Why So Many Start-ups Fail? A Resource Based Approach Through System Dynamics

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Abstract

In the article we address recurring causes of failures in starting up a new company. In particular, we explore flaws in entrepreneurs' mental model when dealing with feedback and delays in building up stocks of assets. The work that we are presenting is in progress but scored the following targets. First, under a theoretical point of view, we laid down borders to define a theoretical territory where the strong connections can be observed that entwine literatures on start-up, on the resource-based view of the firm and system dynamics. Second, we created an experimental laboratory to test individuals' recurring mistakes when dealing with a start-up. Further developments of this work are in the direction of setting an experimental protocol to conduct empirical research on a sample of players.

1 Introduction

In our research we ground on two assumptions. First, large percentage of new ventures fails in their early stage of development. Researchers on new ventures refer that 40% of new ventures fail in the first two years of existence (Small Business Administration, 1999). Timmons (1994) notes that over 20% of new ventures fail within one year and 66% fail within six years. Thus, the fact that a is an accepted empirical phenomenon.
Second, as reported by Chirico (2005) recurring cause of failure falls under the general categories of managerial incompetence and lack of experience. Dun and Bradstreet (1991) pointed out that the main cause of business failure in the USA

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is 'management incompetence of the business owner'. In their survey over 66% of business failures were imputed to 'management incompetence' that is the entrepreneurs' inability to exploit/develop resources and plan, analyze, control or direct the management of the business. Gibb and Webb (1980), in their research in which they analyzed over 200 bankrupt firms, likewise concluded that the primary failure determinants were a lack of skills, knowledge and 'inattention' by management (Beaver, 2003); and also Carroll (1983) confirmed by a "summary of empirical research on organization mortality" that the main cause of failure falls under the general categories of managerial incompetence and lack of experience.

The above facts suggest that successful start-ups are rare; that managers ought to build specific competences and that experience may improve performances of entrepreneurs. But, where does experience from? Presumably, experience emerges from lessons extracted from past failures but how similar are, for example, the skills built in managing the launch of a new line of product within a large organization and skills accrued to independent entrepreneurs trying to start their own business? How much of learning is transferable from one experience to the other? The previous questions lead to the key query of our research: How does learning improve decision-making in new ventures?

The hypothesis we want to test is that learning occurs when decision-makers are able to ex-post rationalize the causal relationships between action and consequences and, in particular, when they are able to appreciate the role played by time delays and feedbacks. Grounding on this assumption, our work is finalized to build a learning environment where we can test if, by interpreting results from simulations and by having revealed pieces of feedback structures of the underpinning simulation model, decision-makers are able to improve their performances in starting a new venture.

The paper is organized as follows; in section 2, we highlight a selection of our literature review, namely we present a thread of contribution in start-up literature that particularly inspired our approach by focusing on the role of time in investing and accumulation key assets. In section 3, we describe the structure of the model and the user interface of the learning environment. Finally, we propose a number of possible experiments in the section 4.

2 Resource-Based View of Start-Up Failure

In his seminal paper, Ian MacMillan (1986a) demonstrates that habitual entrepreneurs are more successful than occasional ones in managing new ventures' start-ups because they have a better command of the specific start-up's technology. One area in which this technology is particularly crucial is in implementing the start-ups, after having selected a potentially promising business ideas and having carefully developed it; the latest are the other two critical areas in which the habitual entrepreneurs' technology seems to explain their exceptional rate of success. Our paper's focus is on the first area and in particular:

- On the ability that some entrepreneurs show in selecting which resources are key and which are less important for the start-up, and consequently in prioritising their investments;
- On the ability of developing the resources at the right timing and pace.

MacMillan and Low (1986) consider that both abilities are part of what they call "flow building and progress optimisation" approach to the start-up's planning. This approach seems to be more consistent with the intrinsically complex nature of new ventures start-ups, which are highly sensitive to emerging factors. According to this framework, the start-ups' success is mainly explained in terms of: (a) assets parsimony (MacMillan 1986b) and (b) flow building planning (the latest being a specific case of a process oriented approach to the start-up's planning). The importance of such a process orientation is also illustrated by Norman (1977) as a key feature of the management of the business idea's life cycle. It is easy to understand that both components (a and b) are needed. This is so because if an entrepreneur is only driven by an assets parsimony orientation, he/she will face the risk to underinvest on resources that could be considered less critical at the beginning of the implementation face, but that may become crucial later on in the start-up's process. At the same time, a pure emerging approach, without a clear identification of the key activities can results in a sub-optimal allocation the resources available for the start-up. In other words, the flow building approach is a strategy according to which the entrepreneur at every moment allocates those inputs at every moment the resources that are strictly required, avoiding any long term investment (resources commitment), until the new ventures' cash flows are large enough and sufficiently stable to make these long term investments sustainable.

We can thus assume that so many new ventures' start-ups fail, because entrepreneurs lack of a comprehensive understanding of the specific economic and financial dynamics of their start-ups and to develop its resources consistently with such an understanding. We thus build a System Dynamics model of new ventures' start-ups, considering them from the Resource-Based Theory perspective. This approach seems to be particularly appropriate as "entrepreneurship and Resource-Based Theories adopt precisely the same unit of analysis - the resource" (Alvarez and Busenitz 2001). The Resource-Based Theory does not prescribes that entrepreneurs should always minimise the resources allocated to the activities and postpone the investments; it simply suggest that they should

understand what resources need to be developed, when investments are needed and at what pace they have to be implemented.
To better understand the start-ups' dynamics, we propose to identify two extreme cases that we decide to label "Large scale" and "Assets parsimony", according with (De Marco 2000). The start-ups that belong to the first category need an aggressive financial strategy because they have to reach as fast as possible the critical mass, which is a consequence of the industry's structure (Ansoff 1965). A fast growth may also be needed to avoid the incumbents' early retaliation, which is one of the most important new ventures failure's factors (MacMillan 1985). On the contrary in highly risky environments, in which for example it is not yet clear in which direction the industry's structure will evolve, it would be better to minimise and to dilute the investments, adopting a process oriented financial strategy.

3 The Learning Environment

In this section we describe the software that simulates the behaviour of a virtual start-up. The name of the project is "Manage your Business" (MyB). The creation of this learning environment was deeply inspired by similar works (known in system dynamics literature with the name of "flight simulators"), mainly Sterman (1986, 1991). This type of programs is usually characterized by offering the user the control over the underlying system dynamics model thought an input interface and showing at the same time the results of the choices of the decision maker.
MyB was developed in C# and is the result of the aggregation of two separate parts that run independently: the first one, that we will call "interface" or "front-end", has the objective of interacting with the end user showing her the firm financial results and the status of the internal organisation (using reports and graphs) and also giving her the feeling of being able to control the company actively though her decisions.
The second fundamental part of the software is in the form of a dll library that implements the system dynamics model that simulates the behaviour of the start-up. Basically, each time a new game starts the front-end calls the dll and initializes a new session. Each time the decision maker changes a parameter, for example price, the interface sends the new input to the dll who manages the change and runs the system dynamics model. The player usually is able to take decisions each game quarter so the system dynamics model is run a quarter a time.
In the following subsections we will explore more closely some characteristics of the system dynamics model and of the interface and, in addition, the issues

arisen during the development of the software.

3.1 The System Dynamics Model

The system dynamics model that constitutes the core part of the simulation: it has been designed using the I-Think environment and, afterwards using Euler's method, the model finite difference equations system has been implemented in the dll library, in order to be able to be managed by the front-end interface of MyB.
The core of the model is built upon 25 stock variables and their relative inflows and outflows; moreover, there are 40 variables between constants, equation variables or input variables that define and describe our environment. There are 8 input variables that give the possibility to the decision maker to control and govern the system. The player is able to change her business strategy quarter by quarter manipulating these values:

1. Product Price (euro/quarter): This variable is used to define the price strategy of the company;

2. Marketing investment budget (euro/quarter): This generic amount collects the budget for all the marketing activities of the firm, like marketing researches and advertising;

3. Research & Development investment budget (euro/quarter): This value indicates the amount of money designated to product innovation

4. Orders of production capacity (units/quarter/quarter): This variable summarizes the investments that have to be done in terms of equipment, materials and plants in order to increment the production capacity, indicating the quantity of units per quarter we want to be able to produce in addition to the existing production capacity;

5. Production capacity rate (%): This value simply indicates the percentage of production capacity we want to use during the following quarter. This variable directly impacts on the total units to be produced per quarter;

6. Hiring (junior/quarter): This indicator describes the number of junior we want to hire for the next quarter;

7. Junior to Fire (junior/quarter): This value indicates the number of juniors we do want to lay-off during the next term;

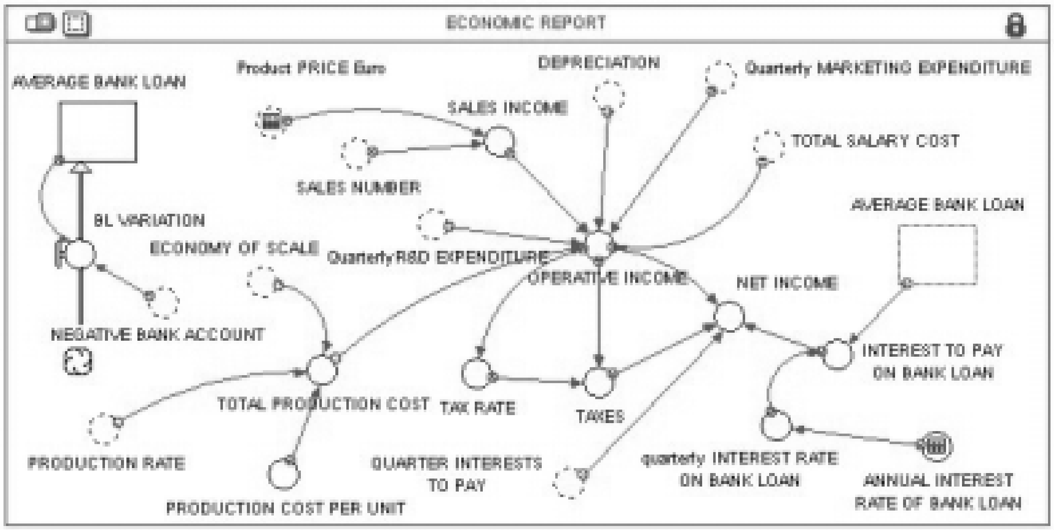

Figure 1: Economic Report dynamics

8. Senior to Fire (senior/quarter): This variable states the number of seniors that the decision maker wants to fire for the next quarter; The 8 sections of the system dynamic model underpinning "Manage your Business" are labelled as follows: Economic Report, Assets and Liabilities, Human Resources, Firm Resources, Quality, Production Dynamics and Market Dynamics. In our model there are no competitors modelled. This is so because our work is focused on the analysis of the internal organisation dynamics that lead start-ups to failure, so we agreed on putting more effort on modelling those to create evidence on which problems arise managing a new business internal dynamics. As a consequence, we assume that our start-up company is the only firm in a small niche market, at least for the first few years. What it follows is a brief description of the most important parts of the model.

3.2 Economic Report

A major effort of our work has been put in modelling the financial aspect of the firm, particularly the economic report and the assets and liabilities report. We think that the information contained in these instruments are valuable and fundamental for the manager to make his decisions; therefore we decided to include them in our flight simulator.

In this section we will describe the dynamics of the economic report (fig.1). We tried to simulate as much as possible reality, offering the user a realistic economic report. The central stock of this side of the model is "Operative income" that, as its name suggests, describes the quarter operative income of the virtual firm. In order to calculate it, we used some other variables which express the income and the costs structure of the report: production costs, sales income, depreciation, marketing and research and development expenditures. All these values are calculated on a quarter-basis. After defining the operative income, we can find the "net income" by detracting from it taxes ("tax" variable) and the interest to pay on eventual bank loans ("interest to pay on bank loan"). The latter is calculated by another stock variable that sums up bank account losses each quarter.

3.3 Assets and Liabilities

As stated before, we put effort in trying to reproduce the financial model our firm in terms of a system dynamics model. However, this leads inevitably to some compromises, because of the strict and sometimes cumbersome mechanism of the financial system.

This section is built upon three important stock variables (fig.2). The first and the most important is "Bank account": its value should reflect the liquidity of our company in terms of cash. On the other hand expenditures can sometimes exceed incomes, so the "bank account" stock can become negative, simulating the fact that firms can require a short term loan to the bank to cover its expenditures. This stock is calculated using and inflow and an outflow. The inflow gathers all the incomes of the quarter: they can be sales income, new equity or money derived from a long-term debt contracted from a bank (we are going to have a closer look at this in the debt section) . The outflow is the sum of all the expenditures of the current quarter: all the investments expenditures are considered, as well as the costs of sales, total salaries cost and tax payments.

Two other mechanisms are included in the model, both integrating a delay. In fact, just a few times in the real world a firm will cash its sales immediately, while they usually do it after couple of months. On the other hand, companies rarely pay their costs just-in-time, while usually they try to delay the expenditures as much as possible. To include this in our model, we introduced two stock, accounts receivable and accounts payable. These two stock are both considered to determine the "current assets" variable and the "current liabilities" variable, but only a fraction of them are captured respectively in the inflow and in the outflow of the "bank account" stock. In this way we introduced a delay, similar to those in reality, in the entry system.

Another similar mechanism is used on the right side of the figure to calculate the "estimated tax liability". We considered to simulate the fact that even if tax are

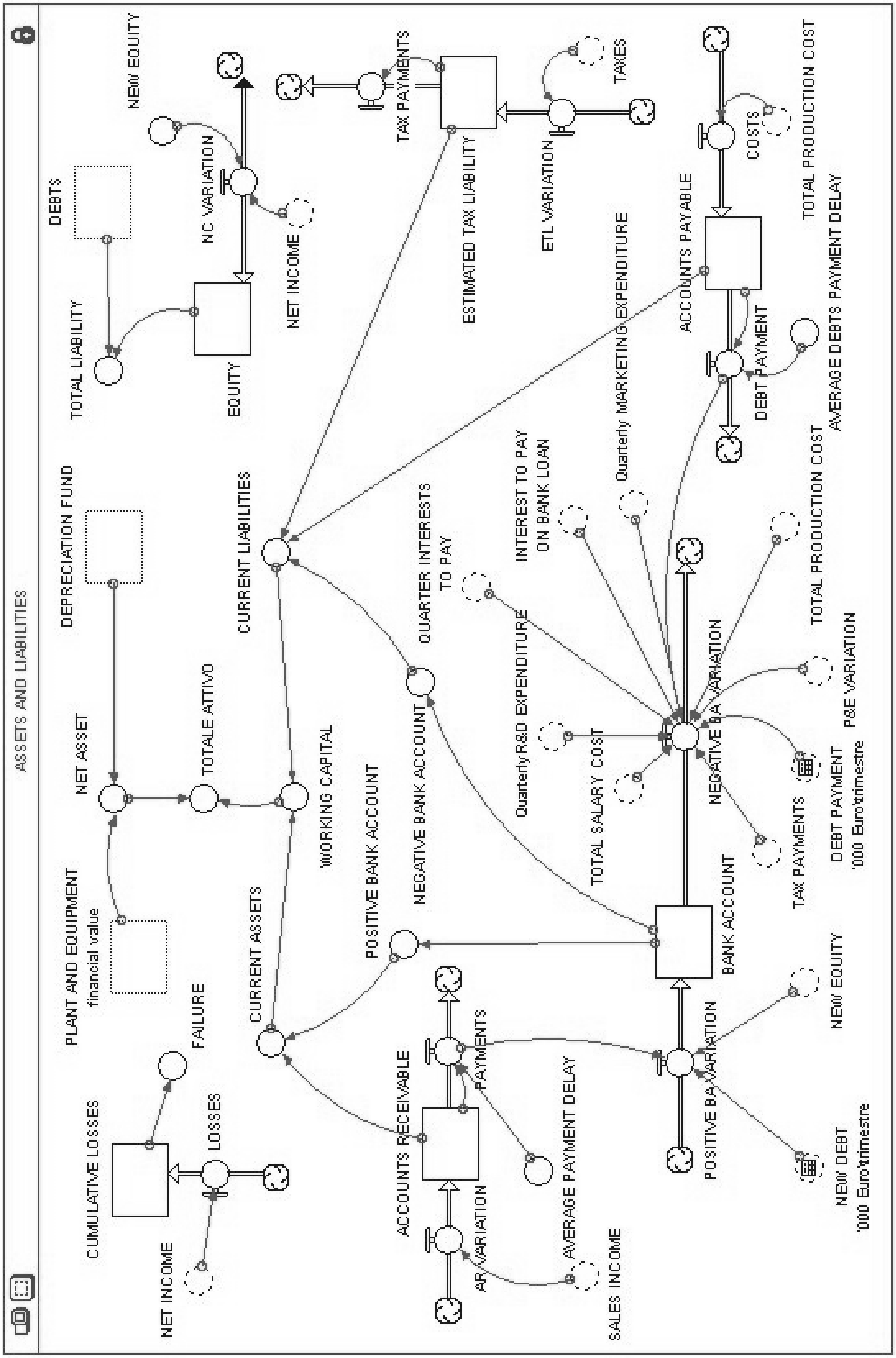

Figure 2: Assets and Liabilities dynamics

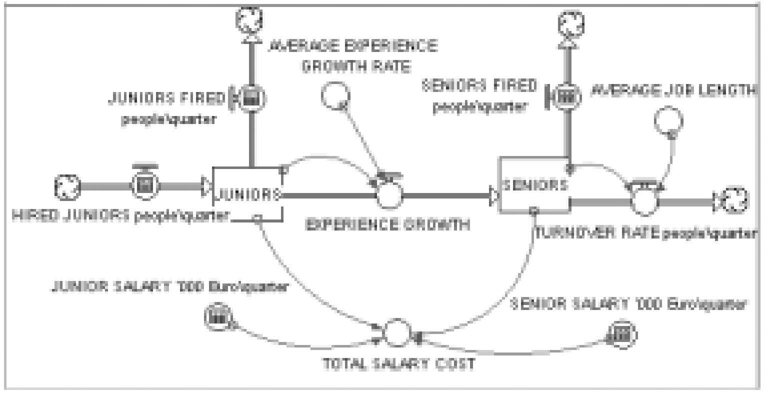

Figure 3: Human Resources dynamics

paid only at the end of fiscal year, they are accounted as liabilities each quarter under the "estimated tax liability" entry in the book; on the top other entries are calculated, as the "working capital", "current assets", "current liabilities" and "net assets".

3.4 Human Resources

The Human Resources dynamics is rather simple and is composed by two key stocks, "Juniors", defining the number of junior personal in the firm, and "Seniors", people hired and with some experience (fig.3). There are no information feedbacks in this section and the most important dynamic here is the delay that connects the two stocks, suggesting that after a fixed number of quarters, defined in "Average experience growth rate" constant, juniors become seniors. A senior is more productive than a junior, but she also expect to receive a higher salary. Salaries are defined and calculated in the three bottom variables, "Senior Salary", "Junior Salary" and "Total Salary Cost". Salaries are constant and defined by the environment and therefore not in control of the decision maker. On the other hand, hiring and firing policy, defining the inflows and the outflows of the stock variables, are decided by the virtual manager quarter by quarter. The last outflow, "Turnover rate", indicates how many seniors leave the company seeking another job opportunity.

3.5 Firm Resources

The "Firm Resources" section is built upon three stock variables, "Production capacity", describing in terms of units per quarter the maximum number of products units that our company can produce; this value can be changed

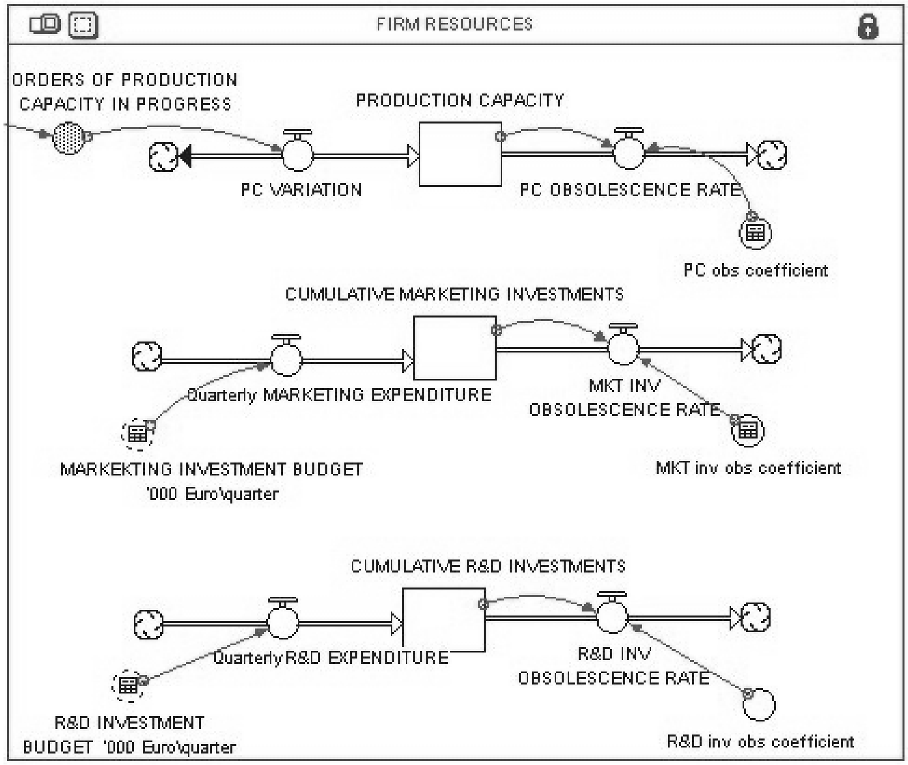

Figure 4: Firm Resources dynamics

adding or removing production capacity (fig.4). Obviously this is subjected to a delay, because this kind of investments usually requires a setup (for example, for installing new equipment or building a new plant). In addition, there is an obsolescence rate that makes our installations old and no more adapt to produce updated products.

"Cumulative Marketing Investments" and "Cumulative R&D Investments" are, on the other hand, two stocks that sum up all the investments done in marketing and research and development. Their behaviour is fairly similar: the decision maker controls their inflow, deciding how much to invest, while their outflows are regulated by a obsolescence rate. This model abstraction is used to indicate the amount of money put into projects that have still some impact on the sales and on the potential market: R&D investments have a direct impact on product lifecycle, while marketing investments help to determine the growth of the potential market.

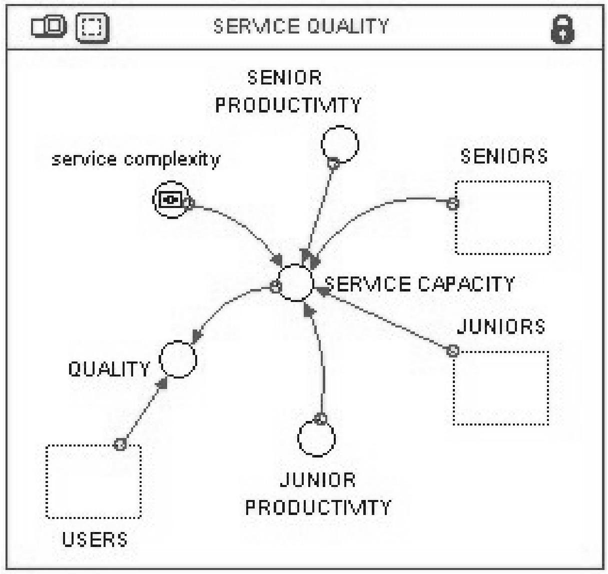

Figure 5: Quality Determination dynamics

3.6 Quality

A small part of the model is centred on determining the quality of service (fig.5). This has a high impact on the percentage of users that are not satisfied by our product and therefore switch brand. Quality is calculated as a rate between the total productivity of the personal and the number of users we have, multiplied by a fixed constant called "complexity of service". The underling assumption is that it is necessary to keep a fixed rate of productivity per customer in order to maintain a high quality product. Productivity is calculated multiplying the number of seniors and juniors for a constant that determines their productivity per capita: obviously a senior is much more productive than a junior.

3.7 Production Dynamics

One of the core concepts of our model is the production (fig.6). We implemented a production systems using stocks and flows in order to determine if our production capacity can match the number of orders we receive; if not, we report a delay created by the gap between the order time and the service time.

As we can see (fig.6), the process starts on the bottom left. Here a number of product units is produced (depending on our production capacity and on the production capacity rate) and put in the "inventory" stock. This can be depleted by serving the orders we receive. If enough product units are present in our inventory in order to satisfy all our requests, no delay is created. If, on the

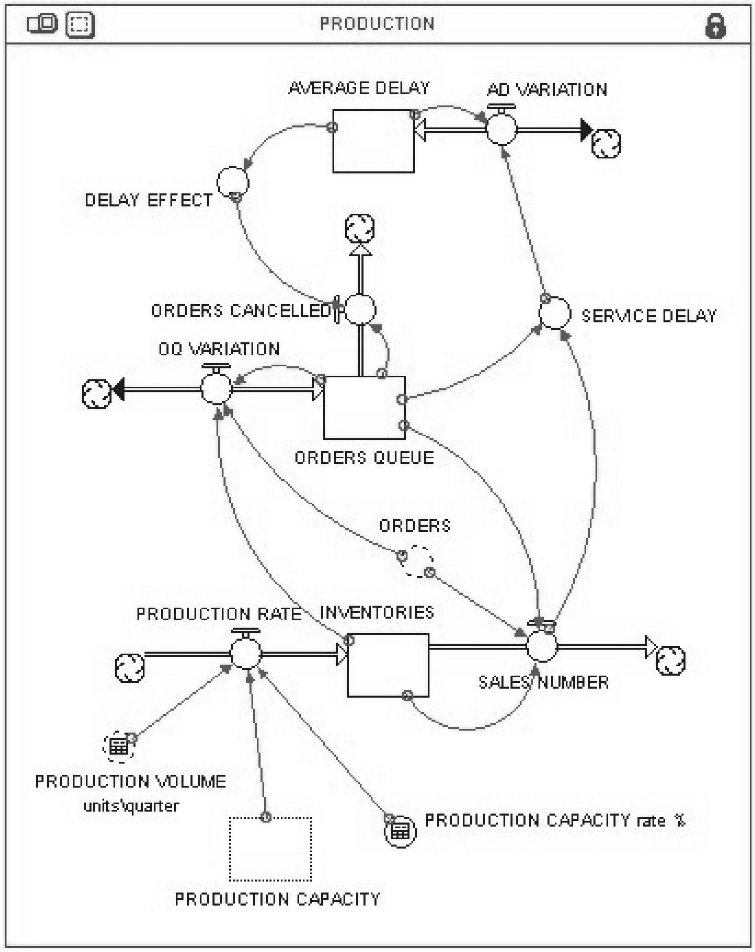

Figure 6: Production dynamics

other hand, some orders are not evaded, these are put in the "order queue". This last stock describes the orders from the last few quarters that were not satisfied, cause a lack of supply. Each quarter the system tries to evade these extra orders. As the orders queue growths, the service delay growths as well. The service delay determines the quantity of orders that get cancelled each term.

3.8 Market Dynamics

Another core section of the model describes market dynamics (fig.7). Its objective is to determine how investments in marketing, R&D, and Price strategy interrelates with the number of buyers of our product.

The model is divided in two parts, one regarding how many users decide to buy our product, while the other related to the calculation of the new potential

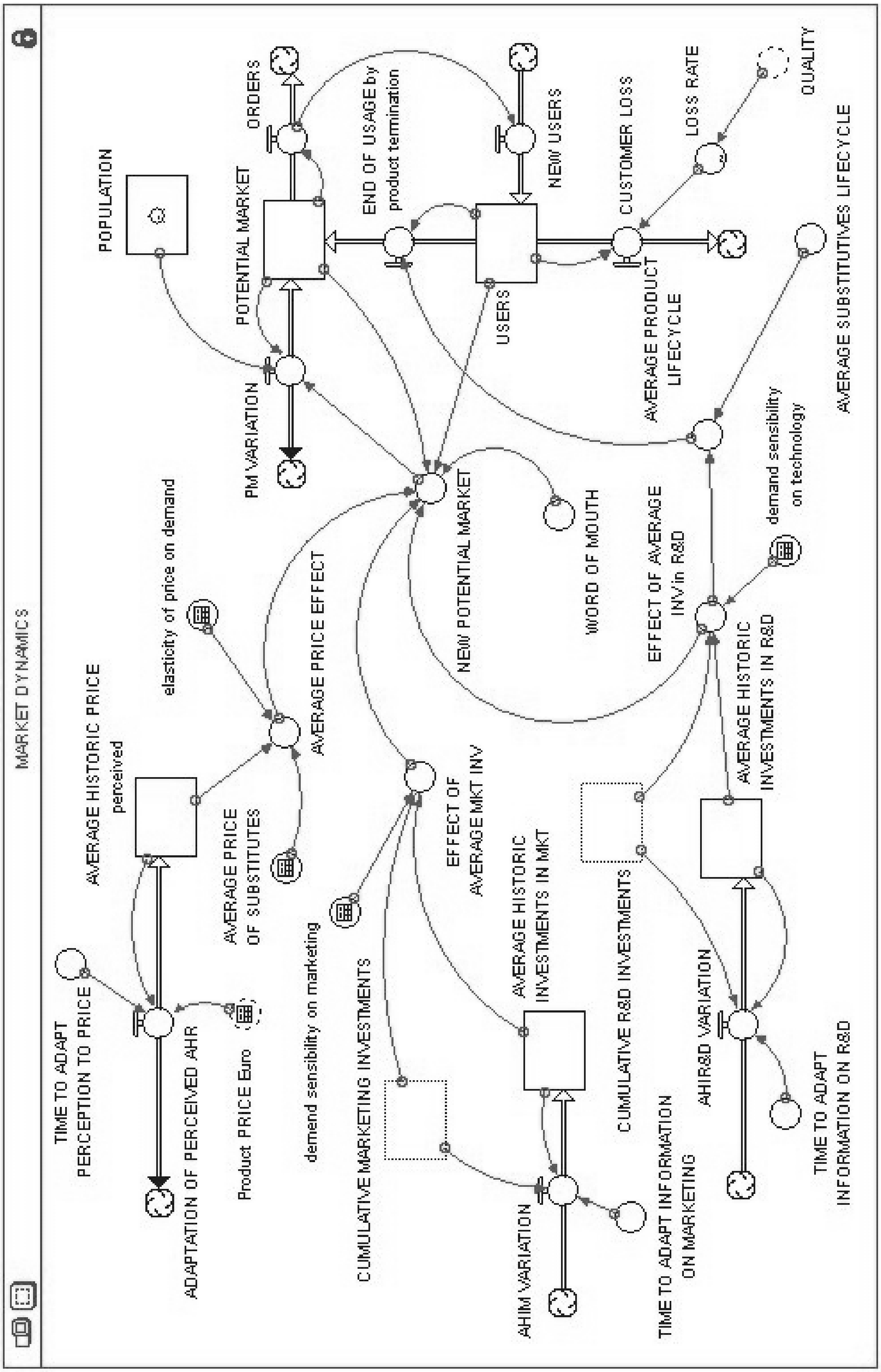

Figure 7: Market dynamics

market.
Let's start from the former: the no-competition assumption simplifies by far how potential customers choose our brand. Simply, our firm is the only one in the market, so every potential user becomes a buyer of our product. The number of buyers is included in the outflow "orders", which each term deploys the "potential market stock". This variable also influences the "new users" inflow, which adds new users to the "users" stock. But how users are retained? Customer fidelity is based on the "quality" variable: until this value stays on a high level, no customer will leave our company. On the contrary, the "customer loss" outflow will deploy our user base. Another force that will lower the number of our user is another outflow named "end of usage". The assumption behind this force is that after the average product lifecycle, current user will need to buy another unit of our product. Therefore, these people are added to the "potential market" stock one more time.
The second part of this section is needed to determine the new potential market. Four different forces are implied in the process: price variation and strategy, marketing investments and R&D investments, word of mouth. The last is the simplest mechanism: "word of mouth" variable is a percentage, that multiplied by the current user base determines a new number of customers that potentially could be interested in our product. This simulates a network externality process.
R&D investments influence the market dynamics in two ways. First of all, it has a direct effect on the determination of the new potential market. The hypothesis is that a major difference from the average historic investment leads to new innovation and therefore more interest in the market. The interesting negative feedback here is that the system tends to balance itself around the historic mean, so that the investment value constantly needs to be incremented. The second effect of R&D investments is that it decreases the product lifecycle.
Marketing investments act in a similar way as R&D investments. It can be assumed that, even if thought different methodologies and different channels, the final objective of both type of investments is to expand the potential market. Even here it is introduced the same adaptive feedback process.
Price strategy is modelled as follow: price decisions will be negatively perceived by the market if a high increment is done and if substitute price is much lower than the firm one. Price perception from the customer will adapt itself to the new price slowly, regulated by the "time to adapt perception to price" variable.
As a final consideration, three variables are constants and can be changed in order to define different sectors: "elasticity of price on demand", "demand sensibility on price," "demand sensibility on marketing" and "demand sensibility on technology".

3.9 The Interface

The interface of MyB is a key factor of our future research. Our learning environment will be used for a didactic matter, but its main goal will be the conduction of some experiments on samples of university students (see section 4 for details). The point is that developing a software like this is an extremely sensible task, that should assure an unbiased experience to the user but also be engaging and easy to use. Testing, testing and testing will be the only way to deliver an excellent final and usable version.
It is not in the purposes of this paper to describe in its full details the various aspects of the front-end, all its controls and its mechanisms. We are including a pair of examples of the type of graphs and of the input forms that the user will be able to see and manage during his game session.
At the same time, even the experimenter can be considered another user of our software: he needs to install it, setup it, control the experiments and gather data obtained in order to run some statistic analysis. Although this is a side problem of the system dynamics research field, we would like to spend some words on this. In the future, as the simulation research stream will continue to expand, more and more of those issues will arise and even the Human Computer Interaction researchers seemed not to consider those topics with the necessary attention.

One of the few contribution to those problem is offered by Boring (2001). Interesting, what he reports is that the HCI community did not investigate sufficiently the issue of designing interfaces for experiments and how the design of these pieces of software deviates from the usual design process. We agree on this idea, highlighting which hot spots should be more considered:

1. Difficulty in executing the software;
2. Difficulty in setting up the software;
3. Difficulty for the participant to understand the software functioning;
4. Inappropriately sized windows;
5. Difficulty with the mode of response;
6. Lack of appropriate feedback;
7. Difficulty in managing the data;

These are just few topics that should be better investigated when developing flight simulators in general and, in the specific, “experimental driven” ones. We tried, using our own methods, to cope with those issues but we also think that is could lead to an interesting open discussion.

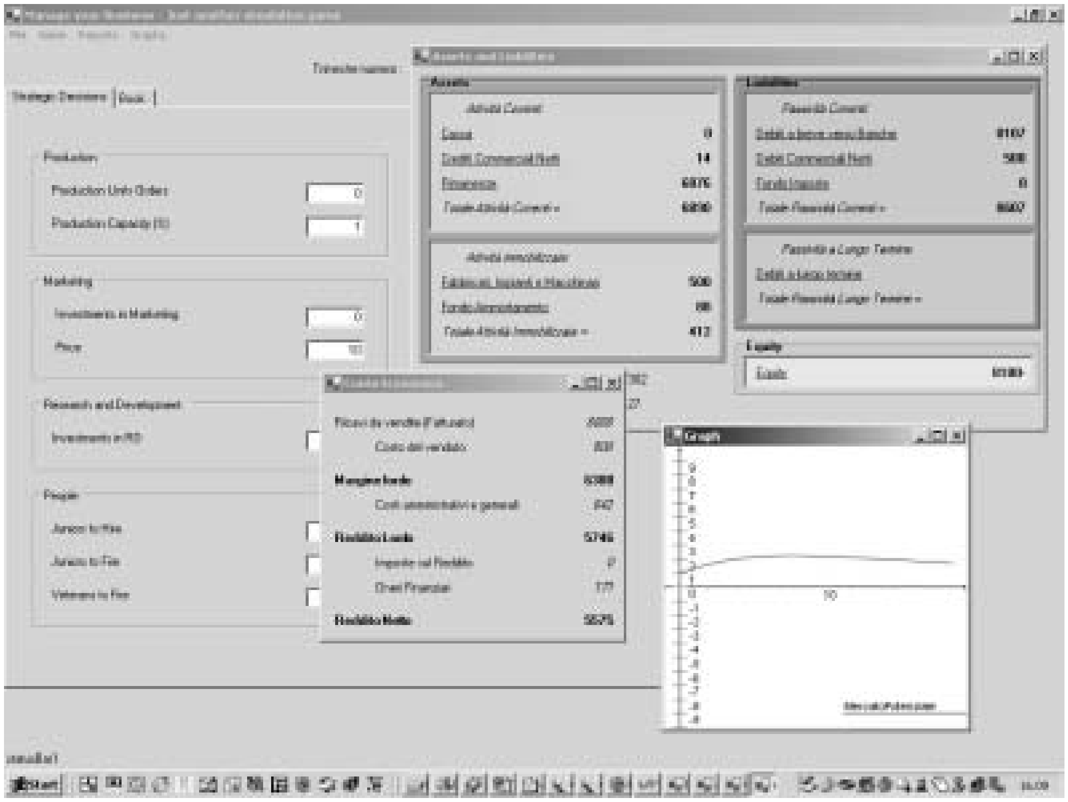

Figure 8: Manage your Business: general interface

4 Conclusions

In the paper we presented the premises our research project and the development of its first stage. We presented a learning environment which will be used in the next step of our research. The next step of our research will be an experimental one impinging upon the design and conduct of a set of decision-making experiments. The experiments, conducted on samples of both university students (undergraduate and graduate) and managers, will explore how learning about feedback and delay dynamics improves performances in new venture start ups. The experiments will also provide empirical data to understand how learning occurs; which information are key to interpret causal mechanisms that explain unfolding dynamics and what barriers prevent decision-makers from capturing weak signals available in the course of their action.
In the experiments, researchers will be allowed to manipulate the initial settings of the learning environment as to produce a number of alternative scenarios, which describe hypotheses on different competitive contexts where the start up takes place.

For example, results in two extreme scenarios will be compared:

1. A scale (size) - driven start-up that mimics dynamics in:
    - Either in a sector where critical mass plays an important role and thus we cannot dilute the investments;
    - Or in an industry where we need to growth fast to avoid an early retaliation by the incumbents.
2. An assets parsimony driven start-up, when on the contrary it is important to minimize and dilute investments, as for examples in highly risky and turbulent environments like high tech and life science.

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