Order and Disorder in a Creative Organisation

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Abstract

This paper addresses the survival of an organisation in the fight for competitive advantage. A simple model of a non-standard successful organisation has been built using System Dynamics which requires definitions of terms such as Quality, Momentum and Inertia. The non-linear nature of this model gives rise to complex behaviour which is explored and analysed. It is concluded that for a company to survive in an ever changing environment it is crucial that it the changes as early as possible and responds to them adequately.

1. Introduction

The authors are interested in the analysis of complex behaviour and are currently investigating several different approaches. Classical approaches search for equilibrium solutions but recent research (Nicholis and Prigorgine 1989) indicates that these solutions are not the best way to deal with the inevitable instabilities and variations in the environment. Looking only at equilibrium solutions excludes parts of the system that could offer more variety. New approaches such as analysing far from equilibrium conditions (Mosekilde and Sterman, 1988) and chaos offer more informative solutions.

A topical and interesting business scenario involving ideas of quality and business organisational structures has been chosen as a vehicle to use the System Dynamics methodology. The authors believe that this approach enriched by the recent discoveries of non-linear dynamics (Strogatz 1994) is a useful heuristic for creating models that exhibit complex behaviour and Powersim is an interactive user friendly tool for exploring the complex behaviour.

2. Background to the Problem.

The background to the problem chosen is contained in a paper presented at the 1994 International System Dynamics Conference at Stirling by the same authors (Stoyanova 1994) This paper described a Danish hearing aid company called Oticon. This company is interesting in so far as the structure of the company was turned upside down in an attempt to allow creativity, imagination and information flow to flourish without the stifling effects of bureaucracy. A causal loop model of the company was produced which tried to capture the innovative structure of the company. This involved defining new concepts such as Momentum and Inertia. The authors are particularly interested in taking well known physical or engineering terms and investigating their relevance in business scenarios. One important property of mathematics is that it is isomorphic and the application of these isomorphisms are fascinating. This paper refines the previous model, describes several runs done on Powersim and analyses the results.

3. Definitions of terms used in the model.

Quality

The term " quality " is overused today and has a myriad of meaning in the business world. The following table is taken from a recent paper (Reeves and Bednor 1994) and provides a succinct summary of important interpretations of the meaning of quality. The meaning chosen by Oticon was "meeting customer expectations" Evaluations from the customer's perspective are taken into account thus making response to market changes important. Oticon , although number four in the world, are considerably smaller than their rivals and to therefore to maintain their market share they must respond quickly to changes in customer demand. Our definition of quality therefore is how well the profile of the product can match the profile of customer expectation. It is assumed that this customer profile is changing and a mark of quality is the speed at which the firm can respond to these changes. Oticon are aware of the weaknesses that are stated in the table but minimise these weaknesses by investing a great deal of research into their customer evaluation procedures.

Definition	Strengths	Weaknesses
Excellence	strong marketing and human resource benefits Universally recognisable- mark of uncompromising standards and high achievement	Provides little practical guidance to practitioners Measurement difficulties Attributes of excellence may change dramatically and rapidly Sufficient number of customers must be willing to pay for excellence
Value	Concept of value incorporates multiple attributes Focuses attention on a firm's internal efficiency and external effectiveness Allows for comparisons across disparate objects and experiences	Difficulty extracting individual components of value judgement Questionable inclusiveness Quality and value are different constructs
Conformance to Specifications	Facilitates precise measurement Leads to increased efficiency Necessary for Global Strategy Should force disaggregation of consumer needs Most parsimonious and appropriate definition for some customers	Consumers do not know or care about internal specifications Inappropriate for services Potentially reduces organisational adaptability Specifications may quickly become obsolete in rapidly changing markets Internally focused
Meeting and/or exceeding expectations	Evaluate from customer's perspective Applicable across industries Responsive to market changes All-encompassing definition	Most complex definition Difficult to measure Customers may not know expectations Idiosyncratic reactions Pre-purchase attitudes affect subsequent judgements Short-term and long-term evaluations may differ Confusion between customer service and customer satisfaction

Table One. Strengths and Weaknesses of Quality Definitions

The description of the product depends on many attributes such as design, price, usefulness, comfort etc. One possibility would be to construct a vector having these components but this would cause unnecessary complications to the analysis. We have therefore assumed that the different attributes can be given a weighted average and thus can be represented as a scalar quantity called "worth". There are three different instances of worth in the model - the worth that the customer puts on the product (Cust_exp), the desired worth of the product set by the company in response to the customer expectation (PDP) and the actual worth of the product that is produced (AP). There are two important causal loops in the model: - one which tries to match PDP to Cust_exp and the other an internal efficiency loop matching AP and PDP.

Quality is defined as the ratio measuring the actual worth of the product to the customer expectation. This can take values between 0 and 1, 1 meaning excellent quality.

This definition of quality has an effect on the conceptual model of the management of the firm. Clemmer (1992) discusses the "traditional paradigm" of management. He noted that in the old paradigm managers do the thinking, employees are there solely to follow instructions. Objectives, standards and measurements start at the top and cascade down the organisation. This paradigm corresponds to what can be called the " mechanistic model of an organisation" described by many classical management theorists. This model describes the organisation as a tool or a machine designed solely to create profits for its owners and its organisational life is governed by clockwork precision. This contrasts starkly to the "organismic model of management " adapted from von Bertalanffy's (1950) work on general systems theory. Here the organisation is compared with an organism whose sole purpose is survival. Like living organisms, organisational structures are dependent on their environments for resources and they can adjust the behaviour of their parts to maintain the properties of the whole within acceptable limits. Management's role is to act as the brain of the system (Beer 1981). It gathers information from the environment by means of good information channels. Feedback is important.

This model induces our current definition of quality and both are strongly linked to current Total Quality Management theories (Spencer 1994).

Critical Mass

This term is needed in the definitions of momentum and inertia. The ideas developed here come from many informative and stimulating discussions with Jerry Meek who is a leading UK cybernetist (Meek 1995). In this paper, we consider mass from three different aspects - size, energy and negative entropy. The size of the company is self evident . The energy of a company can correspond to its activities. It is a measure of how active it is - how many tasks it completes. Negative entropy equates to the information flows - how information passes around the company. (This is one aspect that Oticon has deliberately tried to improve by creating the paperless office etc.) The measures of these different aspects are immensely different - matter converts to energy using $E=mc^2$ and matter converts to negative entropy using Bremermann's limit. The sum of these three components is a constant for any firm. From an observer's point of view two firms could appear to have the same mass yet in reality could be completely different. One could be very much bigger than the other in terms of physical size but the smaller one equates to the larger by using information in a much more positive way.

Momentum

Momentum is defined as the potential of the firm to continue performing the same way. To change behaviour an external or internal force or action is needed. An increase of product performance increases the momentum. Maintaining a performance, the company is pointing in a specified direction and the momentum keeps it going (De Bono 1993) In order to preserve this analogy, momentum is defined in the model as proportional to mass * quality. In this definition the term mass concentrates on the physical size of the firm. Thus a firm which values its product and increases its size will increase its momentum i.e. its tendency to keep producing that product.

Inertia.
Inertia can be defined as that property of matter by virtue of which a body continues in its existing state whether at rest or in uniform motion. (Greenwood 1979) Another definition is "the willingness of things to stay exactly as they are unless moved by a sufficient force" Inertia is not a matter for opposition but of inaction (De Bono 1979). This effort or time taken needed to respond to a change in the environment is taken as a measure of inertia. There is also a effect caused by the mass - it takes longer to move a large object than a small one.

We consider two types of inertia:- the inertia of perception and the inertia of implementation. The inertia of perception corresponds to the time taken for the company to match the desired worth of the product with the customer expectation. The aspect of mass that is important here is the information or negative entropy aspect. If the information aspect is large then the physical size aspect is relatively diminished and therefore the inertia is diminished. If there is little information flow then the physical size aspect dominates and therefore the inertia increases. The inertia of implementation uses the energy aspect of mass i.e. the measure of how active the company is. There is a similar argument i.e. the more energy, the less inertia.

4. The System Dynamics Model

The System Dynamics model is shown in Figure 2 and the equations are shown in Appendix 1. There are several key variables that need to be explained.

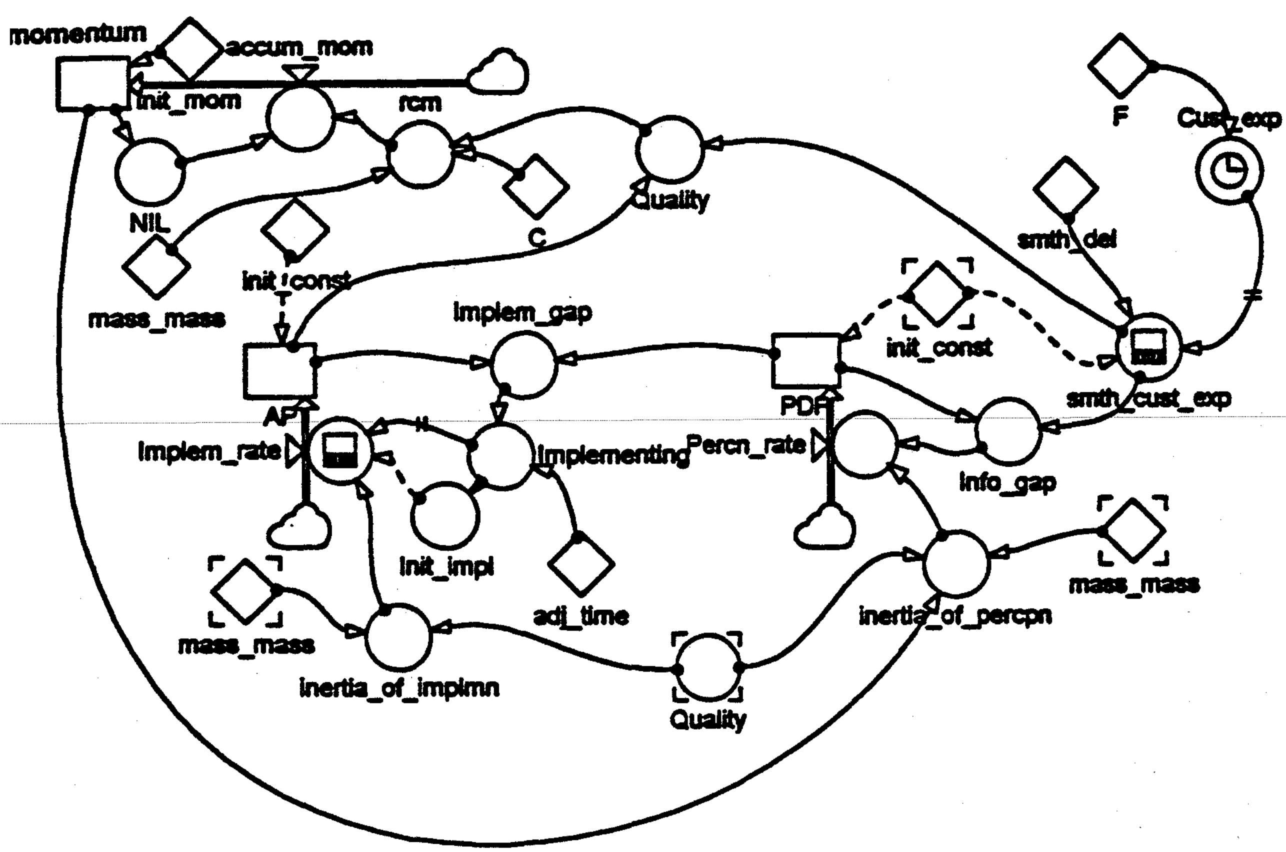

Figure 1. - The System Dynamics Model

Rate of Change of Momentum

Figure 2 represents the rate of change of momentum. We are attempting to model the case that when quality is good and the firm has a certain critical mass, momentum will build up. We have chosen a cut-off point denoted by "C" on the diagram If quality is above this point then momentum will be added to the system otherwise it will not. The region we are interested in is shaded in the diagram. We originally thought that the behaviour of the system would be sensitive to the value of "C", but preliminary runs seem to indicate that it is the combination of C and mass that is more significant. The function taken to give this shape is ARCTAN. The slope of the curve is governed by the critical mass - the bigger the mass, the quicker momentum builds up.

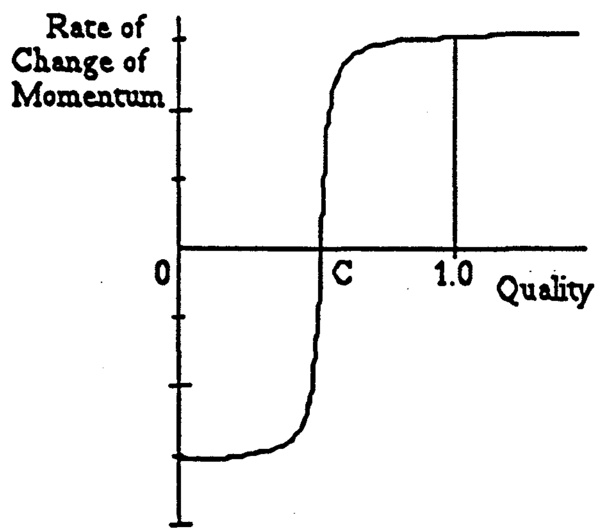

Figure 2. Rate of Change of Momentum

The Inertia of Perception.

This inertia is dependent on the critical mass and the quality. The delay caused by this inertia is also increased by momentum. To represent this we have again used a modified ARCTAN function as shown in Figure 3. Again the slope of the curve is related to the critical mass and as quality increases, the inertia builds up to a peak. The momentum adds an extra delay as can be seen.

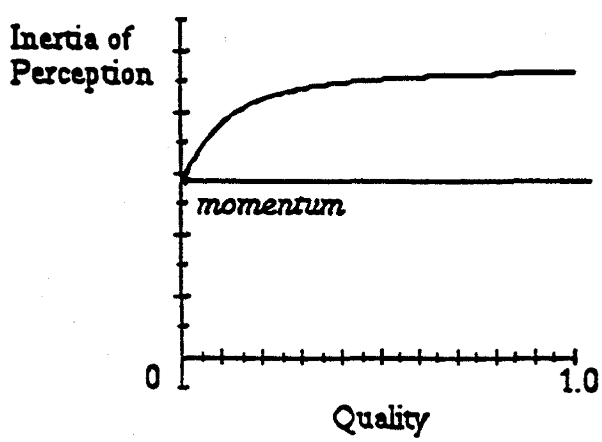

Figure 3. The Inertia of Perception

The Inertia of Implementation.
As the quality ratio increases, the willingness to implement new ideas diminishes and therefore the Inertia increases. This inertia then acts as a delay on the implementation rate. Again the critical mass will also affect the inertia. To model this we initially chose a square law but we found that a cubic expressed the situation more realistically

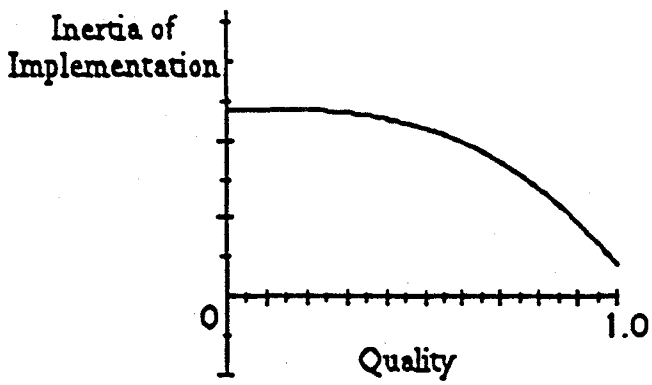

Figure 4. The Inertia of Implementation

Customer Expectation
This is an input to the system. We are interested in the case when a certain product maintains constant customer expectations for some time (start the model in equilibrium), then customer expectations change abruptly and continue changing until stabilising around a certain level.

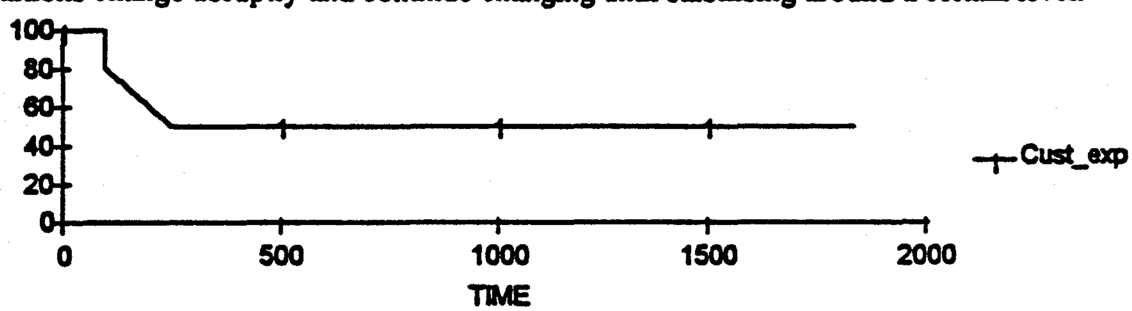

Figure 5. Customer Expectations

5. Results

Many simulations of this model were completed with Powersim using a Runge-Kutta fourth order integration technique. We have found that the eventual state of the company is a delicate balance between the mass, the quality and the momentum. Quality and mass drive the momentum which has a positive link to the inertia of perception. But quality and mass are themselves linked to the inertia and it is the balance between these influences that determines the final outcome. We have found a critical value for the mass. Below this value, the company succeeds and above this value it goes to failure through what seems a chaotic transient. This is shown in the following two runs.

Run 1 (Figure 6) shows the situation where the company survives. The value of the mass is below the critical value. As the customer expectation changes, the quality fluctuates. The length and depth of the transient depends on the value of the mass.

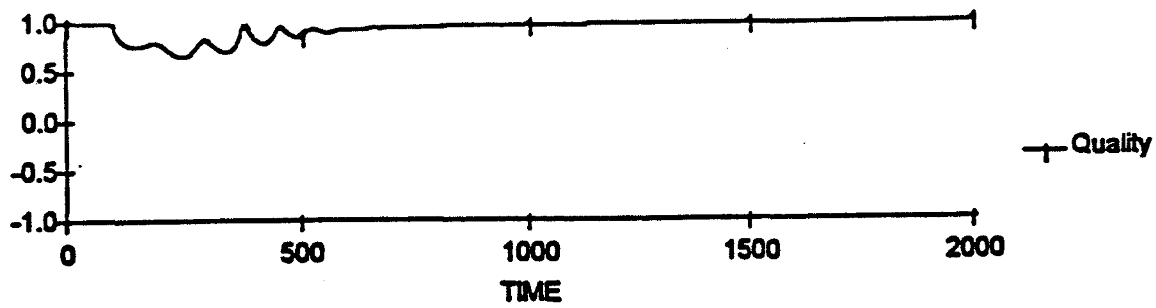

Figure 6. Run 1. Company survives the change

Run 2 (Figure 7) shows the same customer input but with a mass slightly higher than the critical value. Here we have what could be a chaotic transient and the firm does not recover.

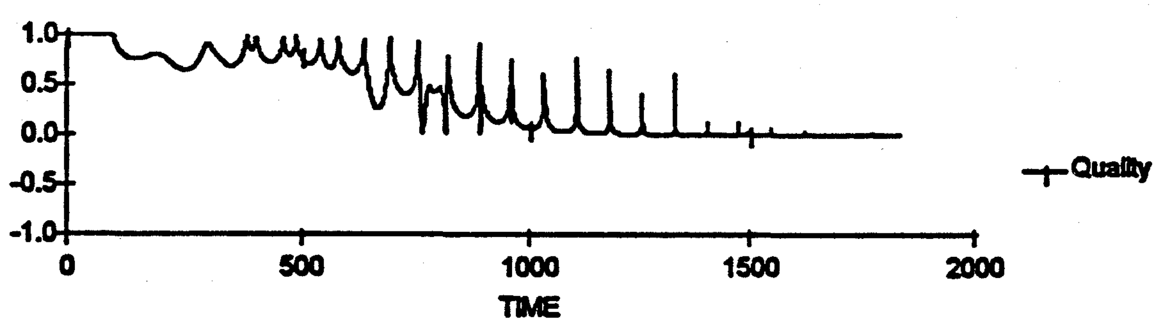

Figure 7. Run 2. Company does not recover after change of environment

We were now interested with what would happen with a more varied input Run 3 (Figure 8) repeats run 1 but with a sinusoidal type input.

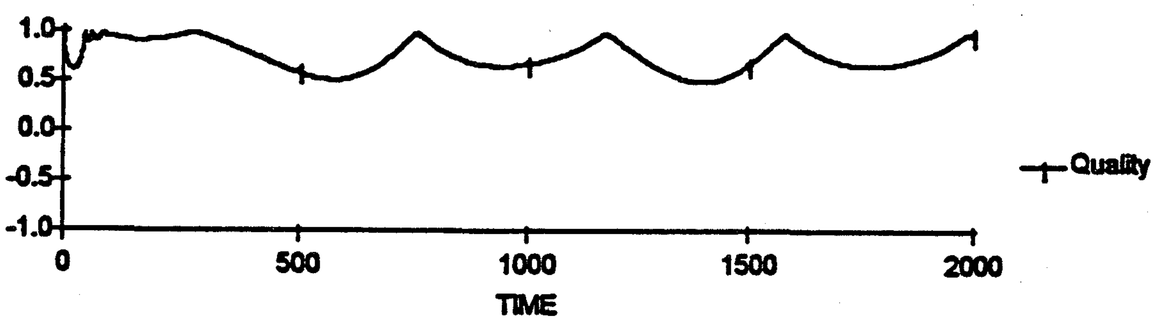

Figure 8. Run 3. Company survives the change

Run 4 (Figure 9) repeats run2 for the new input.

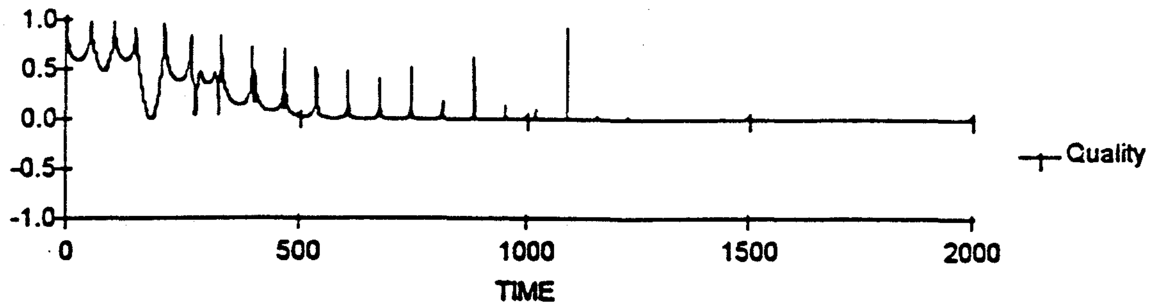

Figure 9. Run 4. Company does not recover after change of environment

6. Conclusion

This was an interesting modelling exercise. Terms such as momentum and inertia have been taken from Physics and we have attempted to use them in a business environment. The idea of the mass of a firm proved to be a critical factor. It should be stressed that our concept of mass has three different aspects and a large mass does not necessarily correspond to a large - in the physical or monetary sense - company.

For a company to survive in an ever changing environment (Cust_exp) it is crucial that it picks up quickly the changes and responds to them. In our model this means diminishing the two inertias. Our examples show that mass in whatever form is a critical variable. There is a critical value in our model and companies below this value have a good chance of surviving whatever the environment. Surviving means continuous adaptation to the changes.

Many runs are still needed to be done and the model is constantly being refined.

7. References

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Appendix 1

```
□ AP
  INIT init_const
  +dt*(Implem_rate)
□ momentum
  INIT init_mom
  +dt*(accum_mom)
□ PDP
  INIT init_const
  +dt*(Percn_rate)
○ accum_mom
  = IF(rcm<0,IF((rcm+NIL)<0,0,rcm),rcm)
○ Implem_rate
  = DELAYMTR(Implementing,inertia_of_implmn, 3,Init_impl)
○ Percn_rate
  = Info_gap/inertia_of_percpn
○ Cust_exp
  = IF(TIME<100, 100, IF ((80-(TIME-100)/F)>50, 80-(TIME-100)/F,50))
○ Implem_gap
  = PDP-AP
○ Implementing
  = Implem_gap/adj_time
○ inertia_of_implmn
  = 4+mass_mass*(1-Quality^3)
○ inertia_of_percpn
  = momentum+5*(3.14/2 + ARCTAN(mass_mass*Quality))
○ Info_gap
  = smth_cust_exp-PDP
○ Init_impl
  = Implementing
○ NIL
  = momentum
○ Quality
  = IF (( AP*smth_cust_exp)>0, MIN(ABS(smth_cust_exp),ABS(AP)) / MAX(ABS(AP),ABS(smth_cust_exp)),
MIN(ABS(smth_cust_exp),ABS(AP))/(MAX(ABS(AP),ABS(smth_cust_exp))+ MIN(ABS(smth_cust_exp),ABS(AP))))
○ rcm
  = 0.3*ARCTAN(mass_mass*(Quality-C))
○ smth_cust_exp
  = DELAYINF( Cust_exp,smth_del,1,init_const)
◇ adj_time
  = 9
◇ C
  = 0.5
◇ F
  = 5
◇ init_const
  = 100
◇ init_mom
  = 0
◇ mass_mass
  = 55
◇ smth_del
  = 12
```