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Developing a model for paradigm shift in service industry

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Abstract
For a long time service industry has been successfully following a mass production manufacturing model, But in last decade, this strategy has lost its effectiveness, putting many successful companies under pressure. Instead a new model has grown to be effective, taking place of old approach in managing service companies. This paper discusses and models the process of above paradigm shift using a system dynamics point of view.

Key words: Service industry, success chain, failure chain.

Introduction
In last half century, service industry has grown a lot, gradually becoming the largest part of US economy (Quinn & Gagnon, 1986). This fast growth is based largely on mass production manufacturing model, in which the main attempt of management is to keep a quick, uniform and clean service (Schlesinger & Heskett, 1991). For example consider usual supermarkets or fast-food companies such as MacDonald's. In this case we can easily see the trend discussed above: for a long time MacDonald's has been a model of efficient and successful service company not only for fast-food operators but also for hotels, retail stores and other businesses where personal contact of personnel with customers plays a great role in the job. In the late 1980's, the unreachable growth and profitability of this company started to stagnate and even fall, the company had much more problem finding satisfactory employees while giving up lots of customers to companies offering more varied menus. Applying traditional solutions, they put more pressure to increase their advantages in the technological field but this even made the situation worse. So what is the problem? Finding the underlying reasons of such stories has been an important field of research in recent years. These reasons are implying some underlying structures which would be very well discussed using SD. The main attempt of this paper is to adopt results of former researches into SD and build a model capable of supporting further microworlds and management games. The paper tends to give a dynamic picture of these theories, investigate the ability of them in causing the paradigm shift's reference mode and build a model capturing "soft " characteristics of service industry. This would give insight for management purposes through steps taken to build the model. According to importance of service industry, it would be necessary for managers of this section to understand the structures causing this paradigm shift in order to adopt wiser and more efficient policies.
Through the rest of this paper we would take a better look at the problem and discuss theories explaining it, then based on these theories a system dynamics model is built to analyze the dynamics of service industry, Finally we are going to analyze the behavior of the model and discuss some policy issues.

Historical Development of the Theory
As mentioned above, service industry has developed using a strategy mainly taken from mass production. In fact most successful companies, has been investing much on expanding technology in their job so that they can restrict personal contact with customers as much as possible. In this way, they needed less skillful personnel which would cost them less and they could minimize their variable costs using automated machines and uniform processes (resulting in uniform service) (Schlesinger & Heskett 1991). For a long time this policy was successful: our picture of big chain supermarkets, banks, fast-food stores and even hotels indicate the same story. But gradually the profitability of service industry attracted many new competitors with new ideas to improve the quality of service as a weapon for improving their market share. This approach, increased the expectation of customers in a way that today old approach seems to have lost its efficiency: most powerful service companies of last decades, are facing lots of problems. They are losing customers while facing a big turnover. On the other hand there has evolved some new

successful companies with a new approach. They value their personnel much more, hiring experienced men with great communication skills so that they can keep a good personnel-customer relationship. These companies avoid replacing their personnel with machines, and try to give much more flexible service. Their personnel have more freedom to solve customer problems as fast as possible and they have linked compensation to performance at all levels of the company. This new strategy has been rewarded by fast growth of these companies gaining higher and higher market shares. Figure 1 shows a typical reference mode for the problem.

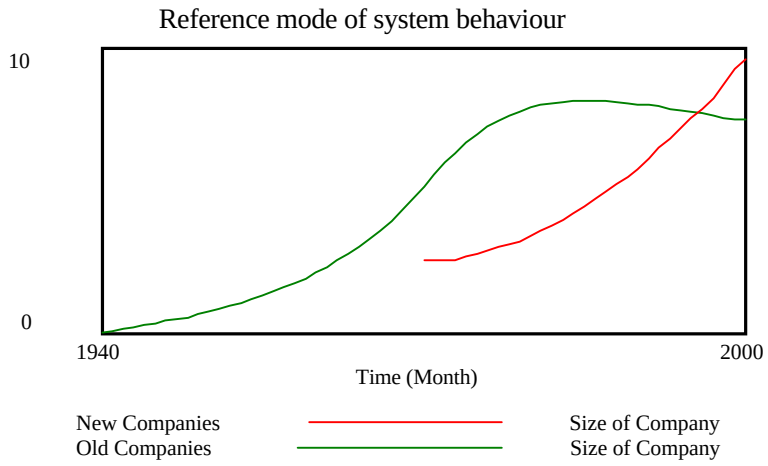


Figure 1

Why this new approach is more and more successful so that replacing old method?
Personal contact is a key element in service industry, in fact it is probably as important as the service you are buying itself, so having skillful front-line workers is a great advantage. Customers prefer the service as they like it, not in the way it is designed, and they want front-line workers to have the freedom to solve their problems as fast as possible instead of referring them to supervisor for anything out of regular. In this way customers served with new method are more satisfied and therefor more loyal, and it is the key to profitability in service industry (Heskett, Jones, Loveman, Sasser & Schlesinger 1994). But what happens to increased salary costs? Although experienced service men need more salary, they acquire much less supervision, while being more profitable compared to rookies (they can serve more customers with better quality). So while they are getting more salary, you can decrease your management layers (Schlesinger & Heskett 1991). On the other hand, most service jobs used to be dead-end ones which were filled by young untrained guys, staying in the position not for more than a year. This means a great turnover cost which can be cut down using professional employees and keeping them satisfied in a quality company (Heskett, Jones, Loveman, Sasser & Schlesinger 1994) . Studies (the same reference) show that, profitability comes mainly from customer loyalty (compared to the number of new customers), and this is driven by customer satisfaction of service. Satisfaction is a result of value added to the service which would come from good communication and personal contact when serving the customer or the great number of choices the customer have when served (imagine a restaurant with variety of menus compared to one serving a few kind of foods). You can increase value added to the service with help of productive employees, those who serve the customer kindly trying to satisfy him in any way they can. But only satisfied, well-trained personnel would be capable of such a behavior. But how can we have more satisfied personnel? It is a common belief to link satisfaction of employee to his salary, but studies show that satisfaction is more driven by factors such as level of liberty of personnel in their job and for implementing new ideas, or how friendly and satisfactory is the work environment. We would call these factors internal quality of the company. In brief, the whole theory can be visualized as figure 2.
It is important to note that most factors discussed above which would finally influence the company, are soft variables such as loyalty, satisfaction, value added and internal quality of company. These are not

easily captured into measurement methods used to evaluate a company. This is on of the reasons this dynamic has been ignored for several years (Senge & Oliva).
One important characteristic of discussed theory is its being a chain of casual relationships rather than closed loop. But an open loop can not contribute to the exponential growth of new-type companies, shown in reference mode. This is where we would concentrate in the rest of the paper to change it into a dynamic model.

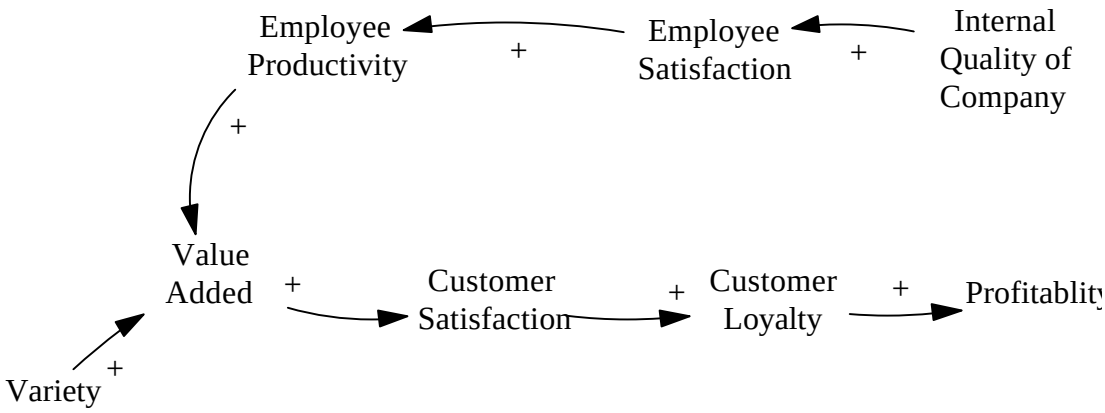


Figure 2

All theories and reasons discussed can be summarized by the following propositions:
1- The policy of putting most pressure on improving machines instead of front-line workers.
2- The cause and effect chain discussed above, which can lead to both success and failure depending on its direction.
3- Profitability of service which lead to increasing competition, and this was a cause of better service quality and more customer expectations.
4- Measurement methods not capable of taking soft characteristics of industry into account, resulting in ignorance of these fundamentally important issues in service.

Focus of the research

In the rest of the paper we are going to take out cause and effect loops explaining reference mode behavior regarding theories mentioned above. This way we would be able to make a quantitative connection between theories and historical reference mode through building a model. After that we will use the model to better understand and evaluate theories and get a better insight into the structures causing this behavior.

Structure of model

In the problem we are discussing, we can identify four important sections: total market, customers, quality of service and company. Interaction of these parts would shape the behavior of model (Figure 3).

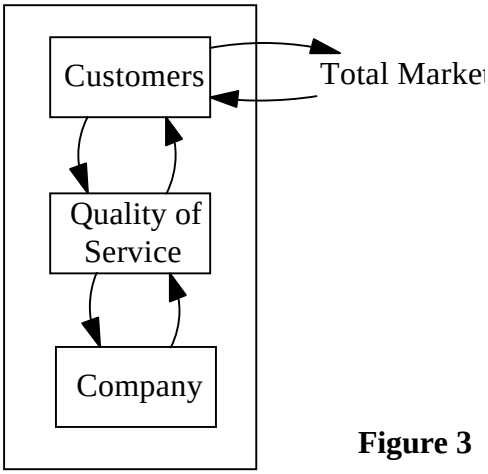


Figure 3

In the reference mode of old companies, we can see an overshoot-decline behavior. The first positive loop that can be responsible for initial growth of these companies is just a common one observed in most cases of growth in economic units. In this loop the increasing profit of company leads to expansion and more advertisement so that they can attract more customers. The more the customer, the bigger the revenue and profit would be and this way the virtues circle is completed (Figure 4, right). It is important to note that the increasing need for service in the community (during initial decades) and the gap between the need and presence of service companies leads to profitability of this industry, and therefore this loop is not bounded for some time. In the model we have shown this assumption putting a large number of total customers which wouldn't stop growth soon. The other positive loop comes from the old paradigm in service: the companies use and improve technology more and more, therefore they come to decrease their variable costs and also decrease the salary they pay, leading to more profitability and growth (Figure 4, left). In reality, level of technology is bounded, so when reaching this boundary the exponential growth driven from this loop would stop and companies insisting on it, would find it no more effective in accelerating the growth. Any way, having reached this point, it is hard to draw back, because the company has set equilibrium between its cost and revenue, based on low salary and low variable cost. Changing this company wide structure into another paradigm is practically hard.

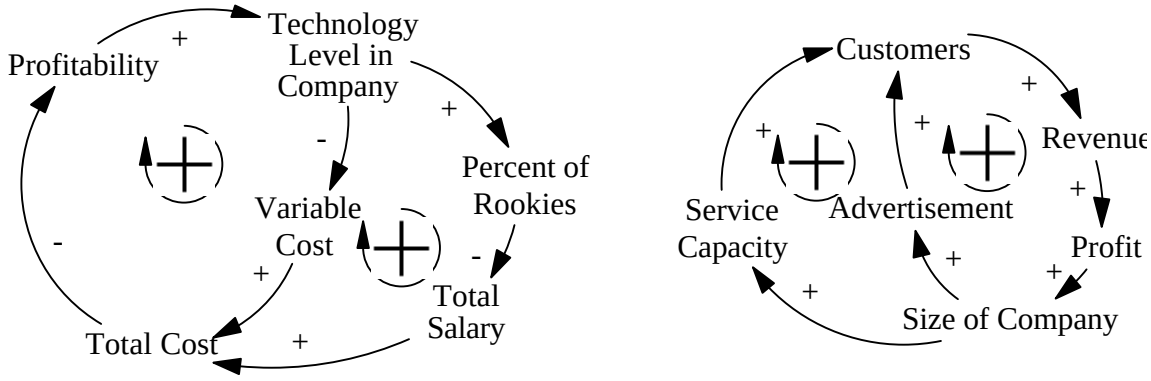


Figure 4

Now the question is: what did stop the growth of flourishing companies?

As a first idea, there is always a market boundary which can account for a companies growth being blocked, but is it the case in our dynamic theory? For sure not all companies using old approach, had reached their market limit, to be blocked by this factor. However, fast growth of service industry has decreased the gap between demand and supply for service, and therefore the limited market has triggered serious competition. As a result, while not forgetting to put this aspect in the model, we should look for some other explanation. Historical data shows parallel growth of new companies while old ones were declining. This indicated that old companies lost their advantage in the competition and therefore gave up their market share to newcomers. As discussed in historical development of the theories, we can look for the reason of this defeat in ignorance to service quality and variety, perceived by customer. Companies paying too much attention to technology, forgot to improve their front-line workers and therefor did not improve their quality. As far as it was the dominant approach in the industry, people wasn't expecting anything better. But gradually things changed and profitability of service, attracted many new competitors with new ideas and approaches. And they put more emphasis on quality to gain better market share. This increased the quality needed to satisfy customers leading to more pressure on old companies who were yet

trying to grow using technology. In fact ignoring employee capabilities and variety of service (which was probably a result of too much relying on technology (Schlesinger & Heskett 1991)) kept the quality of these companies low and stopped their growth when facing new competitors. We can change this dynamic story into cause and effect loops in Figure 5.

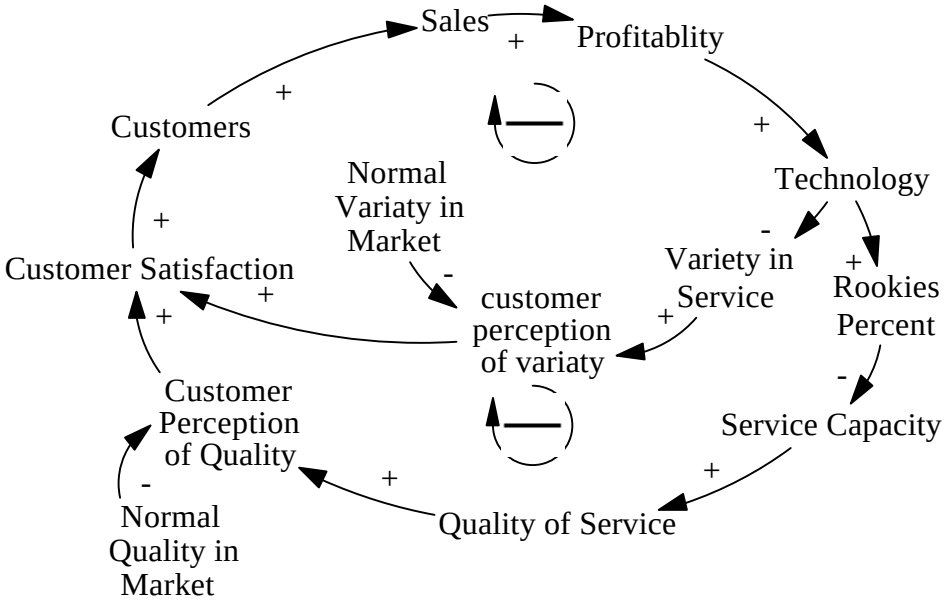
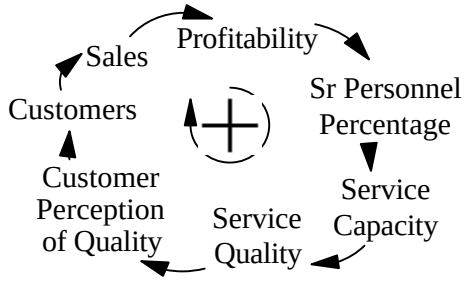


Figure 5

In figure above, as an initial definition, we have taken the quality of service to be the ratio of service capacity to the number of customers. Having a constant number of customers, any increase in service capacity would improve quality. We should note that having this definition, we have to take all factors changing quality, into service capacity. (factors like experience and productivity of workers, their liberty to serve customer with more quality and etc.).

Drawing the structure serving for stagnation of growth in old companies, we now take our attention to fast growth of new companies.

New successful companies tend to employ more experienced people with good communication skills. Their employees are more satisfied than before because they are more free to serve customers as fast as they can. On the other hand job satisfaction arisen from good quality of service would motivate these employees more and results in their productivity. Satisfied workers, like satisfied customers, would stay with the company much more and this means less turnover cost and more profitability. With this approach, different parts of system would reinforce each other to make a well quality organization which would have satisfied, loyal customers and therefore is profitable and growing (Heskett, Jones, Loveman, Sasser & Schlesinger 1994). To capture these features in the model we design following positive loops (Figure 6).



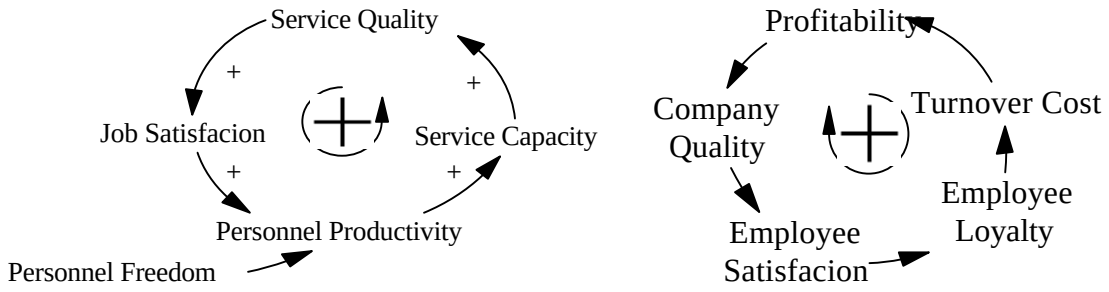


Figure 6

In above figure, the term " Company Quality" refers to what we may measure by the feelings of employees towards their jobs, colleagues, and companies. This could be improved through job training, feedback, good colleagues and friendly atmosphere. As far as new companies invest more on job training, hiring good personnel and satisfying their employees, their profitability would improve "company Quality".

Cause and effect loops discussed, are linking initial theories to a dynamic one which can be now captured in a model. The initial model is going to show the behavior of a company run with old method. To build the model, I took important level variables of the system and expanded the flow diagram around each, having the structure of main loops as a guideline, then linked different parts into a complete model. This model can be found in appendixes 1 and 2.

Here is the list of important level variables:

(Number of) Customers, (number of) Beginner and Sr. Personnel, (level of) Customer and Personnel satisfaction, (level of) Technology and Customer and Personnel perception of quality.

Before discussing model behavior, it is desirable to clarify concept of some key variables as formulated in the model:

Quality- In the model quality is ratio of service capacity of organization to the number of customers. Service capacity itself is number of personnel multiplied by their productivity. And productivity is a function of personnel satisfaction.

Satisfaction- This variable is used for both customers and personnel. For customers it is taken as a function of quality, variety of service, and how much the customer knows the personnel of organization. For employees this variable comes from how they find their job to be effective in satisfying customers and how much management of company invests on improving the internal quality of organization (company quality in figure above).

Normal quality in community- In one sector model, I had only one company. To capture the pressure this company perceives from the side of competitors, I introduced Normal quality in community as an exogenous time series which increases gradually as new companies enter the industry and improve the normal quality acceptable in community. This way the important effect of competition in our dynamic theory (which is increasing quality acceptable by customer while choosing the serving company depends on his perception of quality, is captured. The same story is true for variable: normal variety in community.

Model behavior

The one-kind-of-company model developed, has got the following assumptions:

1- There is only one company using "old method" for decision making.

2- Price of service is set constant. (because it played no important role in our dynamic theory.)

3- Normal quality and variety in market is set as exogenous variables which would increase gradually.

4- There is no market limit for the company.

5- Sales budget is a constant ratio of revenue.

6- Decision making rules does not change during simulation.

After running the model with these assumptions, we came up with the following behavior. The variable "customer " represents the number of customers who would buy service from the company and is an indication of size of company. (Figure 7)

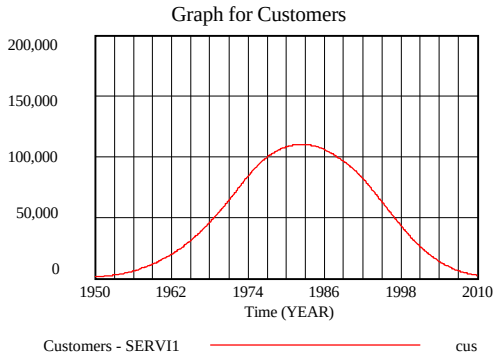


figure 7

This growth and decline behavior is rather similar to our initial reference mode. It is important to note that there is no market limit for the company and all stopping the growth comes from internal structure of the company. Of course the exogenous variables normal quality and variety in community would be a key element in this behavior. The main difference is in the much faster decline of old companies in this run. The reason would return to the 6th assumption above. In this model managers of "old companies" are deciding with the same pattern, in the other words they are not learning from what is happening while managers in reality would learn from situation and change their decision making rules. To explore this behavior we can look at following variables in Figure 8:

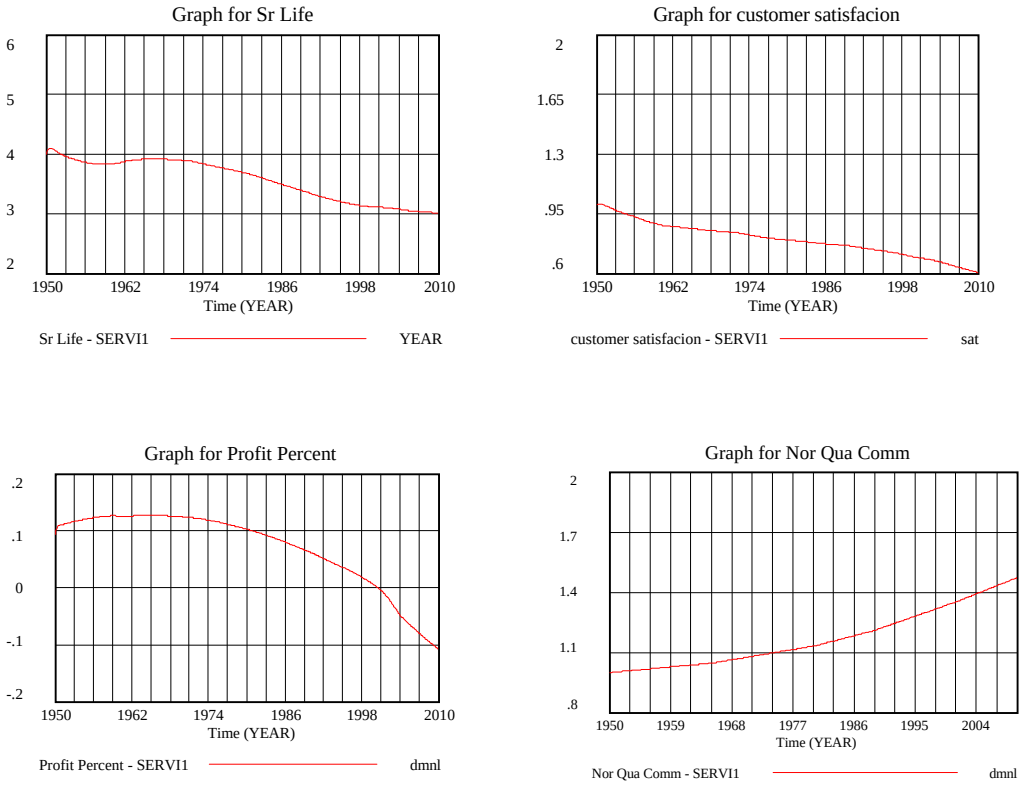


Figure 8

The first graph is showing average experienced personnel loyalty to company (years staying with company). The declining pattern indicates rising turnover costs and decreasing productivity of personnel. The second graph shows customer satisfaction, decreasing customer satisfaction means losing customers faster because of having less loyal customers. As a result we would need more resource allocated to sales without having desired results and finally we are facing less profitability (third graph). It is also important to note the effect of technology on system. As long as company is profitable, it can maintain its technological advantage but after coming short in profit, it can no longer invest much on technology to keep the positive loop alive. In fact investing more on technology in this situation would result in less variety and quality level and more loss as a result, therefor there is no outcome expected, even if they

could invest on the service technology and automation: The company is trapped in its own policies and can not improve unless it changes some of the main decision rules toward regarding customer and personnel satisfaction more and investing on these elements rather than technological aspects. you can see the graph for technology in figure 9. Note that 1 is taken as normal technology in industry at any time.

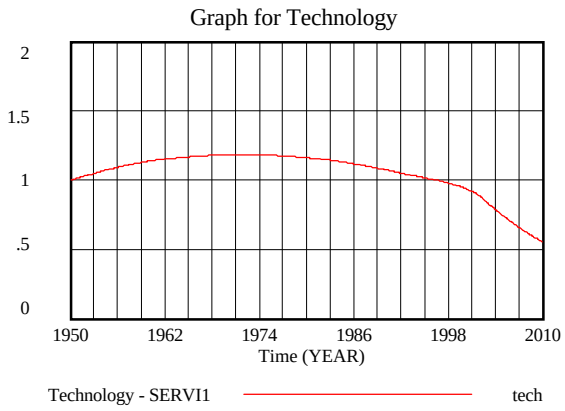


Figure 9

With the insight gained from the model, we can rephrase the dynamic theory of our problem. The initial approach in service companies was to emphasize on technology. This way they could decrease cost of service and use less experienced employees (and pay them less), on the other hand people expectations in market was not so high (because service industry was rather new and its quality was of second importance.) all these together caused a very fast initial growth and high profitability for these companies. This successfulness lasted for some decades, but gradually as new comers in the industry served a higher level of quality to gain more customers. The result was gradual increase in normal quality and variety of service acceptable in community. This meant that market was less and less satisfied with the level of quality served by old companies. Dissatisfied customers, not only left the companies but also made it harder to attract new ones. On the other hand, personnel of these companies, had less and less job satisfaction when getting no positive feedback from customers, so they became less loyal to their companies and this meant more turnover cost and less productivity of personnel. These negative loops not only stopped the growth but also caused further decline. Of course in reality the decline was rarely this fast and serious because managers of old companies could perceive this trend and react on it. Changing their policies, they were able to stay in the competition (but no more as powerful as they were before).

In the initial model, the variables normal quality and variety in community were taken as exogenous variables increasing by time. The behavior of model was sensitive toward change of these variables. In fact by slowing down the increasing trend of these variables seven times, we would come to a change of behavior mode from overshoot and decline to exponential growth. This analysis reveals the need for taking these two variables into the models dynamic instead of leaving them as exogenous variables.

This can be done by expanding the model to capture new companies and their effect on old ones. In this case we would no more need to keep normal quality and variety in market as exogenous variables but they can be determined from performance and competition of old and new companies. Other important assumptions in expanding the model are stated bellow:

1- There are two companies in the model, one using old method and one using new approach.

2- Total potential customers in market are limited (9 million). This means competition to attract more customers is present in the model.

3- The price is yet set constant.

4- The new company does not exist until 1965, when the profitability of old one would make it very desirable to enter the industry and therefore they start working with new strategy, with rather a small size.

5- The old company reacts to the level of customer satisfaction (with some perception and decision delay) by changing its variety and quality goal, combination of beginner to experienced personnel and improving their companies internal quality (which accounts for personnel satisfaction).

In this model, new companies would start working with their new approach, and therefore attract customers in the market very fast. In this way old companies lose their market share while they are not aware of what is happening and become to an even worse position when they can not change the situation easily even if they change their policy. figure 10 shows the behavior of model regarding number of customers for old and new companies. (old companies customers: customers, new companies customers:_ customers2).

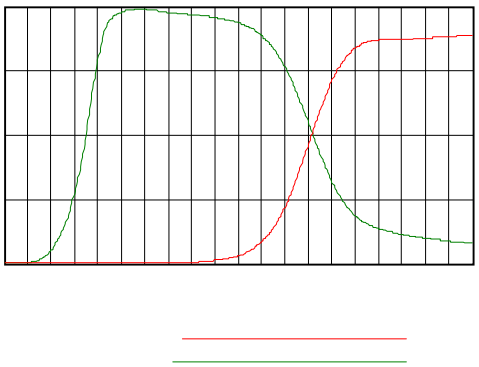


Figure 10

In this graph, the main barrier which has stopped growth of new companies is market limit. In other words taking out the market limit out of the model, new companies would grow exponentially for ever. This difference in behavior, comparing with first model, is due to slower growth of normal quality/variety in community, when we generate it internally according to competition. Of course in reality there would be some other barriers to growth which might have acted before market limit in many cases.

Another important point in this behavior, is that old companies can not gain their initial advantage, although they have reacted to the situation, changing their policies (they wouldn't have any customers left without changing their decision variables). In the model, new companies gain some advantage by increasing their quality and variety of service. As a result the normal quality and variety in community increases (figure 11), this means that people are expecting more than past and don't get satisfied with the quality which was satisfactory 10 years ego. Therefore you should offer much more quality service to customers for gaining their acceptance, but the companies can't afford much more quality because in that case the whole job is no more profitable. Totally, old companies can not find any opportunity for improving their quality as much as needed to improve their market share (In the model, they could gain this change solely through improving their quality goal along with some other parameters, but this wasn't financially affordable.) The best choice for these companies, comes from improving their variety of service and increasing internal quality of organization (policy effect on personnel life in the model). In reality this means having more new ideas, giving personnel liberty to satisfy customers in any way they find to be appropriate and making a more friendly and satisfactory environment in the organization.

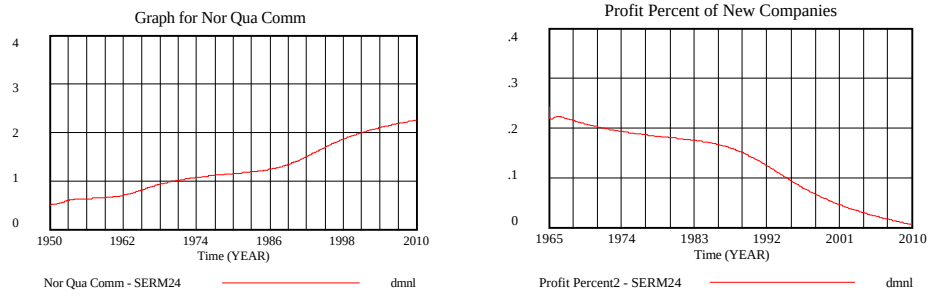


Figure 11

Another important policy issue from the model, arises from the profit percent for the new companies. As you can see in figure 12, there is a declining pattern in this variable. How is it explained?

In the model we have defined quality the as ratio of quality capacity to customers and quality capacity is product of personnel to their productivity. So, for increasing quality, we need to increase personnel or their productivity while the later is limited. Therefore when we gradually reach the boundary of personnel productivity through different policies, we would need more personnel to improve the quality and pay more wage for serving the same number of customers. As a result, increasing quality has got also a negative effect on profitability. It is important to note that in this case positive loops of relating quality to profitability would become ineffective after some time because normal quality in community would increase and therefor greater absolute quality (useful time of personnel spent on one customer) is regarded as normal for customers (having no more positive effect on their loyalty and satisfaction). In reality this story might differ in some ways: quality perceived by customers in not only a function of time spent on them, but also many other factors are important. We have tried to capture these features in productivity of personnel and variety of service which are both limited in the model while innovative new ideas evolving in the service industry are different, they can improve quality significantly while you don't need to spend

so much on them and their variety is not bounded. The whole discussion here has got an important policy output: all companies should be aware that no matter how good is their quality and customer satisfaction today, it would become ordinary in a few years, so they should be always looking for new, innovative ideas to improve their quality. This is a never ending process and profitability of company in long term is bounded to it.

Strategy for improving the model

The first purpose of building this model has been deepening understanding of paradigm shift in service industry. While the model is rather capable of reproducing historical mode of behavior, testing a model validity is rather a continuos process of doing different tests on it and checking diverse policies(Forrester & Senge, 1980), so to improve the model there are always new steps to be taken. These imperial tests would help us understand the theory and its usefulness better and know its limitations. On the case of this model of service industry I would suggest following points as some important ones to work on:

1- This model is not tuned with any real service industry so parameters are mostly based on intuition. Sensitivity analysis on some important parameters shows no change in the mode of behavior but deviations in values were significant so it is very desirable to build the model on some real parameters to see if it is capable of reproducing historical behavior in that specific situation. In this case, it might be desirable to change some parts of the model in order to represent a real case.

2- Most important dynamic of this model arises from some soft variables such as quality, variety, technology, satisfaction and effects of these on each other, as a result the model stands on many lookups. Each of these lookups can be a case of more investigation in different situations, and some of them which are representing decision making rules, will differ according to different managers, so much work arises from investigation of lookups to make them more valid.

3- While this model is trying to capture theories mentioned in the beginning of the paper, it is ignoring some parts which would be important in reality, to release these assumptions, I would suggest following cases: assumption of constant price (while it plays an important role in competition, variety and use of technology in reality), no service backlog or rework (in this model I have taken no backlog for service and shortage of service capacity would result in less quality, also there is no rework), changing some lookups into structures.

4- I have taken a simple definition for quality (as defined in definition part). Using this definition, some creative new ideas are missing in the model. To expand the model, putting some structure to capture these features would be very helpful.

5- Having an improved model, it would be desirable to use it for building an interactive learning environment which can rise many new questions while giving more insight about the dynamic of the system to managers in the service industry.

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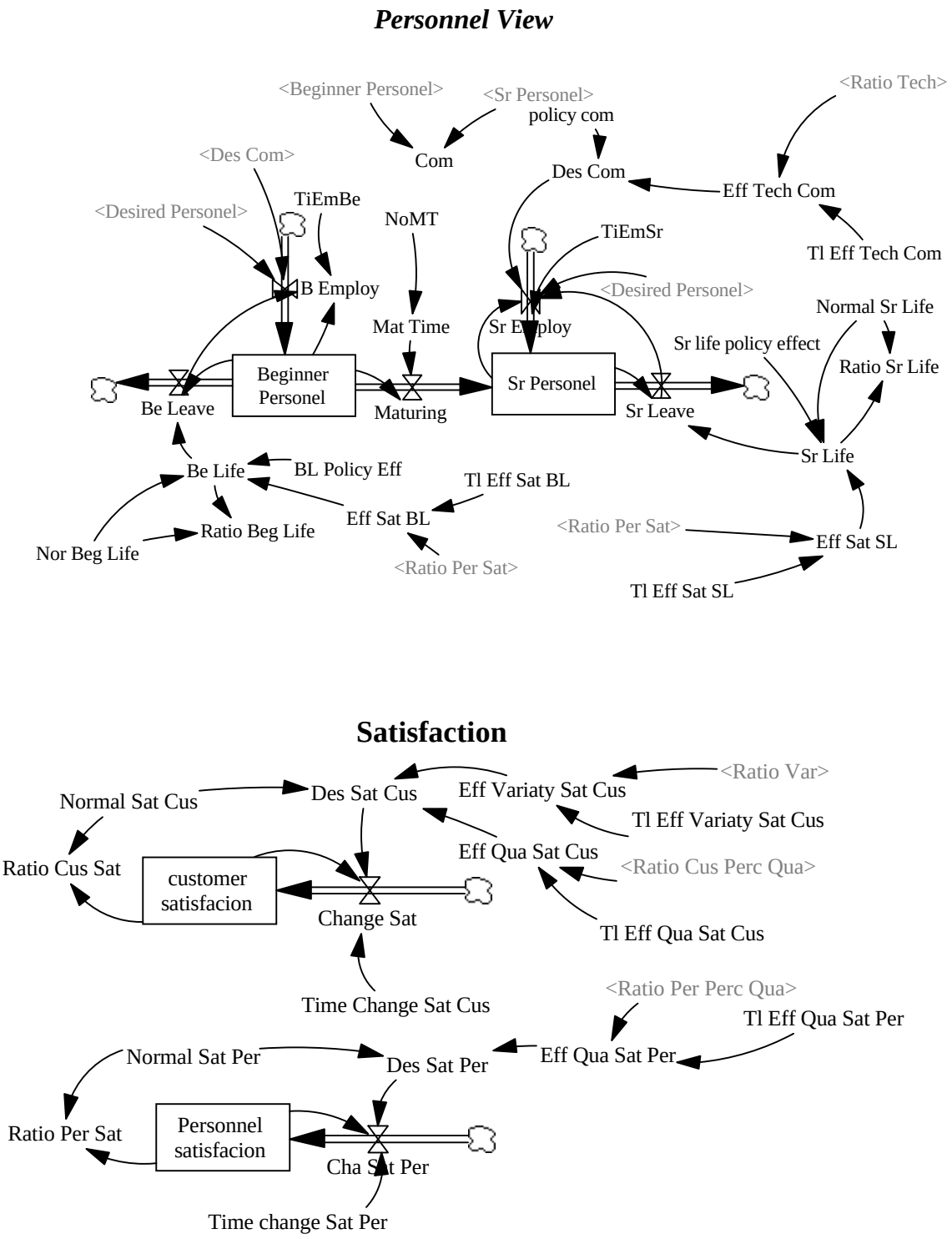
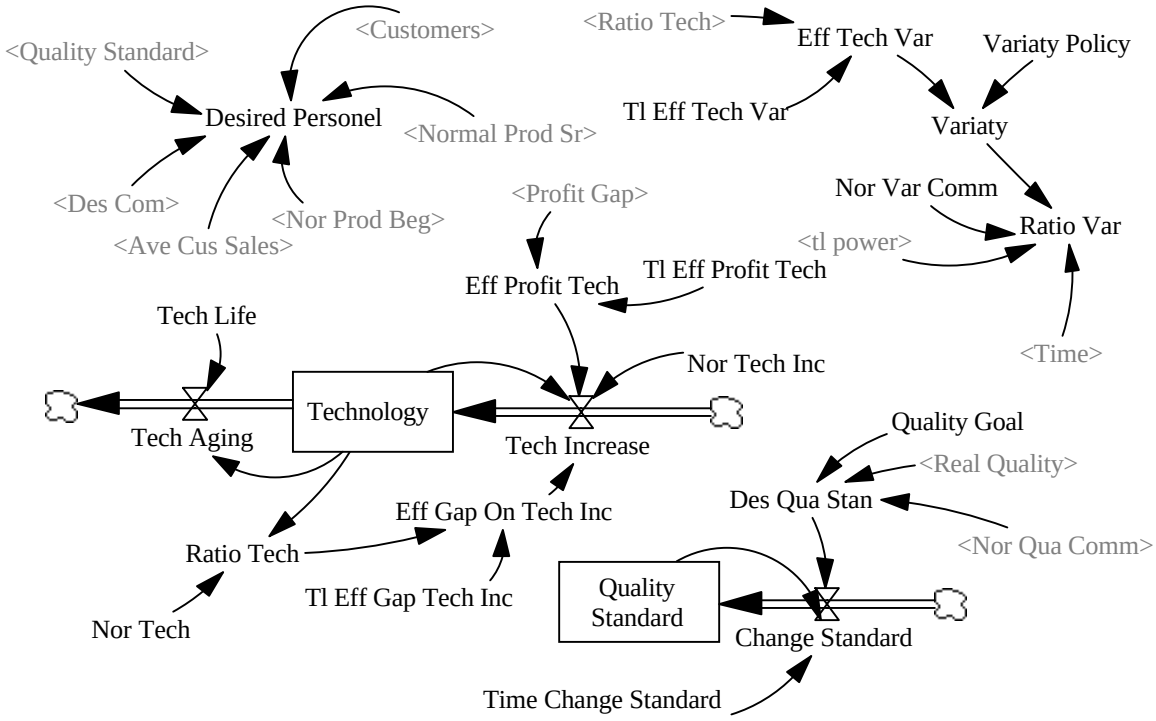
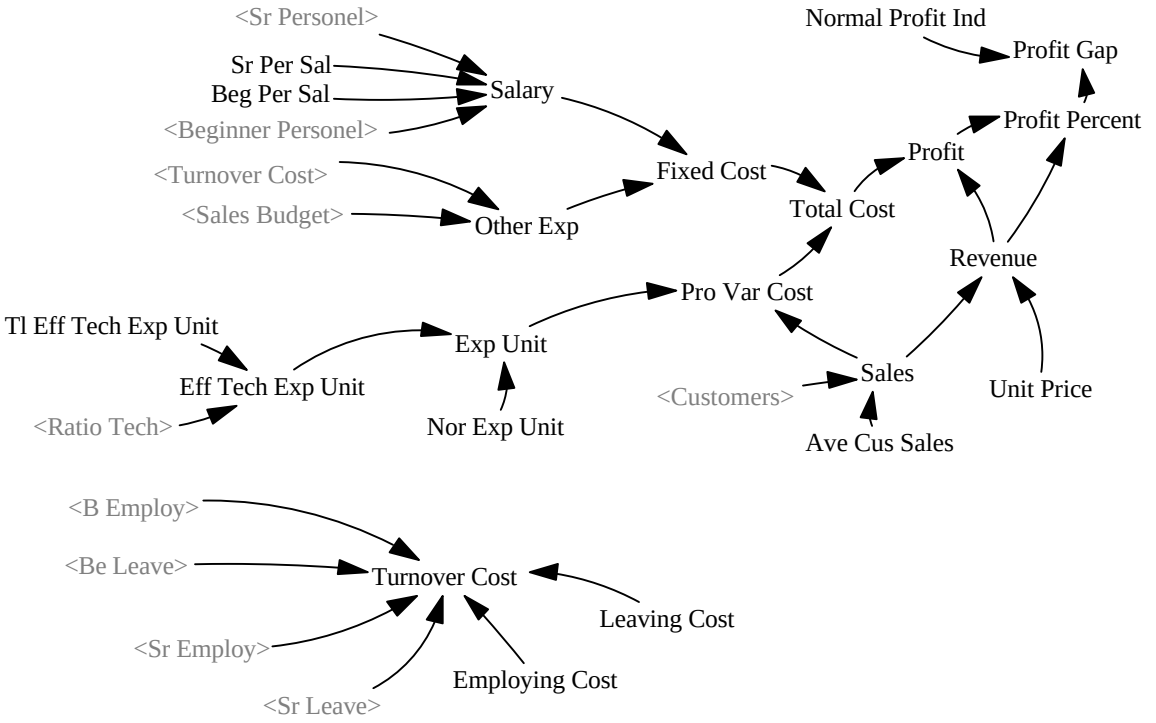
Appendix 1: Flow Diagram of the One-Sector Model:



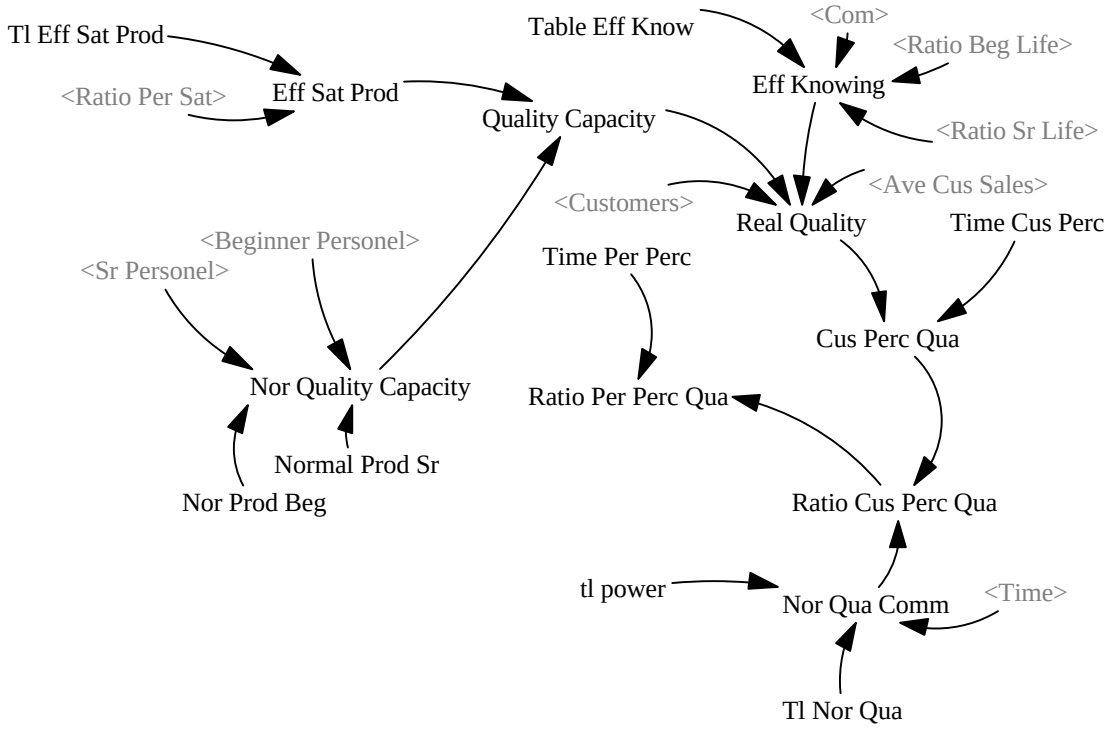
Variaty, Technology, Quality standard & Desired personnel



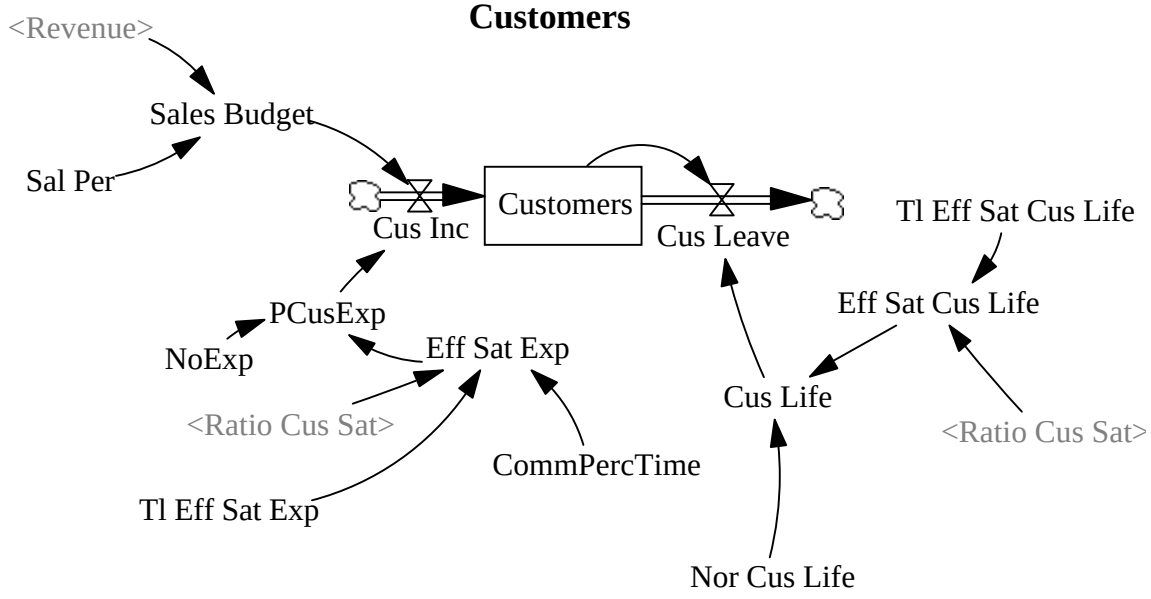
Financial



Quality



Customers



Appendix 2 - Equations of One-Sector model

Ave Cus Sales = 50
~ sale/YEAR/cus
~ average sales of a customer in one year
Eff Sat Cus Life = Tl Eff Sat Cus Life(Ratio Cus Sat)
~ dmnl
~ Effect Satisfaction On Customer Life
Ratio Var = Variety/(1+(Nor Var Comm(Time)-1)*tl power)
~ dmnl
~ ratio of variaty
Nor Qua Comm =1+tl power*(Tl Nor Qua(Time)-1)
~ dmnl
~ normal quality in community
Nor Quality Capacity = Beginner Personel*Nor Prod Beg+Sr Personel*Normal Prod Sr
~ sale/YEAR
~ Normal Quality Capacity of company denying satisfaction
Ratio Per Perc Qua = DELAY1(Ratio Cus Perc Qua,Time Per Perc)
~ dmnl
~ The quality as perceived by personnel
Des Sat Per = Eff Qua Sat Per*Normal Sat Per
~ sat
~ Desired Satisfaction of Personel
Mat Time = NoMT
~ YEAR
~ average time it takes a rooky to become experienced
tl power = 1
~
~
B Employ = (Desired Personel*(Des Com/(Des Com+1))-Beginner Personel)/TiEmBe+Be Leave
~ person/YEAR
~ Beginers employment rate
Be Leave = Beginner Personel/Be Life
~ person/YEAR
~ rate of leaving of beginners
Be Life = BL Policy Eff*Eff Sat BL*Nor Beg Life
~ YEAR
~ actual beginers life
Beg Per Sal = 12000
~ $/YEAR
~ beginner personnel salary
Beginner Personel = INTEG(B Employ-Be Leave-Maturing,15)
~ person
~
BL Policy Eff = GAME(1)
~ dmnl
~ policy of the company to keep its beginer personel
Cha Sat Per = (Des Sat Per-Personnel satisfacion)/Time change Sat Per
~ sat/YEAR
~ rate of changing personnel satisfaction
Change Sat = (Des Sat Cus-customer satisfacion)/Time Change Sat Cus
~ sat/YEAR
~ rate of changing satisfaction of customer
Change Standard = (Des Qua Stan-Quality Standard)/Time Change Standard
~ 1/YEAR
~ rate of changing quality standard
Com = Beginner Personel/Sr Personel
~ dmnl

~ the combination of personel in the system

CommPercTime = 1.5

~ YEAR

~ Community Perception of Satisfacion Time

Cus Inc = Sales Budget/PCusExp

~ cus/YEAR

Cus Leave = Customers/Cus Life

~ cus/YEAR

~ rate of customers leaving the company

Cus Life = Eff Sat Cus Life*Nor Cus Life

~ YEAR

Cus Perc Qua = SMOOTH(Real Quality,Time Cus Perc)

~ NOR PER/cus

~ Customer Perception of Quality

customer satisfacion = INTEG(Change Sat,1)

~ sat

Customers = INTEG(Cus Inc-Cus Leave,1000)

~ cus

~ number of customers

Des Com = Eff Tech Com*policy com

~ dmnl

~ Desired combination of Beginer customer to total customer

Des Qua Stan = IF THEN ELSE(Quality Goal>=Real Quality,(Nor Qua Comm+Quality Goal+Real Quality)/3,(Quality Goal +Nor Qua Comm)/2)

~ dmnl

~ desired quality standard in company

Des Sat Cus = Eff Qua Sat Cus*Eff Variaty Sat Cus*Normal Sat Cus

~ sat

~ Desired Satisfaction of customer

Desired Personel = Quality Standard*Customers*Ave Cus Sales/(Normal Prod Sr/(1+Des Com)+Nor Prod Beg *Des Com/(1+Des Com))

~ person

~ desired number of personnel

Eff Gap On Tech Inc = Tl Eff Gap Tech Inc(Ratio Tech)

~ dmnl

~ effect of gap between company technology and community technology on increase of technology

Eff Knowing =Table Eff Know (Ratio Beg Life*Com/(1+Com)+Ratio Sr Life/(1+Com))

~ dmnl

~ Effect of knowing personel on quality perceived by customer

Eff Profit Tech = Tl Eff Profit Tech(Profit Gap)

~ dmnl

~ effect of profit on technology table

Eff Qua Sat Cus = Tl Eff Qua Sat Cus(Ratio Cus Perc Qua)

~ dmnl

~ effect of quality on satisfaction of customer

Eff Qua Sat Per = Tl Eff Qua Sat Per(Ratio Per Perc Qua)

~ dmnl

~ Effect of quality on satisfaction of personnel

Eff Sat BL = Tl Eff Sat BL(Ratio Per Sat)

~ dmnl

~ Effect of Satisfaction On Beginers Life

Eff Sat Exp = Tl Eff Sat Exp(SMOOTH(Ratio Cus Sat,CommPercTime))

~ dmnl

~ Effect of Satisfacion on Expenses for Advertisment

Eff Sat Prod = Tl Eff Sat Prod(Ratio Per Sat)

~ dmnl

~ Effect of satisfation of Productivity of perssonel

Eff Sat SL = Tl Eff Sat SL(Ratio Per Sat)
~ dmnl
~ Effect of Satisfacion on Sr Life
Eff Tech Com = Tl Eff Tech Com(Ratio Tech)
~ dmnl
~ Effect of Technology on Combination
Eff Tech Exp Unit = Tl Eff Tech Exp Unit(Ratio Tech)
~ dmnl
Eff Tech Var = Tl Eff Tech Var(Ratio Tech)
~ dmnl
~ effect of technology on variaty of company products
Eff Variaty Sat Cus = Tl Eff Variaty Sat Cus(Ratio Var)
~ dmnl
~ Effect of variaty on satisfaction of customer
Employing Cost = 1000
~ $/person
~ cost of employing one new personnel
Exp Unit = Eff Tech Exp Unit*Nor Exp Unit
~ dmnl
~ expenses on on unit
Fixed Cost = Other Exp+Salary
~ $/YEAR
Leaving Cost = 500
~ $/person
~ cost of personnel leaving the company
Maturing = Beginner Personel/Mat Time
~ person/YEAR
~ the rate of maturing of rookies
NoExp = 150
~ $/cus
~ normal budget used to attract a new customer
NoMT = 3
~ YEAR
~ normal maturing time
Nor Beg Life = 2
~ YEAR
Nor Cus Life = 3
~ YEAR
Nor Exp Unit = 8
~ $/sale
~ normal expenses for one unit of product
Nor Prod Beg = 1600
~ sale/person/YEAR
~ normal number of sales a beginer can handle in one year
Nor Tech = 1
~ tech
Nor Tech Inc = 0.07
~ 1/YEAR
~ normal rate of increasing technology
Nor Var Comm ([(1950,0)-(2010,2)],(1950,1),(1971.65,1.01408)
,(1983.09,1.07746),(1995.15,1.19718),(2004.12,1.3169),(2010,1.4507)
)
~ var
Normal Prod Sr = 2700
~ sale/(YEAR*person)
~ normal number of sales an Sr. can handle in one year
Normal Profit Ind = 0.08
~ dmnl

~ normal profit percent in industry

Normal Sat Cus = 1

~ sat

~ Normal Satisfaction of Customer

Normal Sat Per = 1

~ sat

~ Normal Satisfaction of Personel

Normal Sr Life = 4

~ YEAR

Other Exp = Sales Budget+Turnover Cost

~ $/YEAR

PCusExp = Eff Sat Exp*NoExp

~ $/cus

~ Per customer Expenses for Advertisment

Per Perc Qua = SMOOTH(Real Quality,Time Per Perc)

~ NOR PER/cus

~ Personel perception of quality

Personnel satisfacion = INTEG(Cha Sat Per,1)

~ sat

policy com = GAME(2)

~ dmnl

~ Policy for the ratio of Beginers to Sr.s

Pro Var Cost = Exp Unit*Sales

~ $/YEAR

~ the variable cost related to product

Profit = Revenue-Total Cost

~ $/YEAR

Profit Gap = Profit Percent-Normal Profit Ind

~ dmnl

Profit Percent = Profit/Revenue

~ dmnl

Quality Capacity = Eff Sat Prod*Nor Quality Capacity

~ sale/YEAR

~ the capacity of the company for offering service (in number of sales capable of handling)

Quality Goal = GAME(1)

~ dmnl

~ the goal of company for ratio of quality capacity to customers need

Quality Standard = INTEG(Change Standard,1)

~ dmnl

Ratio Beg Life = Be Life/Nor Beg Life

~ dmnl

Ratio Cus Perc Qua = Cus Perc Qua/(Nor Qua Comm)

~ dmnl

~ ration of Customer perception of quality to normal quality in community

Ratio Cus Sat = customer satisfacion/Normal Sat Cus

~ dmnl

~ ratio of customer satisfaction to normal

Ratio Per Sat = Personnel satisfacion/Normal Sat Per

~ dmnl

Ratio Sr Life = Sr Life/Normal Sr Life

~ dmnl

Ratio Tech = Technology/Nor Tech

~ dmnl

Real Quality = Quality Capacity/(Ave Cus Sales*Customers)*Eff Knowing

~ dmnl

~ Real Quality of company for customers

Revenue = Sales*Unit Price

~ $/YEAR

Sal Per = 0.1
~ dmnl
~ ration of total sales used for adv.
Salary = Beginner Personel*Beg Per Sal+Sr Personel*Sr Per Sal
~ $/YEAR
~ expenses for salary
Sales = Customers*Ave Cus Sales
~ sale/YEAR
Sales Budget = Sal Per*Revenue
~ $/YEAR
Sr Employ = (Desired Personel/(1+Des Com)-Sr Personel)/TiEmSr+Sr Leave
~ person/YEAR
~ Rate of Sr. Employment
Sr Leave = Sr Personel/Sr Life
~ person/YEAR
~ rate of Sr. personel leaving the system
Sr Life = Eff Sat SL*Normal Sr Life*Sr life policy effect
~ YEAR
~ actual Sr. Life
Sr life policy effect = GAME(1)
~ dmnl
~ policy of company to keep its Sr. personel
Sr Per Sal = 20000
~ $/YEAR
~ Sr. Personnel salary
Sr Personel = INTEG(Maturing-Sr Leave+Sr Employ,10)
~ person
~ number of experienced personel
Table Eff Know ([(0,0)-(2,2)],(0,0.838028),(0.360825,0.887324)
,(0.721649,0.922535),(1,1),(1.29897,1.07746),(1.62371,1.12676)
,(1.99485,1.14085))
~ dmnl
~ Effect of knowing personel on quality table
Tech Aging = Technology/Tech Life
~ tech/YEAR
~ rate of aging of technology
Tech Increase = Eff Gap On Tech Inc*Nor Tech Inc*Technology*Eff Profit Tech
~ tech/YEAR
Tech Life = 15
~ YEAR
~ life of technology
Technology = INTEG(+Tech Increase-Tech Aging,1)
~ tech
TiEmBe = 0.1
~ YEAR
~ time to employ a beginer
TiEmSr = 0.2
~ YEAR
~ time to emply a sr
Time Change Sat Cus = 0.5
~ YEAR
~ time it takes to change satisfation of customers
Time change Sat Per = 0.3
~ YEAR
~ time it takes to change the satisfaction of personnel
Time Change Standard = 0.5
~ YEAR
Time Cus Perc = 0.8

~ YEAR

~ time for customer to perceive real quality

Time Per Perc = 0.5

~ YEAR

~ time for personel to perceive real quality

Tl Eff Gap Tech Inc ([(0,0)-(2,2)],(0,1.2),(0.262887,1.17606)
,(0.706186,1.11972),(0.891753,1.06338),(1,1),(1.1701,0.753521)
,(1.37113,0.443662),(1.55155,0.253521),(1.74227,0.0915493),(1.88144,0.0422535)
,(2,0))

~ dmnl

~ effect of technology gap on technology increase

Tl Eff Profit Tech ([(-0.1,0)-(0.1,2)],(-0.1,0.1),(-0.0881443,0.415493)
,(-0.0737113,0.647887),(-0.0510309,0.788732),(-0.0329897,0.84507)
,(-0.0175258,0.894366),(0,1),(0.0190722,1.14085),(0.0458763,1.32394)
,(0.0680412,1.40845),(0.1,1.5))

~ dmnl

~ effect of profit on technology increase table

Tl Eff Qua Sat Cus ([(0,0)-(2,2)],(0,0.2),(0.278351,0.316901)
,(0.489691,0.492958),(0.695876,0.71831),(1,1),(1.3299,1.24648)
,(1.57732,1.41549),(1.76804,1.52113),(2,1.6))

~ dmnl

~ Effect quality on satisfaction of customer table

Tl Eff Qua Sat Per ([(0,0)-(2,2)],(0,0.7),(0.28866,0.71831)
,(0.494845,0.767606),(0.675258,0.838028),(1,1),(1.30412,1.14789)
,(1.55155,1.22535),(1.78866,1.28169),(2,1.3))

~ dmnl

~ Effect quality on satisfaction of personnel table

Tl Eff Sat BL ([(0,0)-(2,6)],(0,0.5),(0.479381,0.591549),
(0.778351,0.78169),(1,1),(1.2732,1.47887),(1.53608,2.07042),
(1.70103,2.38732),(1.85052,2.61972),(1.92784,2.72535),(1.98969,2.74648)
)

~ dmnl

~ Effect of Satisfation of Beginers Life Table

Tl Eff Sat Cus Life ([(0,0)-(2,5)],(0,0.1),(0.345361,0.28169)
,(0.628866,0.528169),(0.850515,0.774648),(1,1),(1.19072,1.25)
,(1.35052,1.5669),(1.53093,2.28873),(1.65979,3.20423),(1.82474,3.85563)
,(1.91237,3.94366),(2,4))

~ dmnl

~ Effect Satisfation On Custumer Life Table

Tl Eff Sat Exp ([(0,0)-(2,10)],(0,8),(0.190722,5.66901),(0.386598,3.90845)
,(0.592784,2.28873),(0.768041,1.47887),(0.860825,1.19718),(1,1)
,(1.30412,0.669014),(2,0.4))

~ dmnl

~ Effect Satisfaction on Expenses Table

Tl Eff Sat Prod ([(0,0)-(2,2)],(0,0.3),(0.340206,0.394366),
(0.675258,0.697183),(1,1),(1.41237,1.21831),(2,1.4))

~ dmnl

~ Effect of Satisfaction of Productivity of personel Table

Tl Eff Sat SL ([(0,0)-(2,6)],(0,0.2),(0.42268,0.316901),(0.675258,0.507042)
,(0.912371,0.78169),(1,1),(1.15979,1.45775),(1.34536,2.1338)
,(1.59794,3.46479),(1.76804,4.56338),(1.81959,4.8169),(1.87629,4.94366)
,(1.92784,5.00704),(2,5))

~ dmnl

~ Effect of Satisfacion On Sr. Life

Tl Eff Tech Com ([(0,0)-(2,2)],(0,0.8),(0.304124,0.802817),
(0.551546,0.84507),(0.819588,0.922535),(1,1),(1.19072,1.1831)
,(1.31959,1.28873),(1.45876,1.39437),(1.61856,1.42958),(2,1.5)
)

~ dmnl
~ Effect technology on combination Table
Tl Eff Tech Exp Unit ([(0,0)-(2,2)],(0,1.3),(0.247423,1.28169)
,(0.520619,1.22535),(0.78866,1.1338),(1,1),(1.19072,0.894366)
,(1.5,0.788732),(1.74227,0.725352),(2,0.7))
~ dmnl
Tl Eff Tech Var ([(0,0)-(2,2)],(0.0103093,1.0493),(0.293814,1.04225)
,(0.71134,1.02817),(0.876289,1.02113),(1,1),(1.08763,0.950704)
,(1.17526,0.84507),(1.40206,0.669014),(1.62887,0.577465),(1.78866,0.528169)
,(2,0.5))
~ dmnl
~ effect of technology on variaty table
Tl Eff Variaty Sat Cus ([(0,0)-(2,2)],(0,0.4),(0.247423,0.478873)
,(0.489691,0.612676),(0.690722,0.739437),(0.860825,0.887324)
,(1,1),(1.15979,1.11268),(1.37113,1.19718),(1.60309,1.24648)
,(1.82474,1.27465),(2,1.3))
~ dmnl
~ Effect variaty on satisfaction of customer table
Tl Nor Qua ([(1950,0)-(2020,2)],(1950,1),(1965.52,1.0493)
,(1971.65,1.08451),(1980.31,1.1338),(1989.15,1.21127),(2001.6,1.35915)
,(2010.98,1.48592),(2020,1.67606))
~ NOR PER/cus
Total Cost = Fixed Cost+Pro Var Cost
~ $/YEAR
Turnover Cost = Employing Cost*(B Employ+Sr Employ)+Leaving Cost*(Be Leave+Sr Leave)
~ $/YEAR
~ turnover cost of company
Unit Price = 20
~ $
Variaty = Variaty Policy*Eff Tech Var
~ var
~ variaty of products of company
Variaty Policy = GAME(1)
~ var
~ policy of company for variaty of products
****
.Control
~
Simulation Control Paramaters
FINAL TIME = 2010
~ YEAR
~ The final time for the simulation.
INITIAL TIME = 1950
~ YEAR
~ The initial time for the simulation.
SAVEPER =
TIME STEP
~ YEAR
~ The frequency with which output is stored.
TIME STEP = 0.1
~ YEAR
~ The time step for the simulation.