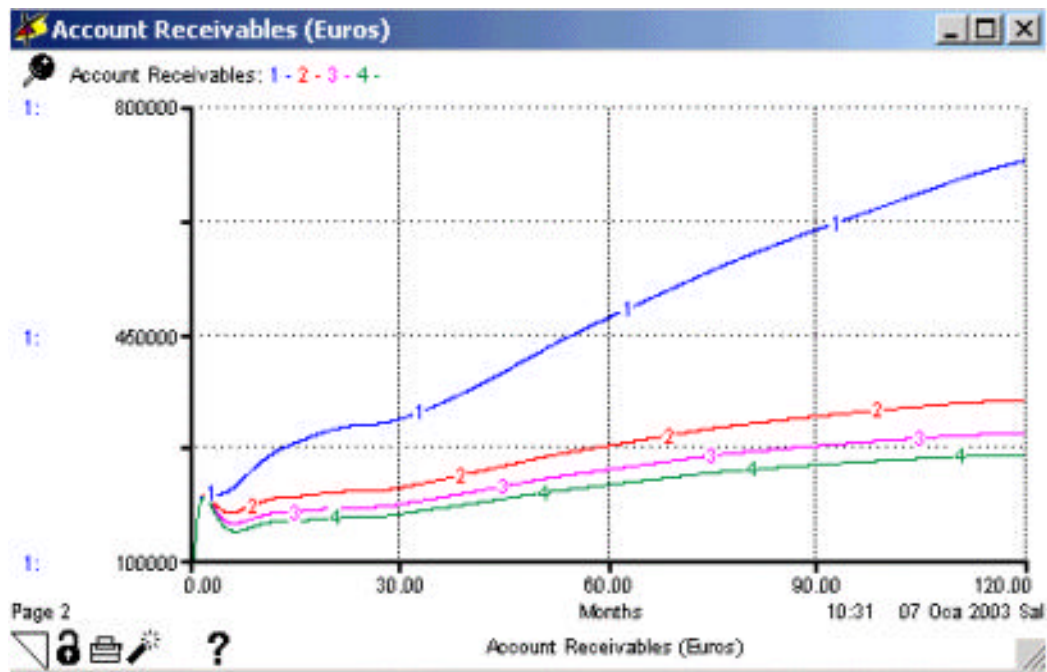


Figure.8 Effect of monthly interest rate on Account Receivables

Expected fact

As interest rate increases, holding account receivables becomes even more undesired for the company. Company is ready to sacrifice its market share in such an environment. However, in order to stay in the market it can tolerate some degree of loss.

Results of simulation:

Results of simulation match with the expected results. As it can be seen, when interest rate increases, orders fulfilling considerably drops. This leads to drop in accounts receivables. However, drastic fall in profitability is unavoidable. Loss is expected after nearly 10% of monthly interest. Also it can be seen that after some level, interest rate is not so effective on order fulfilling rate. We should remember that strategic decisions such as leaving the market are not considered here.

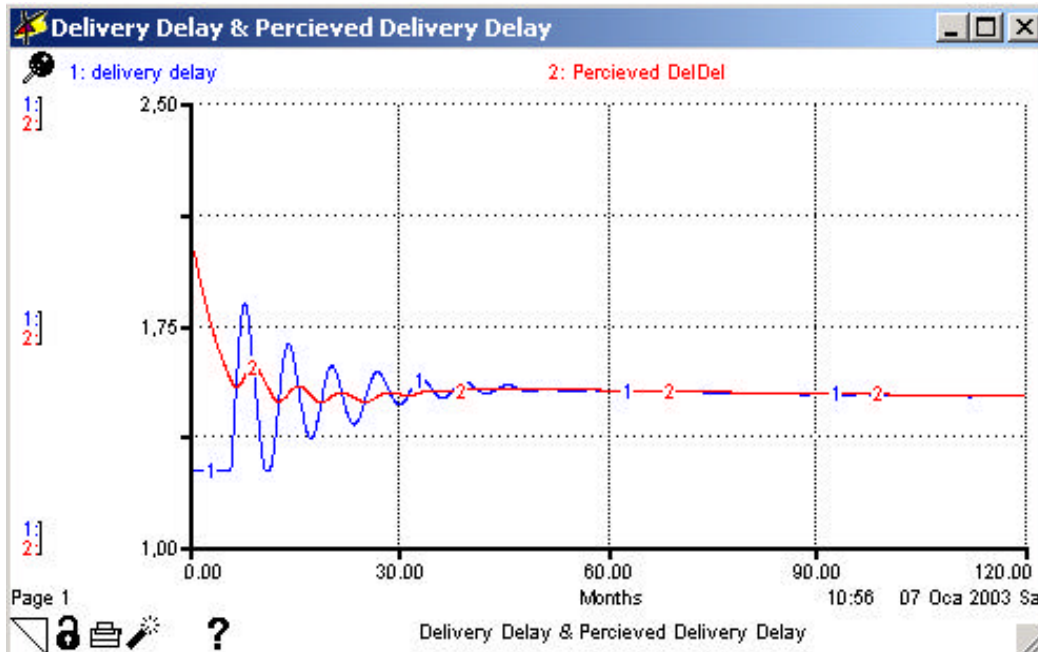


Figure.9 Target Delivery Delay = 1.25 months

For small target DD values delivery delay sticks to 1.25 months and when target $DD \geq 1.25$ behaviour pattern of delivery delay suddenly changes into oscillating. What is the importance of 1.25? It may be easy to see for an expert but it took a long time to understand that this was not due to any structural mistake. 1.25 is the order fulfilling time. In reality, this is the minimum time required to fulfill an order (5 weeks). Remember that UltraSounds are imported and this requires time. So even the target delay is set below this physical limitation, it is impossible to respond quicker to orders. Expected behaviour patterns of delivery delay and perceived delivery delay can be observed when target $DD \geq 1.25$.

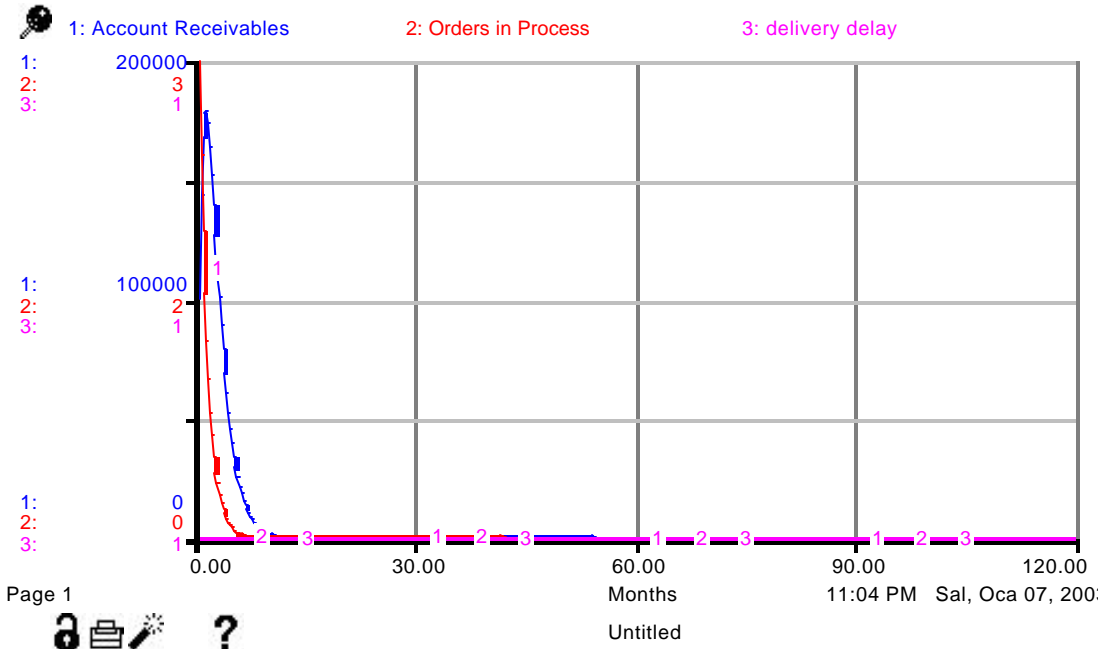


Figure.10 order per expert per month = 0

We expect to come up with zero Accounts Receivables, Orders in Process and delivery delay and what we find as an outcome for extreme condition test as order per expert per month = 0 coincides with our prior expectations.

Gradually as we increase the value of orders per expert per month we come up with increasing Accounts Receivables and Orders in Process. Delivery delay oscillates. This is in fact a very good enough representation of the department's delivery process.

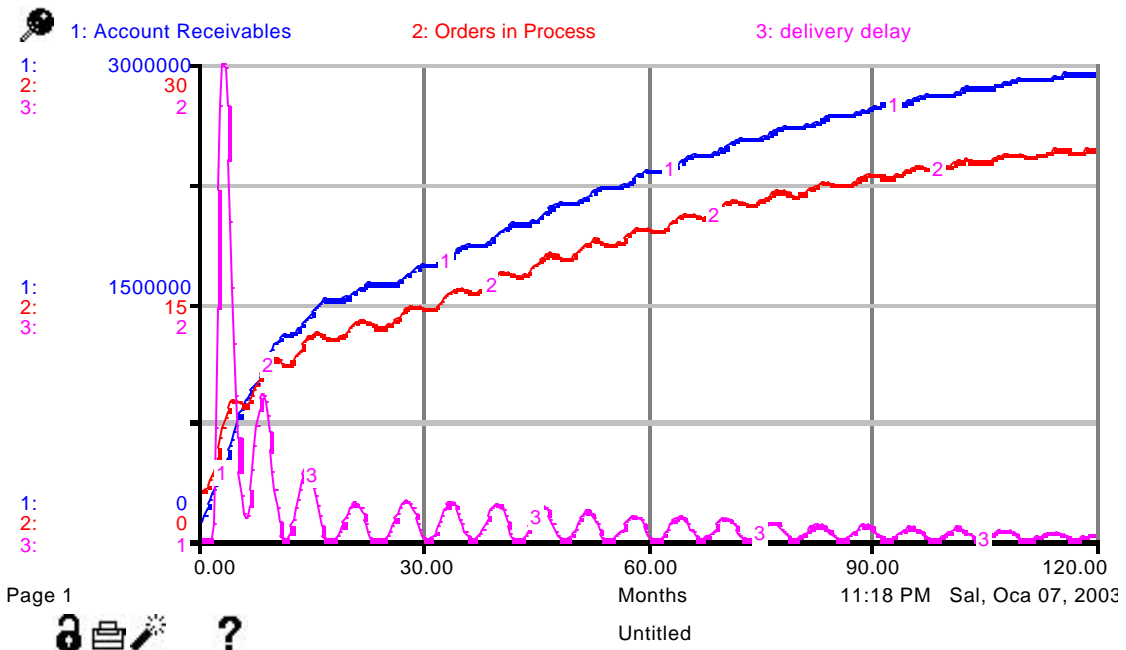


Figure. 11 order per expert per month = 7

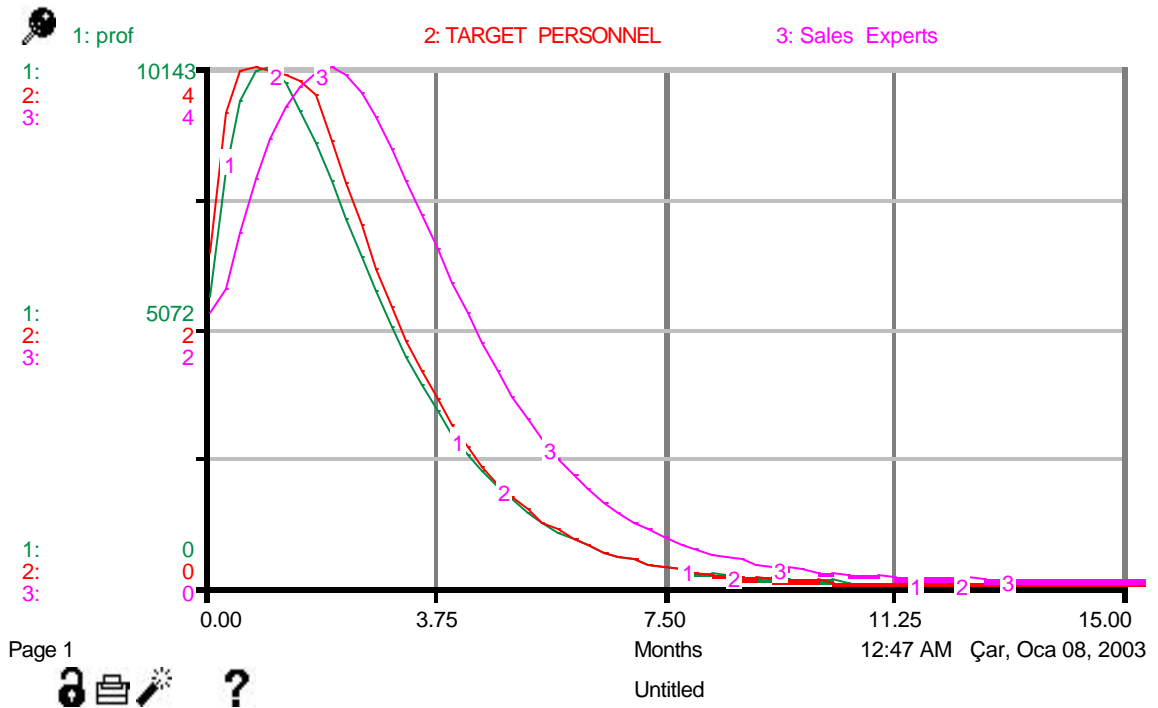


Figure.12 Profitability and Target Personnel when order per expert / month = 0

Expectedly we see that when our profitability drops to zero due to zero order level, our target personnel drops to zero and likewise experts' trend goes with the target level of personnel. After some period (around 7) sales experts get zero as experts trigger the growth of the orders and as there are no experts, there would be zero experts afterwards with zero profitability. Experts do not get zero immediately, in other words at a considerable amount of profitability, experts do not get zero. This reflects a management policy.

8. Conclusion & Future Work

What actually achieved in this project is that a vision into the future of Account Receivables and delivery delay of a Medical Solutions (Ultrasound) department is created and with the help of this vision they would be monitoring their delivery delay and Account Receivables in order to sustain profitability. The department has some decision points such as order rate per expert per month, price, order fulfilling time, cap time, target DD, interest rate etc. These decision points we think have sensitive effects on the outcomes.

We have analyzed model in terms of changing variable values and tried to give insight about what goes on when something is changed. We have tried to emphasize what is really sensitive for decision making.

We knew that the department was the second to market leader in its branch and we have assumed that the total market for Turkey would be growing until the end of the simulation. Maybe that's why it may seem doubtful that the Account Receivables increase till the end of simulation, but one must keep the mentioned assumption above in mind. Although Account Receivables increase, we should also have a look at the profitability variable. It is also increasing and for this reason, as we expect a bigger market, the department seems to be hiring 3 or 4 more sales experts till the end of the simulation.

One can find our assumptions in the model. We reflected them to our equations. For instance, if we would have a divisibility by zero error, we defined the lower level close to zero. Price is an approximate value because they do not have a fixed price, as it changes from customer to customer. Likewise, market value per salesmen, desired profitability, profitability margin and total market figures are external estimations.

For future work, the model may be enlarged by adding more details and also the model may be applied for the whole Medical Solutions Group by forming pseudo terms such as pseudo price, pseudo costs etc. The group has many operating units (devices) and they may form data for pseudo product. This project may be accepted as a pilot project in which the main focus was on a unit of the department. However, modeling the same problems for the whole department should be the goal.

One extra remark about future study is that a draft simulation game is prepared for the department so that management policies can be simulated among the department's managers whom would decide better which variable to change how much. In addition, the simulation will be carried out for the whole Medical Department, not only ultrasound section.

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APPENDIX I-INPUT FUNCTIONS

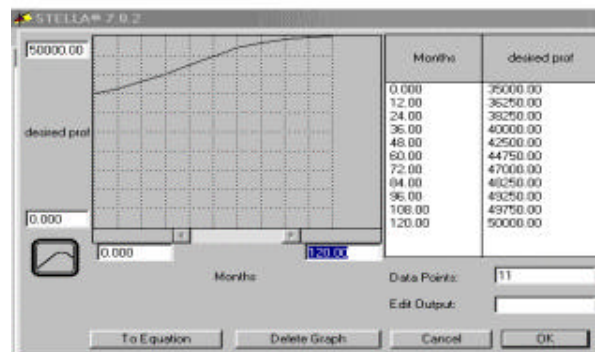
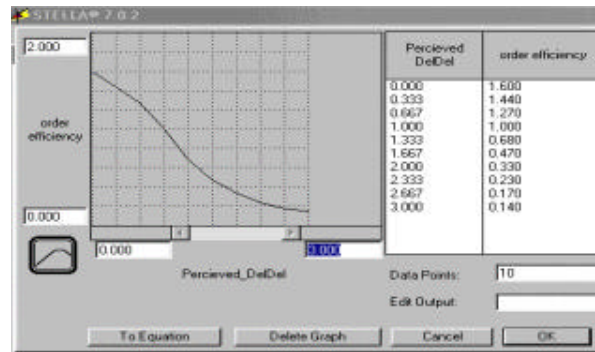


Figure.13 Order efficiency & desired profitability

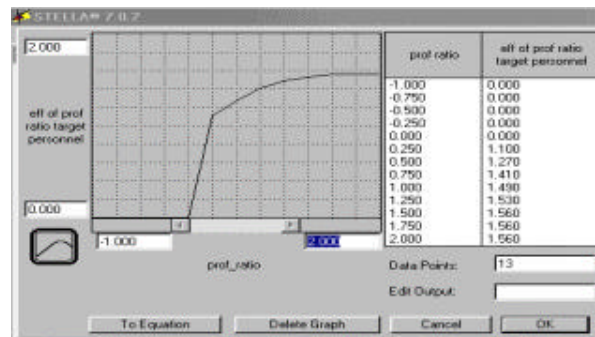


Figure.14 Effect of profitability ratio on target personnel

APPENDIX II-EQUATIONS

$$\text{Account_Receivables}(t) = \text{Account_Receivables}(t - dt) + (\text{incoming_rate} - \text{receiving_rate}) * dt$$

$$\text{INIT Account_Receivables} = 100000$$

INFLOWS:

$$\text{incoming_rate} = \text{price_per_order} * \text{orders_fulfilling}$$

OUTFLOWS:

$$\text{receiving_rate} = \text{Account_Receivables} / \text{receiving_lag_time}$$

$$\text{Fulfilling_Capacity}(t) = \text{Fulfilling_Capacity}(t - dt) + (\text{capacity_change_rate}) * dt$$

$$\text{INIT Fulfilling_Capacity} = 5$$

INFLOWS:

$$\text{capacity_change_rate} = \text{discrepancy} / \text{cap_time}$$

$$\text{Orders_in_Process}(t) = \text{Orders_in_Process}(t - dt) + (\text{orders_coming} - \text{orders_fulfilling}) * dt$$

$$\text{INIT Orders_in_Process} = 3$$

INFLOWS:

$$\text{orders_coming} =$$

$$(\text{Sales_Experts} * \text{average_order_per_expert_per_month} * \text{order_efficiency}) / \text{order_adjustment_time}$$

OUTFLOWS:

$$\text{orders_fulfilling} =$$

$$\min(\text{Fulfilling_Capacity} * \text{capacity_usage}, \text{Orders_in_Process} / \text{order_fulfilling_time})$$

$$\text{Percieved_DelDel}(t) = \text{Percieved_DelDel}(t - dt) + (\text{Adjustment_Flow}) * dt$$

$$\text{INIT Percieved_DelDel} = 2$$

INFLOWS:

$$\text{Adjustment_Flow} = \text{Discrep_BetweenAct\&Perc/ATforDelDel}$$

$$\text{Sales_Experts}(t) = \text{Sales_Experts}(t - dt) + (\text{hiring} - \text{retiring}) * dt$$

$$\text{INIT Sales_Experts} = 2$$

INFLOWS:

$$\text{hiring} = \text{estimated_retiring} + ((\text{Personnel_Discrepancy}) / \text{sales_hiring_adj_time})$$

OUTFLOWS:

$$\text{retiring} = \text{Sales_Experts} / \text{average_expert_turnover_period}$$

$$\text{ATforDelDel} = 6$$

$$\text{average_expert_turnover_period} = 60$$

$$\text{average_order_per_expert_per_month} = 3$$

$$\text{capacity_usage} = \min(1.5, \text{Fulfilling_Capacity} / \text{possible_target_delivery_rate})$$

cap_time = 1.2
 customer_delay = 0.25
 delivery_delay = Orders_in_Process/orders_fulfilling
 discrepancy = possible_target_delivery_rate-Fulfilling_Capacity
 Discrep_BetweenAct&Perc = delivery_delayPercieved_DelDel
 estimated__retiring = SMTH1(retiring,est_time)
 est_time = 48
 market_value_per_salesmen = 5000000
 monthly_Interest_rate = 0.01
 order_adjustment_time = 2
 order_fulfilling_time = 1.25
 Personnel_Discrepancy = TARGET__PERSONNEL-Sales__Experts
 possible_target_delivery_rate = Orders_in_Process/target_DD
 price_per_order = 100000
 prof = receiving_rate*prof_margin-Account_Receivables*monthly_Interest_rate
 prof_margin = 0.1
 prof_ratio = prof/desired_prof
 receiving_lag_time = customer_delay+delivery_delay
 sales_hiring__adj_time = 1
 target_DD = 1.25
 TARGET__PERSONNEL =
 (Total_Market/market_value_per_salesmen)*eff_of_prof_ratio_target_personnel
 desired_prof = GRAPH(time)
 (0.00, 35000), (12.0, 36250), (24.0, 38250), (36.0, 40000), (48.0, 42500), (60.0, 44750), (72.0,
 47000), (84.0, 48250), (96.0, 49250), (108, 49750), (120, 50000)
 eff_of_prof_ratio_target_personnel = GRAPH(prof_ratio)
 (-1.00, 0.5), (-0.75, 0.55), (-0.5, 0.65), (-0.25, 0.72), (0.00, 0.00), (0.25, 1.10), (0.5, 1.27), (0.75,
 1.41), (1.00, 1.49), (1.25, 1.53), (1.50, 1.56), (1.75, 1.56), (2.00, 1.56)
 order_efficiency = GRAPH(Percieved_DelDel)
 (0.00, 1.60), (0.333, 1.44), (0.667, 1.27), (1.00, 1.00), (1.33, 0.68), (1.67, 0.47), (2.00, 0.33),
 (2.33, 0.23), (2.67, 0.17), (3.00, 0.14)
 Total_Market = GRAPH(time)
 (0.00, 1.9e+007), (12.0, 1.5e+007), (24.0, 1.4e+007), (36.0, 1.6e+007), (48.0, 1.8e+007), (60.0,
 2e+007), (72.0, 2.1e+007), (84.0, 2.2e+007), (96.0, 2.3e+007), (108, 2.4e+007), (120,
 2.4e+007)