A simulation model for the behaviour of innovative companies.

by **Marco Santoni**,
Elemedia, Via dei Bruni 27, 50139 Firenze. tel. 055/475500
E-mail msantoni@mailhub.val.it

Abstract

ASIMOV (Autopoiesis Simulation Model for Valuation) was developed in the context of an applied research project on Small and Medium-sized Enterprises (SME), and is a simulation model for the behaviour of an innovative company in a market characterised by rapid changes.

The model is based on two elements: the **nucleus** and the **membrane.** The nucleus represents the operational strength of the company; the membrane its capacity for interaction and exchange with the outside world.

Special attention is paid to the membrane for the effects of telematics, particularly telework. In fact, the model is intended as a predictive instrument for the implementation of types of telework.

The purpose of ASIMOV is to make forecasts regarding the nucleus-membrane dynamics that take place in companies after an investment in an observable and partly predictable market. With a three-year time horizon in the simulation it is possible to consider most phenomena. The simulation model, developed with High Performance Systems Inc.'s **I THINK® ,** is parametric, allowing it to adapt quickly to specific situations at reasonable cost.

Basic structure

The basic model is inspired by the concept of autopoietic organisation as developed by H. Maturana and F. Varela. Autopoiesis is the self-replicating ability of living things; that is, the processes of transformation and subsequent reorganisation of the components of the individual. In analysing innovative companies we felt it necessary to use this model: even these, to stay competitive, must exploit to the maximum their self-organising capacity. A change is now taking place on the outside which should be considered: the telematic opportunity, particularly telework, will strongly influence the membrane dynamics, and also act upon the nucleus.

From observation of innovative SMEs we can deduce that these tend to evolve with periodic oscillations between two extremes: one where the activity of the nucleus prevails and then that of the membrane.

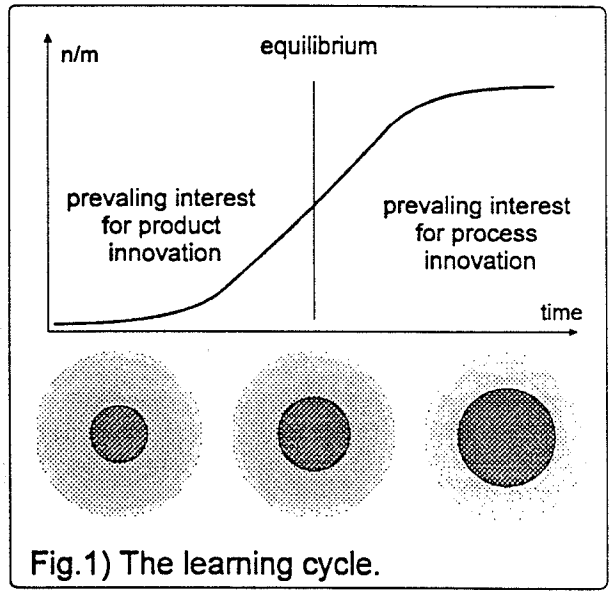


Fig.1) The learning cycle.

The oscillation is necessary to reap the benefits of the reciprocal activity: the nucleus transforms the ideas of the membrane into money and the membrane obtains money from the nucleus to develop other ideas. There is a danger: when the period spent beyond the two limits is too long the company may even fail. The condition of equilibrium is highly unstable and discontinuities in the market may cause movements that are unforeseen or even unwanted.

The evolution can be linked to an "S" curve. When the membrane dominates the nucleus there is a prevailing interest for product innovation: below the limit permitted for great

creative potential nothing results. In the opposite case the dominance of the nucleus shows a prevailing interest for process innovation: beyond the limit the company, only theoretically efficient, tends to assume bureaucratic or conservative behaviours: a new growth cycle is necessary that launches another "S" curve.

As the evolution is linked to an "S" curve, it follows a learning cycle: fig. 1). It is interesting, using the simulation model, to be able to make forecasts regarding the influence of telematics and telework on the dynamics of SMEs. From the simulations based on real cases it has been seen that, with the recourse to widespread types of telematic innovation in production processes or in the provision of services, it is easier to set off a new growth cycle (product innovation: another "S" curve) when sudden shifts in the market threaten the very survival of the company.

The cause-effect diagram

Moving from the basic model, defined, with only two elements, at the most abstract level, to one that may be applied to real cases on the observed socio-economic scene was not easy. The behaviour of an innovative company is characterised by very many elements indeed. It was necessary to make an accurate selection keeping in play only 15 elements that interact. In Fig.2) the "autopoiesis life"cause-effect model is shown. Given the limitations of space, I have provided a glossary of the elements in the cause-effect diagram. Knowledge and Productive Capacity respectively are the factors that characterise the potential of the Membrane and the Nucleus. The investments are directed towards these, as a function of the Profit obtained dynamically from success in the market due to Sales.

Elements to be particularly noted

The dynamics of innovative companies are traditionally governed by periods of investment alternated with actions aimed at reaping the economic benefits of these.

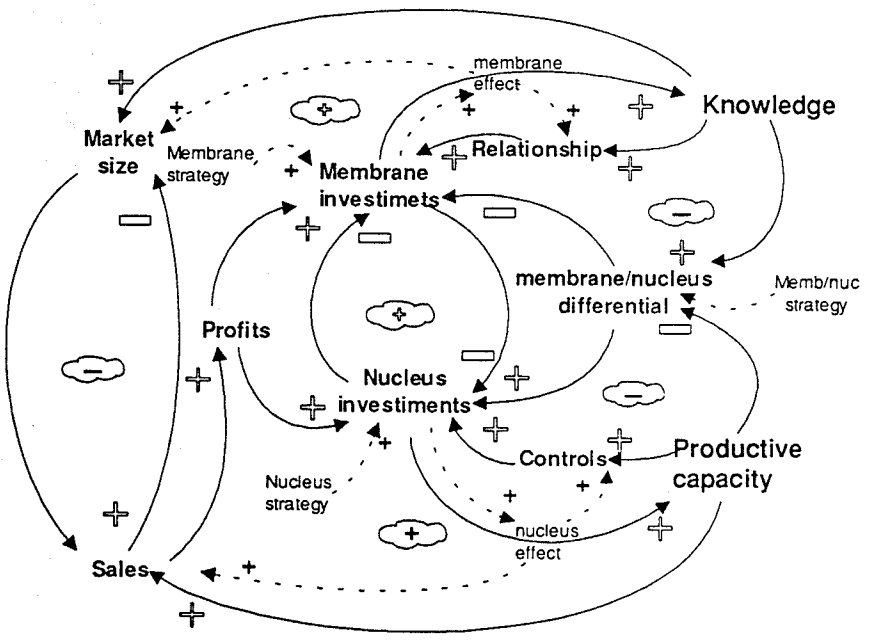


Fig. 2) "Autopoiesis life" cause-effect model

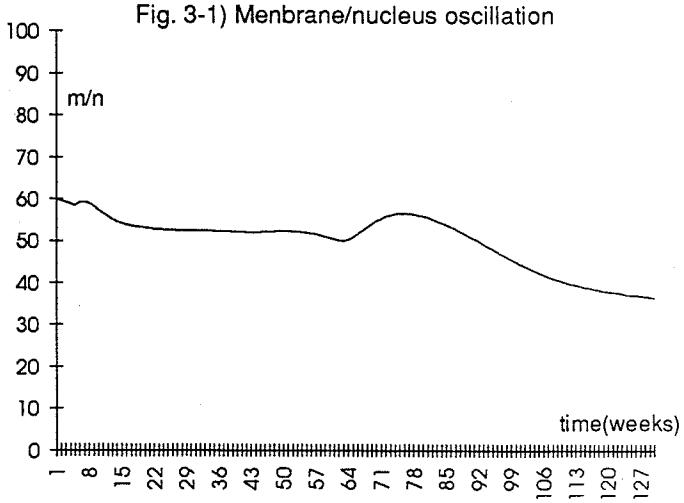
Now, thanks to the telematic networks, new forces can come into play, at limited cost, that can permit a more sustained action of the membrane and impose very strong changes from a cultural point of view. It is important to understand the nature of these and what may be the levers in order to continue to govern the company system. Primary objective: do not let it to stay too long beyond the limits. In particular I think we should focus on the upper limit (when the nucleus is too large).

For other reasons:

- it may take the company into unsuitable territory
- it may lead to the loss of the capacity for innovation
- dangerous fixed costs

With ASIMOV it is possible to identify how telework can provide the means to avoid the trap just described.

Fig. 3-1) Menbrane/nucleus oscillation

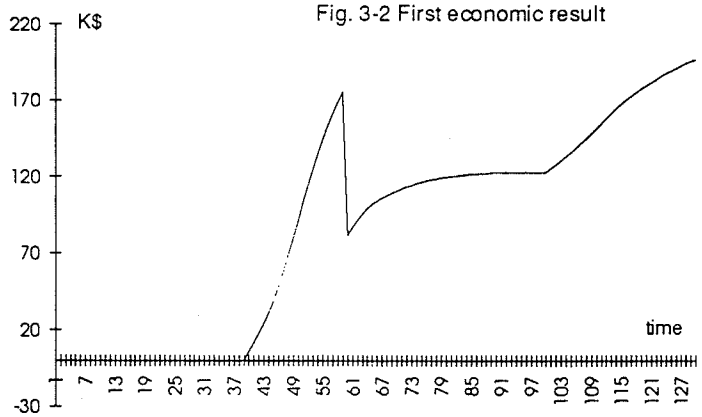


. It is necessary to observe certain basic rules: the structure of the innovative company must be as flat as possible. Two levels: **planning** and **implementation** with a light "senior team" structure in which the same leader participates, so as to always assure the maximum working potential, a desire to meet, and the best interaction with customers, with partners or with contacts. For the research one needs to have a model with a very strong interaction with the outside. The use of highly specialised external professional components, connected to the network (physically and in terms of organisation), some of these also located on the outside, should also be anticipated.

Simulation dynamics

The ASIMOV model was formulated for SMEs. This allows some simplifications that would otherwise be difficult on a practical level. Most importantly, it can be assumed that a SME has a dominant product and not a mix. On this assertion the model represents the market dynamics, linked to investments both on the nucleus and the membrane, based on two cycles of product innovation in a two and a half year period.

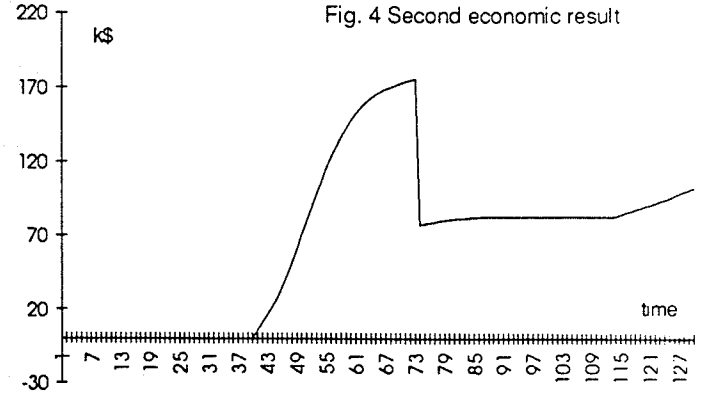
Fig. 3-2 First economic result



The dynamic model derived from that of cause-effect shown in Fig.2) contains, despite the simplifications made, more than 120 elements.

There are many variables that may be set before the launch of the simulation. We are particularly interested here in highlighting the levers that regulate the rate and the speed of exploitation of the investments towards the nucleus and towards the membrane.

Fig. 4 Second economic result



When deciding on an investment of this type the strengthening of the capacity of the membrane should precede that of the nucleus. In Fig.3-1) we see the membrane/nucleus

oscillation resulting form a simulation session where the two cycles have been correctly balanced.

This makes it possible to respect the investment plans on the second product. As can be seen in Fig.3-2), when a sufficient economic result is reached, part of the profit is placed in new investments and this triggers in Fig.3-1) a new "S" curve. After some weeks even the second investment, having been initiated in the predicted time scales, generates profits.

So in fig. 3-1) we can see the complete oscillation in the relationship between the potential of the nucleus and the potential of the membrane.

When the rate of investment is not well-judged there can be various types of degeneration. Each of these, when it is highlighted by the model, must be analysed in the market context in order to avoid errors when applied to the real situation.

Fig.4) shows an example of what happens when the placing of investments is not well-managed in terms of timing and synergy. In this case, despite having achieved the necessary profit level (several weeks late however) it is not possible to control the second action, and the curve begins to rise too late and almost imperceptibly.

Glossary

1. **Productive Capacity:** the set of technological infrastructures and the capacity to utilise them, together express the *capacity for transformation* of ideas into new products/services;
2. **Knowledge:** the ownership of knowledge internally or immediately accessible outside, expresses the *innovative capacity* of the company;
3. **Controls:** the resources dedicated to verifying, measuring quality controls on production processes;
4. **Market size:** the potential capacity for absorption of the products/services (limiting variable: many other concurrent variables would be necessary);
5. Membrane effect: influences due to the interest in maintaining active exchanges with experts, external consultants, multidisciplinary project teams, research centres, ..., expresses the *innovative potential* of the company;
6. Nucleus effect: influences from the company's procedures or processes, from the interest in efficiency and quality improvement, from attention paid to the activities, express the *viable potential* of the product/service projects so as to increase the *competitive capacity* in the market;
7. Investments in the membrane: criteria (including timing) for the issue of investments towards the Membrane;
8. Investments in the Nucleus: criteria (including timing) for the issue of investments towards the Nucleus;
9. **Relationships:** the resources dedicated to maintaining active relationships and exchanges with the outside;
10. **Membrane/Nucleus Differential:** observed dimensions of the width of the Membrane and of the Membrane/Nucleus relationship;
11. Strategy (inv.) of the Membrane or of the Nucleus: mode of issue as a function of the strategic objectives and the market forecasts;
12. Membrane/Nucleus Strategy: "desired" dimensions for the width of the membrane and the relationship between nucleus and membrane (ideal differential);
13. **Profit**: general economic result based on success in the market (limiting variable: many other concurrent variables would be necessary);
15. **Sales:** number of product/service units placed in the market in a unit of time.