A SIMULATION MODEL FOR TELECOMMUNICATIONS SERVICES PARTIALLY SUBSTITUTING.

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1.- Introduction

In the S.D. conference (1.993), was exposed the Mistela, an integrated simulation model applied to a Telecommunications Operator. This described among other questions, the forecast demand equations of traditional services with historical data (monthly, since 01.1980 to 12.1992), based on conventional econometric procedures. However, the provision of demand of new services can not be made by this method, and we appealed then to other kind of model. In the new version of Mistela the demand equation of a new service draws a logistic curve. Thus we appeal to Lotka-Volterra models, so of the kind predator-prey, based on the following analogy: The total market is the roof, or the saturation level, and the behaviour of each predator would be connected among them, so the pure logistic would be modified as a function of aggressivity among the services. Such aggressivity depends of the price policy, the relative quality,..., of the market strategy in short.

2.- Objective

The present work intends to contribute with a practical accomplishment on the evolution of the different mobile telephony services in use in Spain, taking advantage of facilities of software Vensim,. We will refer it step by step, so that other colleagues could use it in subsequent projects, in a way similar to as us have made or attempted to make with the precedents .

3.- The system (dynamic)

The mobile telephony starts in Spain in 1.982 with analog systems or ***tma***, with a slow takeoff, and it is in October of 1.995 that makes its appearance a new technology, or ***gsm***.
The view of these observed data and the experience of happened what is in other countries, carries us to suspect the possible application of a model Lotka-Volterra type, (like theVijay Mahajan-Eitan Muller). Evidently each case (system) carries associate a series of factors or exigible phenomena to a correct interpretation of the mere mathematics formulae that we employ in explaining the phenomenon: Conditions like publicity, price, complexity of use, coverage, tariffs of the calls, infection,... own of the strategies of the marketing, and of the technology in fact. These features come collected, and explained in a series of terms or variables, that in principle and by simplicity we identify like constant or parameters. Subsequent models more refined will assume the variability in the time of the same, or the explicit dependencies in relationship to other variables, like the mentioned price.

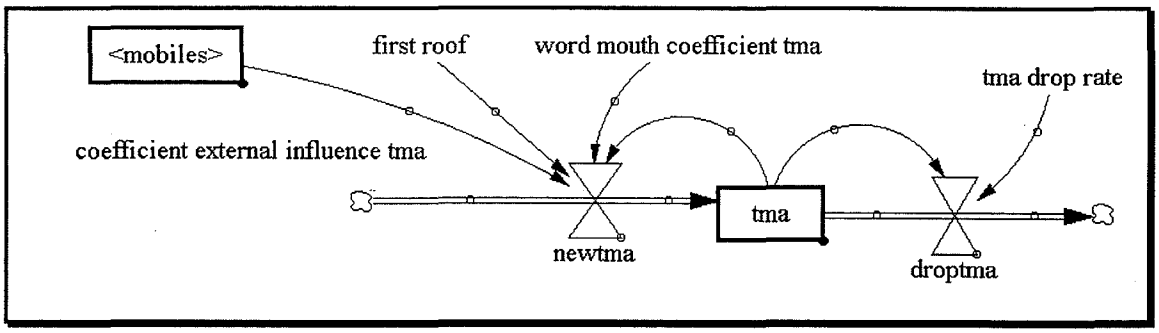
4.- Description of the model.

Initially, in the first period, while only exists the tma, the growth comes explained by the model of Bass: $dx1/dt = (a1 + b1x1/N1)(N1 - x)$, that translated to Vensim, and with the meaning associated with each element is :

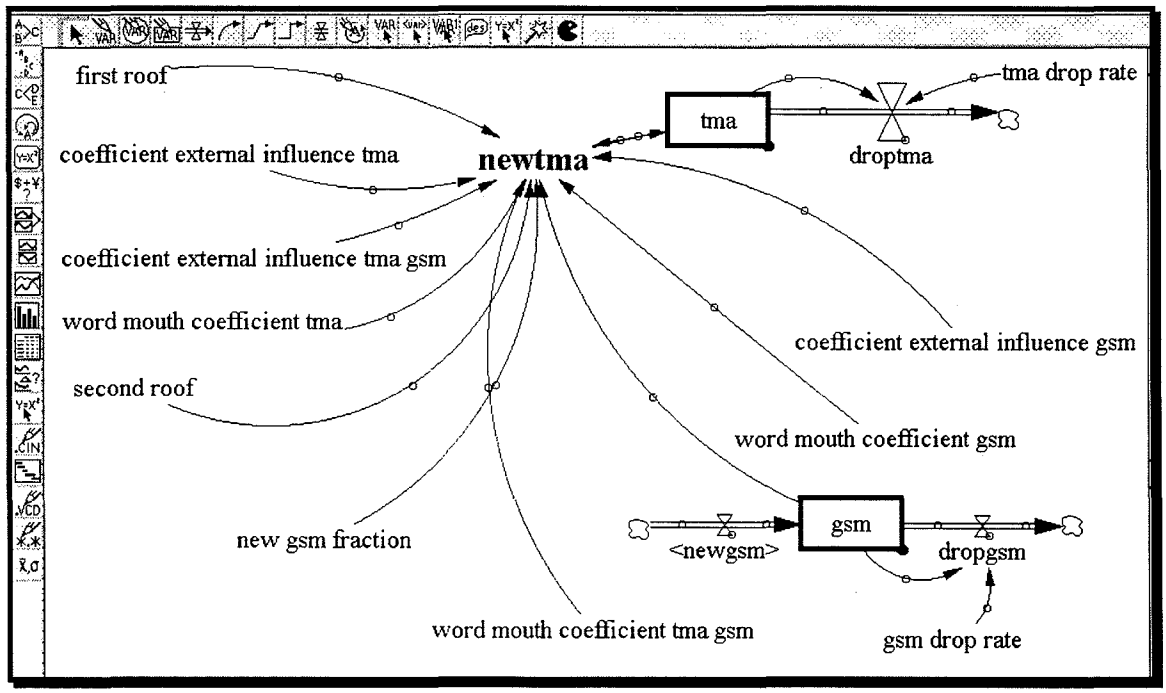
newtma=(coefficient external influence tma + word mouth coefficient tma*tma/first roof)* (first roof- mobiles)

Where the new tma customers or newtma, are proportional to the external influence coefficient (that it is related to the appraisal on the part of potential market of the campaigns of the promoting of the service tma), plus the contribution of the contagion effect (mouth-to-

mouth propaganda) among clients and not clients, through contact between both collective. Graphically:



When it appears a second competitor, the gsm, we consider that the potential market is expanded, on the one hand were having the first roof, that is increased with potential clients that appreciate the new performances of the second system, like better quality of voice, possibility of transmitting data, use in foreign countries, and other. This compels us to consider different values for the parameters, as are evident, among other: More aggressiveness in the advertising (external influence coefficient), more communication of the mouth-to-mouth due to the novelty of the appended services. In spite to have a greater roof, some of the new clients (second roof - mobiles) will not buy the old system, we consider thus a proportion or fraction of the potential of new gsm clients. The discrepancy (1-new gsm fraction), or rather the rest acquire the old system. Exist on the other hand the possibility of the fact that part of the ancient tma costumer, upgrade to the new system, this is reproduced with a similar expression, but affected of different values in their imitation and innovation parameters. Graphically the model is the next:



The model in Vensim, remain with these new supposed:

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mobiles=tma +gsm [total clients of mobil phones (in service)]
droptma=tma*tma drop rate

gsm=INTEG(newgsm-dropgsm,gsm initial)
newtma=(1-u)*(coefficient external influence tma +word mouth coefficient tma*tma/first roof) *
(first roof- mobiles) + u*((1- new gsm fraction)*(coefficient external influence gsm +
(word mouth coefficient tma*tma+ word mouth coefficient gsm*gsm)/second roof)*(second roof - mobiles)
- new gsm fraction * (coefficient external influence tma gsm +word mouth coefficient tma gsm*gsm /second roof)*tma) [new clients of mobil phones tma]
migration tma= u* (new gsm fraction * (coefficient external influence tma gsm +
word mouth coefficient tma gsm*gsm/second roof)*tma) [new clients in gsm from tma upgraders]
newgsm=u*(new gsm fraction*(coefficient external influence gsm +
(word mouth coefficient tma*tma+ word mouth coefficient gsm*gsm)/second roof)*(second roof - mobiles)
+ new gsm fraction * (coefficient external influence tma gsm + word mouth coefficient tma gsm *
gsm / second roof)*tma)
demand tma=newtma-droptma
nigsm=newgsm-dropgsm [net demand new clients in mobil phones of gsm]
dropgsm=gsm*gsm drop rate
u=if then else(Time<67,0,1) [activation of second period]
tma =INTEG(newtma-droptma,tma initial)

The task is now, to determine the parameters. Initially, in feature of the observed values, and through rapid calculations, we give to these some values, and we simulate. Observing considerable discrepancies, we attempt a greater approach, through the adjustment of the calculated values of the most meaningful variables, with the observed data of the same. This operation we accomplish it through the *parameter optimization of Vensim*. Also, as contrast, we look into a file, generated in the calibration, that classifies the relative importance of each parameter in the difference among data and model. As can verify below, these values of little relief, they are very next to zero.

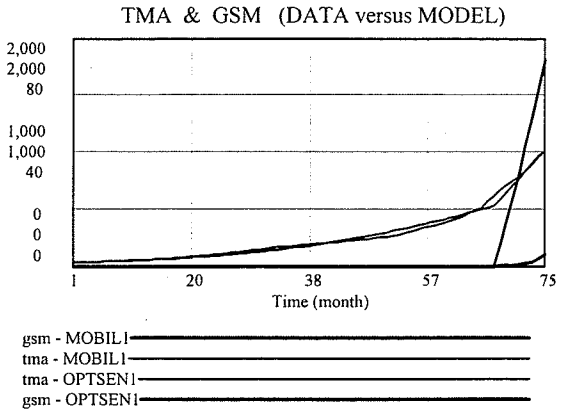
Calibration: Output File

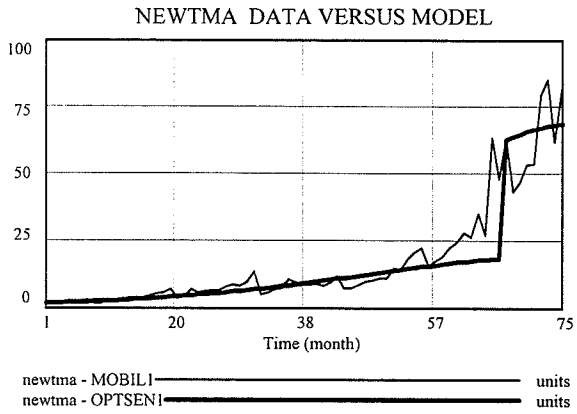
Initial point of search.
COEFFICIENT EXTERNAL INFLUENCE GSM = 0.01.
GSM DROP RATE = 0.02. NEW GSM FRACTION = 0.03.
WORD MOUTH COEFFICIENT TMA = 0.06. ... ...
Simulations = 1. Pass = 0. **Payoff = -1.79427e+007**.
After 1349 simulations. **Best payoff is -55931.5** .Normally terminated optimization
:OPTIMIZER=Powell.:SENSITIVITY=All Constants=10
0 <= COEFFICIENT EXTERNAL INFLUENCE GSM = 0.00839895 <= 0.5
0 <= C EXT INFLUENCE TMA = 0 <= 0.5 +/ 0 <= C EXT INFL TMA GSM = 0.0490957 <= 0.5
0 <= GSM DROP RATE = 0 <= 0.5 */ 0 <= TMA DROP RATE = 0.00629905 <= 0.5
0 <= NEW GSM FRACTION = 0.0785066 <= 0.5
0 <= W MOUTH C GSM = 0 <= 0.5 */ 0 <= W MOUTH C TMA = 0.05939 <= 0.5 */0 <= W M C TMA GSM = 1 <= 1

Parameter Sensitivity

Sorted Parameter Sensitivities: Parameters are changed by +- 10%, if 0 by +- 0.1

PARAMETER	-0.1	0.1
coefficient external influence tma=0	-1.29807e+033	-6.47774e+007
word mouth coefficient tma=0.0593944	-300426	-370155
tma initial=29.783	-28058.7	-30743
first roof=1300	-13953.5	-3911.73
second roof=5500	-5285.86	-5627.25
tma drop rate=0.00629905	5475.85	-4944.63
coefficient external influence gsm=0.00839895	-3274.46	-3244.64
word mouth coefficient gsm=0	98.7052	-1767.5
gsm drop rate=0	-1751.26	-898.428
new gsm fraction=0.0785066	-339.475	-432.565
coefficient external influence tma gsm=0.049095	-37.606	-34.4523
word mouth coefficient tma gsm=1	-28.0081	27.3326
gsm initial=0	13.5475	-14.3634





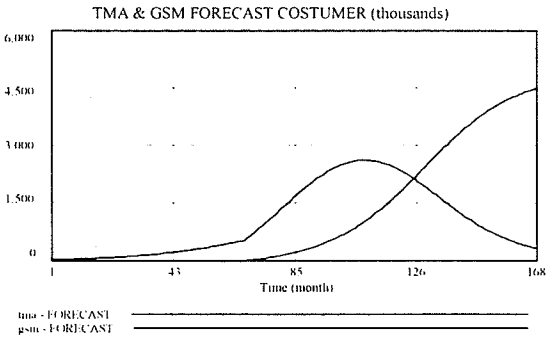
The view of these results give us a certain margin on the kindness of the procedure, accompanied results of the followed logic: They are warned more the promotional efforts of the GSM among users of the TMA, it does not exist infection among users of the GSM, it there is low among those of TMa, and very high among those which are candidates to migrate to GSM. Prevail the attraction to the old system, more consolidated, better known, more coverage,...

On the other hand, some observed data let something that wish, by their erratic behavior, what makes us to note any possible error of picking up or transcription. When this is thus, we will must to recalibrate it through the KALMAN filter, that assures us a front immunity to the noise and errors so much in the structure of the model, as of the observed data.

5. Next projects.

We will follow investigating in the use of Kalman filtering, to settle the inaccuracy of the observed data. Also we will complicate the model, transforming some of the parameters in variables depending of the time and other variables of the environment, like the price. Thus for example this could make vary the roof, by means of a formulation like:

$N(t)=[M(t_o)(P(t_o)/P(t)]\ ^{\wedge}b$, where b measures the elasticity of demand to the price, and N is the roof, in t_o and in t time.



Other factors will have to be introduced in the system as corrections to a simple optimization position, for instance: Restrictions to the growth of the primitive technology, in favor of the new, the favored tariffs of gsm, to confront other of competitors that appear and complicate this development of two species,... All this carries to different figures of this attached graph.

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