Managing Intellectual Capital through Interactive Learning Environments based on System Dynamics and Accounting Models
The Dynamic Intellectual Capital Scorecard

Abstract

This paper shows the potential impact of Interactive Learning Environments (ILEs) embodying System Dynamics (SD) and accounting models to support top management decisions in allocating business resources in a planning setting for Intellectual Capital (IC) management.

Human resource training and organisational expenditures are often budgeted as discretionary costs and quite seldom their impact on business performance over time is properly investigated.

The above issue provides the basis for an ILE portraying a "scorecard" including a quali-quantitative framework for IC monetary and non-monetary assessment.

In the first section of the paper, an overview of the conceptual foundations of IC and different methods for its assessment is given. Main assumptions, strengths and weaknesses are remarked.

A quali-quantitative evaluation approach for IC management is then proposed by the authors, and justification for applying the SD methodology is given.

In the second section, the ILE is analysed with particular reference to: 1) its conceptual framework, 2) the case-study providing the background on which the simulator lies, 3) how to integrate the simulator into the planning context, and 4) what players can learn from it.

Introduction

Why the market value of a firm may significantly result higher than its book value? What are the primary causes of success for a company against its competitors? How can one explain that firms relying on large capitals are likely to achieve a lower performance, compared to those competitors having bounded financial resources? What are the reasons of the sudden collapse of those businesses identified as "pillars" of the economy, provided their perceived strong profitability and image?

To answer the above questions an helpful concept is that of *intellectual capital* (IC). IC refers to a knowledge system that can be both related to the individuals working in a firm, and to the business organisation itself.

IC is likely to be assessed both in monetary (likewise other tangible assets commonly included in financial statements) and non-monetary terms.

Its monetary evaluation is usually done according to different approaches, such as: cost, market, and income. Furthermore, other "hybrid" methods have been proposed by the literature.

The approach that is adopted in this paper for IC monetary assessment combines both the cost and income method. We propose to assess IC according to its potential impact on the future company performance in achieving a sustainable growth.

Such a monetary evaluation must be combined with a qualitative assessment, providing a framework of those factors (i.e., policy levers, resources, drivers and performance indicators) impacting on business knowledge.

According to this approach, a dynamic feedback view of IC accumulation and depletion processes is adopted, to support the management of human and organisational capital development in a planning setting. Such an approach is based on System Dynamics (SD).

By focusing stocks and flows affecting business strategic assets' dynamics, the SD methodology is adopted to frame and manage systems that are characterized by complex cause-and-effect relationships. This paper proposes a "scorecard" based on Interactive Learning Environments (ILEs) embodying both SD and accounting models to support decision makers' learning processes in IC management. An ILE is a computer-based model aiming to reproduce in a 'virtual context' the system where decision makers operate. Playing an ILE allows one to simulate in a "safe" environment decisions that would be made in the real world and test their consistency, according to alternative scenarios (Davidsen, 2000; Maier & Grossler, 2000; Morecroft, 1994; Sterman, 1992). The use of SD-based ILEs, supported by a learning facilitator, is likely to foster decision makers' learning processes and question their mental models, with a view to the real feedback structure driving key-variables' behaviour.

The paper is divided into two main sections.

In the first section, an overview of the conceptual foundations of IC and different methods for its assessment proposed by the literature is provided. Main assumptions, strengths and weaknesses are remarked, to outline a synthetic framework for further analysis.

A quali-quantitative evaluation approach for IC management is then proposed, and justification for applying the SD methodology is given.

In the second section, an ILE providing a *Dynamic IC Scorecard* to support decision makers, in either a planning or education setting, is shown.

The ILE is discussed with particular reference to: 1) its conceptual framework, 2) the case-study providing the background on which the simulator lies, 3) how to integrate the simulator into the planning context, and 4) what players can learn from it.

The concept of Intellectual Capital

In order to explore the conceptual context for IC assessment, it is worthwhile to firstly analyse the concepts of "intellectual" and "capital".

The term "intellectual" comes from the Latin *intelligere*, i.e. to understand, to learn.

The term "capital" refers to investments in tangible or intangible production factors, leading to an expectation of future yields.

It follows that the concept of "Intellectual Capital" ought to be related to those investments done by a firm in order to improve the capability of its people and the organisation itself to *understand*, i.e. to better frame the system where decisions are made. Therefore, building IC means fostering the learning capability of the firm to make sound decisions about *ends/goals* to achieve, and related *means*. Such means refer to those resources to be acquired or built, coordinated and deployed for the achievement of business ends/goals. Among such resources, the so called *strategic assets* (Amit & Schoemaker, 1993; Dierickx & Cool, 1989; Mahoney & Pandian, 1992; Wernerfelt, 1984; Teece *et al*, 1997) are particularly significant, as they provide the firm with the production factors from whose exploitation it is possible to build a competitive advantage or achieve consensus with stakeholders (Coda 1984; 1987).

Strategic assets relate to the *stock* of available factors which are scarce, not easily tradable, difficult to imitate and industry specific. They are gradually built through an *inflow* driven by current *routines* (Nelson & Winter, 1982), and the interaction between the firm and its relevant environment, which are a pre-condition for human resource and organisational learning. They are also subject to an *outflow* associated to inertial depletion, resulting from either physical/technical aspects (e.g. obsolescence) or shifts in the industry *dominant logic* [1] (see figure 1) (Prahalad & Bettis, 1986; Morecroft, 1987; Glucksman & Morecroft, 1998).

--- FIGURE 1 ABOUT HERE ---

Most strategic assets are intangible and cannot be bought on the market (e.g. business image and reputation, customer base, managers' personal contacts). Others may also refer to tangible resources, which can be purchased from suppliers (e.g. machinery and other technological equipment, warehouses, product portfolio). However, their endowment cannot reach a satisfactory

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[1] "In an evolving business environment, such a company must be adaptable; indeed its resource system may change out of all recognition from one competitive era to the next. To achieve this adaptability, a company must successfully manage its own metamorphosis from dependence on one source of sustainable advantage to dependence on another (Morecroft, 1998).

level if the firm is not able to provide a knowledge system which allows people to deploy them according to a common framework driven by pursued goals.

Without learning, leading to a significant knowledge stock, a firm is not able to build strategic assets. Therefore, IC can be considered as a primary strategic asset for the acquisition and deployment of others, to foster business growth. Organisational *routines* and the interaction processes between the firm and its relevant environment, combined with the existing stock of knowledge (i.e. IC), will be likely to build up new strategic assets (e.g. customer base, image). However, growth also implies the need to strengthen the body of knowledge on which the firm relies. In fact, managing a higher level – and often wider scope – of strategic assets requires that the company increases its effort to foster individual and organisational learning (see figure 2).

--- FIGURE 2 ABOUT HERE ---

One of the possible limits to IC development, related to the above pattern of behaviour injected by business growth, can be associated to the current available technology. In fact, when a given technology is being fully exploited, it is likely that IC reaches a threshold level, beyond which further investments in the current body of knowledge will generate decreasing returns [2]. Furthermore, the above phenomenon will be likely to generate an inertial obsolescence *outflow* in the IC stock, that will gradually increase, in spite of rising investments aimed to keep stable the current knowledge domain.

The concept of knowledge is not only referred to individuals' or business' *know-how*, i.e., the attitude to find proper means to achieve pursued goals. It can also be related to other two dimensions: the *what* and *why*. The concept of *know-what* refers to the attitude to detect specific subjects or issues on which to be focused (Kogut & Zander, 1992). The concept of *know-why* is, instead, referred to the understanding of cause and effect relationships between issues and events related to business performance, as a result of a learning process which shapes the way of thinking of individuals and the company (Quinn *et al*, 1996; Nonaka, 1991).

The above said perspective shifts the research focus from the concept of *intellectual property* – associated to the acquisition of patents, trade marks and other intangibles usually posted in a financial statement – to that of *intellectual resource*, i.e., a production factor profiling a capability to frame the relevant system and make proper decisions. Investing in IC impacts on the quality of company decisions. Such decisions are related to the pursued goals and the acquisition,

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[2] "According to M. Darling, executive Vice-President of Human Resources for Canadian Imperial Bank of Commerce (CIBC), the rate of learning must equal or exceed the pace of change in the external environment, simply put, keeping one step ahead" (Darling 1996; Kennedy, 1998).

coordination and deployment of different resources, according to a common frame provided by a "business formula" which cannot be easily replicated in other contexts.

Investments in education and human resource development (leading to *human capital* accumulation) are only a key-factor of IC. This also consists of *structural capital*, which results from the process of individual knowledge elicitation, in order to act on human capital as a lever to build up business knowledge (Edvinson & Malone, 1997).

The individual knowledge elicitation process takes place in both internal and external activities. In the first case, investments in organisational and information structures, and procedures generate the so called *organisational capital*. In the second case, investments aimed to build strong and long term relationships with external counterparts (e.g. customers, suppliers, competitors) give rise to a shared knowledge system, which may relate to products, information, distribution systems, etc. This is the so called *customer* or *relational capital* (Stewart, 1997).

The assessment of Intellectual Capital

Such a shift of focus from the concept of *property* to that of *resource* implies a radical change of perspective. In fact, the above said view suggests that IC cannot be defined as a physical resource (or a "sum" of different physical assets), which can be financially measured and posted in a financial statement. It is, rather, a system of intangible resources providing the company with a *know-how*, *know-what* and *know-why*. Such an attribute of the business system is likely to be assessed first of all, in qualitative terms and, only in a second step, as a synthetic monetary indicator, according to the value of investments in human and organisational resources [3].

According to the literature, a monetary assessment of IC can be done through three main methods, i.e.:

1. Cost approach;

2. Market approach;

3. Income approach.

The *cost approach* refers to either historical or replacement costs.

Historical costs (e.g. human resource hiring, education and training, house/car renting, medical care and other fringe benefits, organisation design, information and control systems)

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[3] The term "organisational resources" is referred not only to organisational structure and procedures, but also to information and control systems.

take into account the actual expenditures done by the firm for the acquisition of human and organisational resources (Flamholtz, 1985).

Replacement costs focus expenditures the firm ought to sustain to substitute its own human and organisational resources, by either 'purchasing' them from the market or re-constructing them. Such costs contemplate those aimed to recreate the utility of IC, also in a form or appearance that may be quite different from an exact replica of the actual set of resources (Reilly & Schweihs, 1998; Brooking, 1996, p. 181).

The *market approach* focuses the current value of IC resources. Such value is often referred to market-derived empirical transactional data (Reilly & Schweihs, 1998), competitive bidding between different responsibility areas (Friedman & Lev, 1974), or the difference between the company market and equity book value.

The *income approach* is based on the present value of expected monetary benefits (e.g. gross operating margin or cash flows) a firm can earn from its IC investments in a definite or indefinite future.

Furthermore, there are some "hybrid" methods (Tobin, 1969; Stewart, 1997), combining different viewpoints of the above said approaches [4].

A qualitative approach to IC assessment has been proposed by different scholars, implying the use of indicators (referred to human, structural and relational capital) such as: knowledge worker turnover rate, new product sales as a % of total sales, customer retention rate, customer satisfaction (Stewart, 1997, p. 245; Sveiby, 1997; Edvinsson & Malone, 1997).

Each of all the above methods has some limitations. The cost approach implies that reliable data on out-of-pocket and/or virtual costs are available. Furthermore, it implies that cost is a valid measure for the value (i.e. the expected return) related to investments done. Main critiques to the market approach can be summarised as follows: (a) the stock market is volatile and strongly affected by factors that are outside the control of a firm; (b) both book and market values tend to be understated

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[4] Tobin proposed an assessment of IC based on the so called "q" method. According to this approach, the "q" factor is defined as a ratio between the asset market value and its replacement cost. If "q" is greater than 1, the asset is worth more than the cost of replacing it. Such a method has been indicated as useful to measure both the value of a single asset and the company as a whole. An analytical framework (so called NCI, developed by the Kellogg School of Business at Northwestern University) for the calculation of the above factor, refers to the replacement cost as a sum of fixed assets and back accumulated depreciation, and inflation (Stewart, 1997; Joia, 2000).

(Stewart, 1997, p. 225); (c) the difference between the market value of the firm and its equity book value is far from being only related to IC.

According to Edvinsson and Malone (1997, p. 185) any list of measures can only be designed in order to start a debate on what constitutes the value of IC in a company. Although we basically agree on this statement, we also believe that a quantitative measurement can be afforded to enhance something more than the start of a simple debate. Provided that any IC assessment cannot pretend to focus an objective value, it is important to recognise the limitations of any of the above approaches, and proceed towards a qualitative assessment of IC combined with a quantitative one. In fact, only the understanding of the net of cause-and-effect relationships impacting on IC, and related delays and non-linearities, can allow decision makers to manage – and, possibly, assess – IC resources.

We also believe that any monetary assessment, linked with a qualitative one, can be useful to foster the planning process concerning investments in human and organisational resources. Such investments are often budgeted on an incremental basis, as discretionary costs. They are planned without a closer look on the impact they will be able to generate on the future business performance and how, during the planning time horizon, resources (e.g. people knowledge) will be developed and deployed in the different areas (Ornati *et al*, 1982; Tyson & Fell, 1986).

Our perspective implies, instead, a shift of focus in defining the role of the Personnel or Organisation unit: rather than only focusing on short-term and operating issues, such function is also asked to face strategic matters (Matthis & Jackson, 1984, chapters 1 and 2).

Particularly in those contexts where business knowledge is the main driver of success, the Organisation function can play a coordinating role in the planning process. In fact, in order to adopt a strategic approach to set IC policies in a given time horizon, it ought to involve line units in reasoning about effects such investments will generate on performance, depending on how human and organisational resources will be allocated and deployed by each unit.

A conceptual framework for IC assessment proposed in this paper

As previously remarked, the method we propose for IC assessment combines a qualitative analysis of key variables (i.e., policy levers, resources, drivers and performance indicators) impacting on business knowledge with a synthetical monetary evaluation, based on the potential impact of IC investments on future company performance.

In order to assess IC, it is not proper to add up single components, such as: human, structural and customer capital. In fact, they are an attribute of the whole business system, rather than well

identified resources. This makes illusory any attempt to assess IC as a sum of the three above components [5].

Therefore, relationships among human, structural and customer capital are not additive, but multiplicative. This means that the focus of analysis ought to be shifted from a monetary evaluation of the single parts to the understanding of the *system* of factors influencing IC.

A framework for such analysis is provided in figure 3, depicting the building blocks of a scorecard for IC quali-quantitative assessment.

--- FIGURE 3 ABOUT HERE ---

Resources (i.e., personnel, human resources turnover, monetary investments) are built as an effect of IC policies. They can be qualitatively assessed through two main indexes associated to human resource knowledge and the quality of organisational structure. Such resources define the knowledge of the company, in terms of *know-how*, *know-what* and *know-why*.

The company knowledge impacts on performance drivers which are industry specific. For instance, in the telecom industry they could be related to: *time to fix customer requests* and *innovativeness*.

If we refer to the same industry, performance indicators related to the above drivers can be defined concerning *customer service*, *time to market* and *plan flexibility*. Such drivers lead to four other synthetic outcome measures, such as *operating income*, *company image*, *ROI*, and *market share*.

The above factors allow one to make a qualitative analysis of business knowledge.

Such framework provides the basis for a monetary assessment, proportionally to the change in performance fostered by IC investments in the planning time horizon. This analysis can be either conducted in a budgeting or final reporting setting.

IC can be evaluated according to the following parameters (Bianchi, 1995):

- the annual performance increase, in monetary terms, referred to the planning time horizon;

- the desired performance increase from investments done in training and organisational structure.

The annual performance increase (ΔP) is calculated from:

- the increase in operating income;

- the ratio between operational investments at the beginning and at the end of each year in the planning time horizon.

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[5] "Edvinsson and Malone (1997, p. 187) propose that intellectual capital is the arithmetic mean of all capital components in play" (Joia, 2000, p. 72).

The desired performance increase (DesΔP) from IC investments is proportional to the ROI that would provide a satisfactory yield on such investments.

The above two variables are calculated as follows:

$$\Delta P = \text{Annual increase in Operating Income} \times \frac{\text{Initial operational Investments}}{\text{Ending operational Investments}} \qquad [\,1\,]$$

$$\text{Des}\Delta P = \frac{\text{Training \& Organisational}}{\text{investments}} \times \text{Desired ROI} \qquad [\,2\,]$$

Based on [1] and [2], IC will be evaluated according to training and organisational structure expenditures, proportionally to the ratio between the performance increase in the planning period, and desired performance increase that would allow the company to fully capitalise IC expenditures.

$$\text{Intellectual capital} = \text{Training \& Organisational expenditures} \times \frac{\Delta P}{\text{Des}\Delta P} \qquad [\,3a\,]$$

At the time when the plan is drawn up, provided that both training and organisational expenditures and the ratio "ΔP/DesΔP" are referred to different perspective years, it is necessary to calculate their present value, in order to assess the expected IC monetary value the company could get from adopted policies [6].

Consequently, the equation [3 a] could be reformulated as follows:

$$\text{Intellectual capital} = \sum_{k=1}^{n} \left(\frac{\text{Training \& Organisational expenditures}_k}{(1+i)^k} \right) \times \sum_{k=1}^{n} \left(\frac{\Delta P_k/(1+i)^k}{\text{Des}\Delta P_k /(1+i)^k} \right) \qquad [\,3b\,]$$

The bigger is the ratio between the two performance indicators, the larger will be the amount of capitalised training and organisational expenditures. However, the maximum value of IC cannot be higher than the value of training and organisational expenditures actually done [7].

Based on the above remarks, the proposed method tries to match the cost and income approaches to provide a monetary assessment of IC.

Also this method has some drawbacks which can be referred to:

1. the indirect relationship between IC investments and business performance;

2. the relevance of the synthetic indicator "$\Delta P/Des\Delta P$" for business performance measurement;

3. the relevance of the planning time horizon according to which the impact of IC investments on business performance is assessed. It ought to be long enough to capture the indirect effects that a given IC investment policy would be likely to generate on business results;

4. the relevance of both the discount rate and the desired ROI on human resource and organisational expenditures.

Concerning the first drawback, it is possible to assert that, although the relationship between IC investments and performance is indirect, without a significant knowledge stock a firm would not be able to build strategic assets, leading to an improvement of results. Therefore, an increase in business performance over a relevant time horizon – except from unexpected external favourable events – could not be achieved without any IC investment policy.

Such method does not pretend to give an exact value of IC. It only aims to suggest managers a meaningful range of training and organisational expenditures that could be capitalised. However, this value would not be posted in the company financial statement. The main reason to estimate it is, instead, to support a learning-oriented planning, to foster communication between line and staff units and a better understanding of the impact of IC policies on future business growth.

If one considers the second drawback, it is possible to observe that although the above synthetic performance indicator is only related to a monetary parameter that is associated to profitability, other performance measures linked to competitive and social success are captured by the qualitative framework underlying IC monetary assessment.

Regarding the third drawback, it is worth remarking that the planning time horizon cannot be pre-defined. On the contrary, this method aims to stimulate managerial thinking about the cause-and-

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[6] The discount rate will be both related to the specific risk of invested equity, and to industry risk. Such a rate may differ from the desired ROI on IC investments, as the latter could be higher than the discount rate, in order to prudentially assess the value of capitalised human resource and organisational investments.

[7] So, the maximum value of the ratio "$\Delta P/Des\Delta P$" that will be taken into account will be one.

effect relationships between IC investments, strategic assets acquisition and deployment, and business performance. So, the planning period must be calibrated according to the decided investment policy and the way human and organisational resources will be allocated and deployed in each unit. The same remarks are also relevant about the setting of both desired ROI and the discount rate.

The above considerations emphasise that such an IC monetary assessment is not conceived as a stand-alone method. It is rather a means to foster managerial debate over the allocation of IC resources, in the light of a wider qualitative framework.

Furthermore, there is still a major drawback in the static scorecard portrayed in fig. 3. In fact, it does not capture neither the net of cause-and-effect relationships impacting on IC, nor related delays and non-linearities.

Consequently, a feedback view of the relevant system ought to be adopted in order to better explore the dynamics of IC investments.

A useful methodology to conduct this study can be referred to System Dynamics (SD).

A dynamic feedback view of IC accumulation and depletion processes

By focusing stocks and flows affecting business strategic assets' dynamics, SD is adopted to frame and manage systems that are characterized by complex cause-and-effect relationships. This is the case of IC accumulation and depletion processes (Bianchi & Bivona, 2002).

Figure 4 illustrates an aggregated feedback structure affecting the dynamics of IC.

--- FIGURE 4 ABOUT HERE ---

Training and organisational expenditures are an inflow into the stock of total accumulated investments in the different years included in the IC planning time horizon. The level of such expenditures represents a potential inflow into the IC stock. However, this inflow also depends on the actual performance ratio ("$\Delta P/Des\Delta P$"). The higher is the performance produced by knowledge built through the training and organisational expenditures, the higher the IC inflow will be. This will also imply a lower rate of current training and organisational expenditures. In other words, all the expenses that are not recognised as investments in IC can be considered as current costs.

Also the IC stock is affected by an outflow, that is associated to business knowledge obsolescence, which may depend on physical/technical issues or shifts in the industry *dominant logic*.

There is a limit, however, to IC growth. This can be due, for instance, to the exploitation of a given available technology, or a product/market mix, approaching the maturity or decline stage. In fact, as far as IC reaches a threshold level, the change in business performance declines. This reduces the performance ratio and, consequently, the capitalisation of human resources and organisational expenditures.

The above relationships ("Intellectual Capital ⇨ Change in performance ⇨ Performance ratio ⇨ Capitalised Training and Organisational expenses ⇨ Intellectual Capital") originate a balancing feedback loop.

A reinforcing loop can be detected in the relationship between: "Total Training and Organisational expenditures ⇨ Desired change in performance ⇨ Performance ratio ⇨ Capitalised Training and Organisational expenditures ⇨ Total Training and Organisational expenditures". The effects produced by this loop can be significant if the firm – relying on a satisfactory level of its current IC stock – strongly reduces training and organisational expenditures. Such a myopic policy can generate in the short term illusory increasing returns, in terms of performance ratio on IC investments. In fact, a lower stock of total training and organisational expenditures will reduce the desired change in performance (given a desired ROI). This will increase the performance ratio [8]. Consequently, a higher performance ratio will increase the flow of capitalised training and organisational expenditures, which will drain the stock of total expenditures done.

In the medium-long term, however, the effects produced by such loop will become weak. In fact, both the above said limits to IC growth, underlined by the balancing loop, and the draining effects generated on IC by obsolescence will gradually reduce the level of company knowledge. This will imply structural problems in the strategic capability of the firm to foster future growth.

It is worth remarking that a second balancing loop is associated to the relationship "Intellectual Capital ⇨ IC obsolescence ⇨ Intellectual Capital". The effects generated by such loop are difficult to perceive by decision makers, due to the inertial depletion of IC. Quite often, the human mind or information systems are unable to promptly capture such effects, which become evident only when it is too late to timely recover a satisfactory level of company knowledge.

An ILE embodying an SD and Accounting model to support IC Management in a planning setting: the Dynamic Intellectual Capital Scorecard

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[8] In fact, desired change in performance is the denominator of the performance ratio.

The above commented feedback view of IC accumulation and depletion processes provides the conceptual framework for an ILE, based on SD ad accounting models, aiming to educate top management operating in a planning setting to better frame and manage variables impacting on IC.

Based on a case-study of a telecommunication company (*Nextcel*) operating in the mobile industry, the simulator was built around the concept of *Dynamic Intellectual Capital Scorecard*.

An ILE (continued): the Nextcel case-study

In 1998, in San Diego (USA) a pool of entrepreneurs decided to start a telecommunication company, *Nextcel* [9].

In a couple of years, Nextcel would have become a leader in the mobile telecommunication (GSM) and Internet industries.

In order to tackle its two main competitors, Nextcel aimed to build a competitive advantage through its high technology broadcasting stations and a:

- timely customer service;

- reliable coverage;

- proper plan flexibility.

The strong relationships built up with an international cellular phone producer allowed Nextcel to provide a high quality customer service level. This result was also well supported by effective training programmes.

By the end of the first year of activities, Nextcel gained 5% of the national market.

The next two years showed a positive trend. The customer base increased from 2.4 million in 1999 (9% market share) up to 5 million by the end of 2000 (12% market share).

During this two years period, the mobile telecommunication industry showed an annual increase of 35%.

However, the year 2001 showed a strong decrease in both the customer base growth rate and operating margin. Company market share was oscillating around 5%. In order to face such unexpected phenomenon, Nextcel conducted an analysis of the "best practices" of high-tech leading companies. After such analysis, the firm decided to strongly invest in both specialized training programmes referred to different employee profiles, and organisational structure (procedures, information and control systems). Such investments aimed to better develop and, in particular, use company knowledge to build up a sustainable competitive advantage.

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[9] The name of the firm has been intentionally disguised.

- *What are the main processes behind IC dynamics?*
- *How to manage human resource knowledge, abilities and skills in order to allow the firm to promptly face customer queries and generate new products?*
- *How to assess its IC?*

Based on the above case-study, the ILE users are asked to draw up a four years plan and to outline IC policies which are compatible with Nextcel sustainable growth. They are also requested to analyse and discuss expected results from adopted decisions, in the light of a dynamic feedback view of IC accumulation and draining processes.

Through facilitated simulation sessions (Vennix 1996), users are supported to understand the hidden feedback structure of the relevant system and to envisage what changes could be made to the system's structure, through different policies, in order to affect key-variables' behaviour (Davidsen 1996).

Such an approach is intended to stimulate decision makers' capability to better frame cause-and-effect relationships underlying the dynamics of business knowledge and performance. It is also aimed to match the SD view to the traditional accounting perspective, according to which human and organisational expenditures are budgeted as discretionary costs, without a proper cross-functional analysis of the IC policies' impact on business performance over time.

An Interactive Learning Environment (continued): the structure of the simulator

The simulator consists of five main sectors:

- a *guided introduction*, including the concept of IC and the Nextcel case-study;
- an *input window*, which allows the user to customise the simulator, according to different issues, such as: the initial number of employees in each training stage (classroom vs. on-the-job training) or knowledge level (trained vs. expert), normal training programme length in the industry, normal organisational investments obsolescence time;
- a *control panel* embodying main policy levers (e.g. monthly employees to be hired, new hired training programme length, organisational investments, network investments) and scenario options (e.g. concerning market growth rate, customer mobility);
- *reports* including financial, income, and cash flow statements, as well as an IC monetary assessment;
- *graphs* including main variables impacting on human capital, structural capital, IC drivers & performance indicators, and customer capital.

An ILE (continued): an analysis of two simulation scenarios

In order to show how the simulator can improve top management learning processes in IC planning, two scenarios will be now commented.

Scenario 1: a myopic IC policy

The first scenario implies a medium customer mobility (about 2.5 years) as well as a medium attractiveness of both major competitors.

According to this scenario, Nextcel monthly hires 30 employees on average.

In order to face the sharp annual market growth rate (35%), new hired personnel is primarily allocated to deal with daily customer requests. This increases the average time to start training programmes for new hired from 10 (i.e. the industry standard) to 30 days.

For the same reason, also the average frequency of training programmes for both trained employees (180 days) and experts (360 days) is lower than the industry standard (i.e., 60 and 180 days, respectively).

As shown in figure 5, the company investment policy is able to produce a satisfactory yield, portrayed by positive EBITDA, ROI E ROE and growing bank balances.

--- FIGURE 5 ABOUT HERE ---

According to the adopted IC monetary evaluation method, the 95% of human capital and organisational structure expenditures would be capitalised.

If one would have to evaluate this scenario only based on the monetary values portrayed by the accounting reports, expected results could be considered as very satisfactory.

However, a dynamic analysis of non-monetary IC indicators can be useful to better understand the meaning of the above accounting values.

As shown in figure 6, in the first eighteen months, the company hiring policy would be able to provide a reasonable customer service. Nevertheless, from the second half of the simulation, customer service significantly deteriorates. Consequently, both the company market share and image dramatically decrease.

--- FIGURE 6 ABOUT HERE ---

As shown in figure 7, although hiring and training expenditures are growing and organisational investments are stable, this policy does not allow the company to foster a significant increase in human resource knowledge.

Consequently, plan flexibility performance improvement is too weak to allow Nextcel to sustain its market image.

Furthermore, the low training investments are a primary cause of turnover increase, due to employees dissatisfaction.

--- FIGURE 7 ABOUT HERE ---

As shown in the previous graphs, the positive financial results expected from the adopted policies are trivial. As a matter of fact, a closer analysis of the business competitiveness shows that the level of its strategic assets would be substantially reduced. Such assets (e.g. company image, customer service, company innovation) would not allow Nextcel to keep a sustainable competitive advantage and sustain growth in the long run [10]. The effects of such phenomenon are well captured by the bottom-right graph in figure 6. In fact, although in the first half of the simulation the firm is able to increase its customer base, this happens as an indirect effect of two reasons, i.e.: a) the sharp market growth rate; b) the primary allocation of new hired personnel to front office activities, and the short training programme length. The effects of such myopic policy become evident only in the second half of the simulation, when the customer base collapses, in spite of the significant market growth rate. Such a scenario provides a good enough analysis of the causes underlying the limits to growth experienced by Nextcel in the last period.

The above counterintuitive results demonstrate that financial and other static quantitative indicators may not able to provide decision makers a systemic and dynamic view of observed phenomena.

This can be particularly true for the investigation of the impact generated by IC on company performance in the short and long run.

For this reason, an SD model embodying financial, other quantitative measures and intangible assets can provide decision makers more fruitful insights to assess sustainable policies.

Scenario 2: a sustainable IC policy

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[10] Such phenomenon has been analysed in the system dynamics literature by different scholars. The People Express case-study (Whitstone, 1983) offers a good example of the risks that a company may face when a myopic policy ignoring the perils of growth can imply. See also Senge (1990, chapter 8) and Morecroft (1997).

A second scenario shows a sustainable IC policy. It is based on two simulation runs, implying the same market assumptions of the previous one (i.e. medium customer mobility and medium attractiveness of both major competitors).

In this scenario, in order to cope with the sharp growth in the customer base, implying an increasing need of people available to deal with requests and launch new products, the company decides to hire and train a growing number of employees. It starts to monthly hire 60 people and, in order to sustain growth, it gradually reaches a rate of new hired personnel equal to 350 people per month.

Scenario 2 - Run 1 (an aggressive training policy)

In order to improve company knowledge, it is initially decided to provide employees with a training programme length equal to the industry standard.

At the end of the simulation, the users can observe that, although the company has achieved a significant growth rate (in terms of employees, productivity, customer service, market share, image, and customer base) profitability is very low (see figure 8).

--- FIGURE 8 ABOUT HERE ---

This implies that the achieved performance would not allow the firm to capitalise training and organisational expenditures.

A debate fostered by a learning facilitator allows players to associate the main reason of such a low profitability to high education costs.

Scenario 2 - Run 2 (a smoother training policy)

In order to sketch a sustainable growth scenario, players formulate a second simulation run of the same scenario plan. Such a run implies that the length of periodical re-training programmes for trained employees is initially reduced to 10 days (against an industry standard of 20 days). The players also plan to increase such a length to 15 days from the fourth simulation semester.

Scenario 2 - A comparison of Run 1 and 2 results

Figure 9 shows that only in the second and third year this policy would lead to lower competitive results (market share and company image). However, at the end of the simulation, competitive performance related to the two runs would reach the same level. An explanation to this phenomenon is that the productivity of IC investments may find limits to growth when decision makers adopt an too aggressive training policy. In fact, in the first run of this scenario, the number of experts is not sufficient to both support the increasing volume of current activities (e.g., dealing with customer requests, launching new tariff plans) and the education of the massive number of new hired employees that growth requires.

Furthermore, it is possible to observe that in both simulation runs customer service oscillates because of the difficulty of the firm to face growth through its skilled employees. Such oscillations are at the same time the cause and effect of market share fluctuations. In fact, a lower customer service reduces demand, which in turn decreases the workload for Nextcel employees. This increases – other conditions being equal – customer service again.

--- FIGURE 9 ABOUT HERE ---

The limits to growth of IC investments productivity are also captured by the behaviour of the human resource knowledge index, displayed in figure 10. The figure also shows financial effects generated by the two simulation runs, associated to hiring and training costs. If compared to the first scenario, such results would allow the firm to earn a lower ROI in the first two years (2% and 15%) and a higher ROI in the last two years (13% and 21%).

Therefore, the second run policy ought to be preferred to the first run scenario.

--- FIGURE 10 ABOUT HERE ---

However, according to the adopted IC evaluation method, the second run of this scenario would allow the firm to capitalise only the 16% of training and organisational expenditures.

How can one explain that a policy leading to better competitive and financial results is likely to give rise to a lower percentage of capitalised IC expenditures?

In order to understand the reasons of this phenomenon, it is necessary to analyse the net of causalities underlying IC non-monetary indicators.

A comparative analysis of Scenario 1 and Scenario 2 (run 2)

If we look back to figure 9, we can observe that, in the first half of the simulation related to the second run of scenario 2, Nextcel gets an improvement in its market share, fostered by a higher productivity.

However, after the second year the higher growth rate enhanced by productivity and image is tackled by the lack of trained human resources. Such an effect is magnified by the need to devote more skilled personnel to the training of new hired people.

As a consequence, customer service declines, which reduces both market share and image.

In order to counterbalance such phenomenon, the company progressively increases its labour force.

In the long run, this strategy allows Nextcel to increase service and recover market share.

As shown in figure 10, a balanced policy of growing investments in hiring/training and organisation structure allows the firm to substantially increase its human resource knowledge.

As a result, both plan flexibility and company innovation grow. In particular, company innovation reaches a higher level than in the first scenario, but eventually declines. In fact, the marginal productivity of IC investments decreases as it reaches the potential maximum level that is achievable from a given technology (see figures 7 and 10).

Figure 11 summarises main differences in key variables' dynamics related to the two explored scenarios.

--- FIGURE 11 ABOUT HERE ---

Concerning the first scenario, the above considerations suggest that although the performance increase achieved in the four years gives a satisfactory yield, the endowment of strategic assets would not be able to sustain future growth.

On the contrary, the second scenario (run 2) would imply:

- higher IC investments, leading to better financial results in the long run and lower yields;

- a higher endowment of strategic assets that would allow the firm to sustain future growth.

To summarise, the ILE suggests the following remarks:

- the percentage of capitalised training and organisational expenditures refers to the *flow* of results generated by investments done in a given time period. As a consequence, although a small investment can give a satisfactory yield, it could not provide the firm the necessary *stock* of strategic assets to sustain future growth;

- such investments in strategic assets will allow the company to achieve a performance increase. This will make the capitalisation of training and organisational expenditures possible (see reinforcing loop "Intellectual Capital ⇨ Other Strategic Assets ⇨ Change in performance ⇨ Performance Ratio ⇨ Capitalised training & organisational expenditures ⇨ Intellectual Capital" in figure 12);

- the higher is the growth rate of the firm, the higher will be the stock of its strategic assets needed to make growth sustainable. However, to build a higher level of strategic assets, larger investments in IC will be necessary (see the reinforcing loop "Other Strategic Assets ⇨

Training & Organisational expenditures ⇨ Capitalised training & organisational expenditures ⇨ Intellectual Capital ⇨ Other Strategic Assets" in figure 12);

- a growing IC stock will increase IC obsolescence, which will require higher human resources and organisational expenditures, in order to keep the existing level of company knowledge. Therefore, the weight of such expenditures on total IC investments will be growing (see the reinforcing loop "Intellectual Capital ⇨ IC obsolescence ⇨ Training & Organisational expenditures ⇨ Total Training & Organisational expenditures ⇨ Capitalised training & organisational expenditures ⇨ Intellectual Capital" in figure 12);

- consequently, intellectual capital obsolescence will provide a limit to further growth in the IC stock (see the balancing loop "Intellectual Capital ⇨ IC obsolescence ⇨ Intellectual Capital" in figure 12);

- a second limit to IC growth is given by the likelihood that the positive loop enhanced by the increase of other strategic assets affecting company performance, can continue to be dominant. In fact, as far as IC reaches a threshold level, given an available technology, the productivity of further IC investments will decline. This will reduce the capitalisation of human resources and organisational expenditures (see the balancing loop "Intellectual Capital ⇨ Change in performance ⇨ Performance ratio ⇨ Capitalised training & organisational expenditures ⇨ Intellectual Capital" in figure 12).

--- FIGURE 12 ABOUT HERE ---

From the above remarks it follows that, if the firm is able to build a critical mass of strategic assets to sustain growth, the effectiveness of further IC investments will be decreasing.

Consequently, a significant share of IC investments must be allocated to keep the existing level of company knowledge.

An ILE (continued): what users can learn

As previously remarked, through facilitated simulation sessions, users are supported to understand the hidden feedback structure of the relevant system and to envisage changes to the system's structure, to be made in order to affect IC key-variables' behaviour.

Figure 13 shows main feedback loops of the simulator related to the framework previously depicted in figure 3.

--- FIGURE 13 ABOUT HERE ---

Hiring allows the firm to improve time to fix customer requests and customer service. This improves company image and increases the customer base. A larger customer base generates two effects.

On a side it increases sales revenues, which provide more financial resources to invest in training (that increases the human resource knowledge index) and organisational structure. Such investments trigger innovativeness, i.e. an important driver of growth. A higher innovativeness improves performance indicators, such as plan flexibility and time to market. This is also likely to enhance company image, which in turn enlarges the customer base (reinforcing loops R1, R2 and R3 in figure 13). Such growth could be also fostered by network investments, (e.g. systems, antennas) which would improve Nextcel local coverage. This would imply an improvement in company image and – other conditions being equal – customer base.

On another side, however, a larger customer base could generate bottlenecks in the provision of services, provided a given available labour force. Such a phenomenon is captured by the model through the balancing loop B1 in figure 13, which links customer requests to service as a result of time to fix customer requests. Hiring new employees is likely to counterbalance the above limit to growth (reinforcing loop R4 in figure 13).

Figure 14 provides a simplified picture of the model stock-and-flow variables and related policy levers affecting human resource knowledge index [11].

--- FIGURE 14 ABOUT HERE ---

Such exhibit shows main sequential stocks portraying Nextcel human resource endowment, i.e.: new hired, in training personnel, trained employees, and experts.

The company hiring policy affects the first stock. The outflows of this stock are affected by decisions impacting on the average time to start training programmes to new hired personnel. In fact, such decision influences the number of people going to an "in training" stage. It also affects the number of new hired employees who decide to resign. If this time is too short (if compared to industry practice), the resignation rate increases.

The average training programme length affects the outflow of people in training into the stock of trained employees. The shorter is such period, the higher the outflow will be. However, a too

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[11] A different stock and flow analysis of the company skill resources has been provided by Winch (2001) and Hafeez & Abdelmeguid (2003).

shorter training programme length (if compared to the industry standards) is likely to reduce human resource productivity and, consequently, customer service.

The same reasoning is relevant for the "re-training" of trained employees and experts. Furthermore, there is a relationship between the time to start retraining and employees turnover. In fact, this increases if the mean time between two education programmes is longer than the industry standards.

An aggregate measure of human resource knowledge is provided by a stock index, whose inflow (learning) is triggered by a co-flow associated to the number of employees moving from a level to the next, being each one characterised by a different potential.

At the same time, the human resource index level is dissipated by an obsolescence outflow, associated to the human resources resignation rates.

Figure 15 provides a synthetic picture of the model stock-and-flow variables, related policy levers affecting human and organisational resource indexes, and performance indicators.

--- FIGURE 15 ABOUT HERE ---

As it is possible to observe, the organisation structure index is increased by an inflow triggered by the company investments, and decreased by an obsolescence rate which is related to different internal and external factors (e.g. technological progress, competitors innovation).

Both human resources and organisation structure indexes affect two main performance indicators: time to market and plan flexibility.

A third performance indicator is associated to customer service, which is affected by: a) the number of employees in each stage of the chain commented above; b) their productivity level, and c) the organisational structure index, which may either foster or tackle people productivity.

Concluding remarks

This paper has shown the potential impact of ILEs embodying SD and accounting models to support top management decisions in allocating business resources in a planning setting for IC management.

Human resource training and organisational expenditures are often budgeted on an incremental basis, as discretionary costs. They are planned without a closer look on the impact they will be able

to generate on the future business performance and how, during the planning time horizon, resources (e.g. people knowledge) will be developed and deployed in different business areas.

By focusing stocks and flows affecting business strategic assets' dynamics, the SD methodology has been adopted in this paper to provide decision makers a learning vehicle supporting them to frame and manage the complex and peculiar system characterised by IC.

The ILE that has been analysed has portrayed a "scorecard" providing a quali-quantitative framework for IC monetary and non-monetary assessment.

The two simulation scenarios commented in the last section of the paper, suggest how managing IC only based on a monetary and static approach is likely to lead decision makes to a myopic resource allocation in the planning process. This may also happen when a qualitative analysis of IC indicators is not supported by a dynamic view of the processes driving the accumulation and depletion of strategic assets.

Further empirical research will be necessary to experiment the contribution our methodology and the ILE are likely to give to top managers' learning processes, in both educational and planning contexts. We believe that such analysis will give us more insights for both including in the ILE more relevant issues (or re-focusing existing ones) and developing new ILEs based on case-studies, aimed to foster decision makers' learning on other key-problems related to IC management.

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Figures
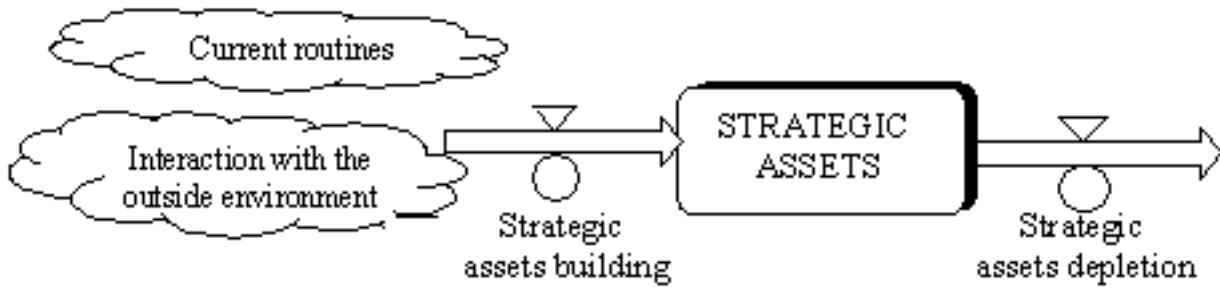
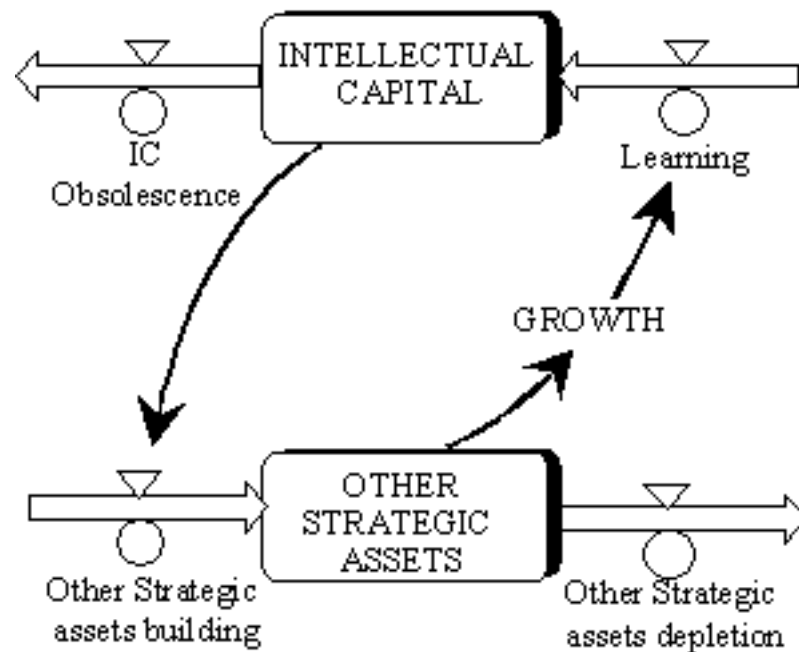Figure 1 – Strategic assets accumulation and depletion

Figure 2 – Intellectual and other strategic assets accumulation and depletion processes underlying business growth
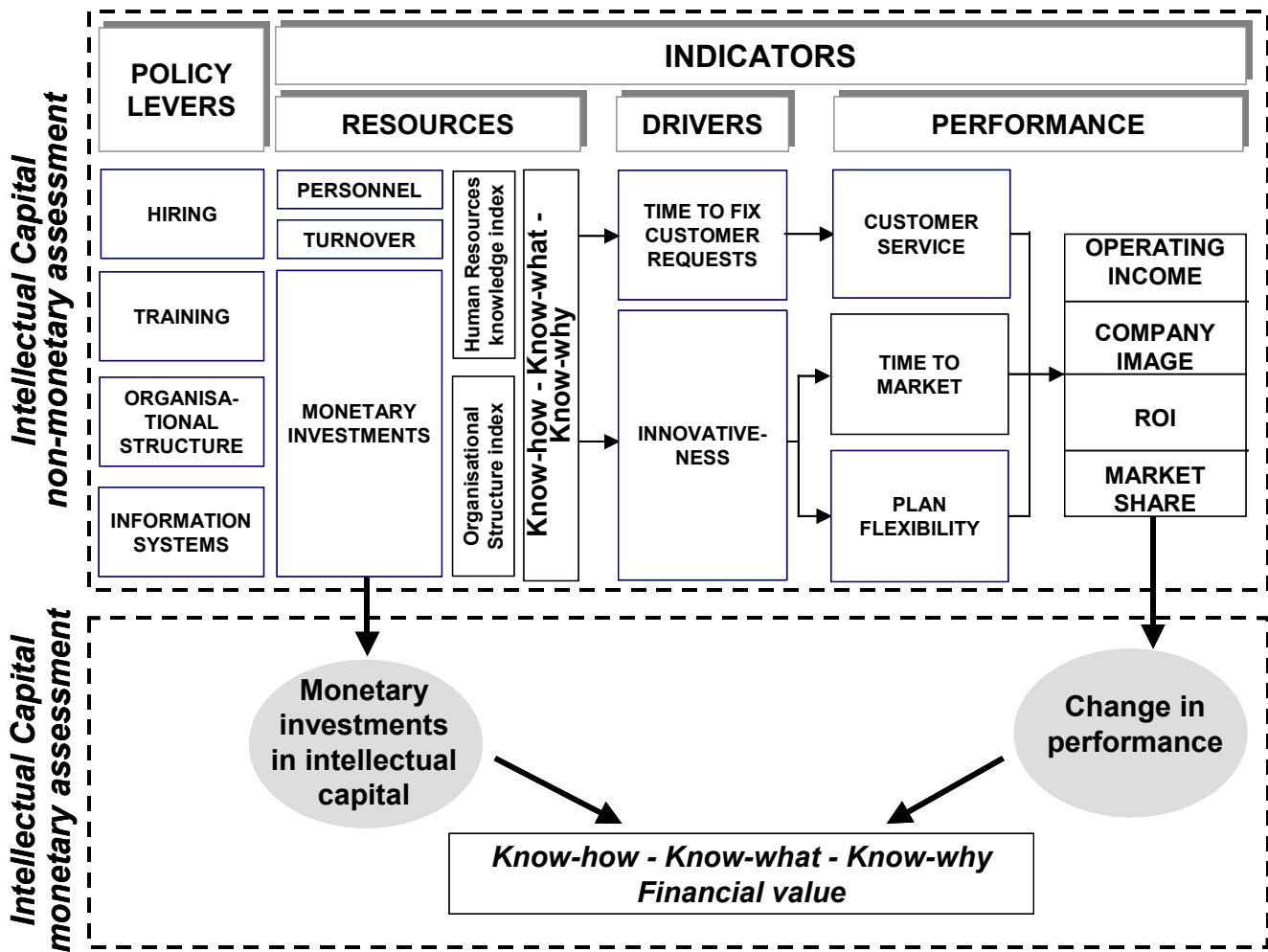
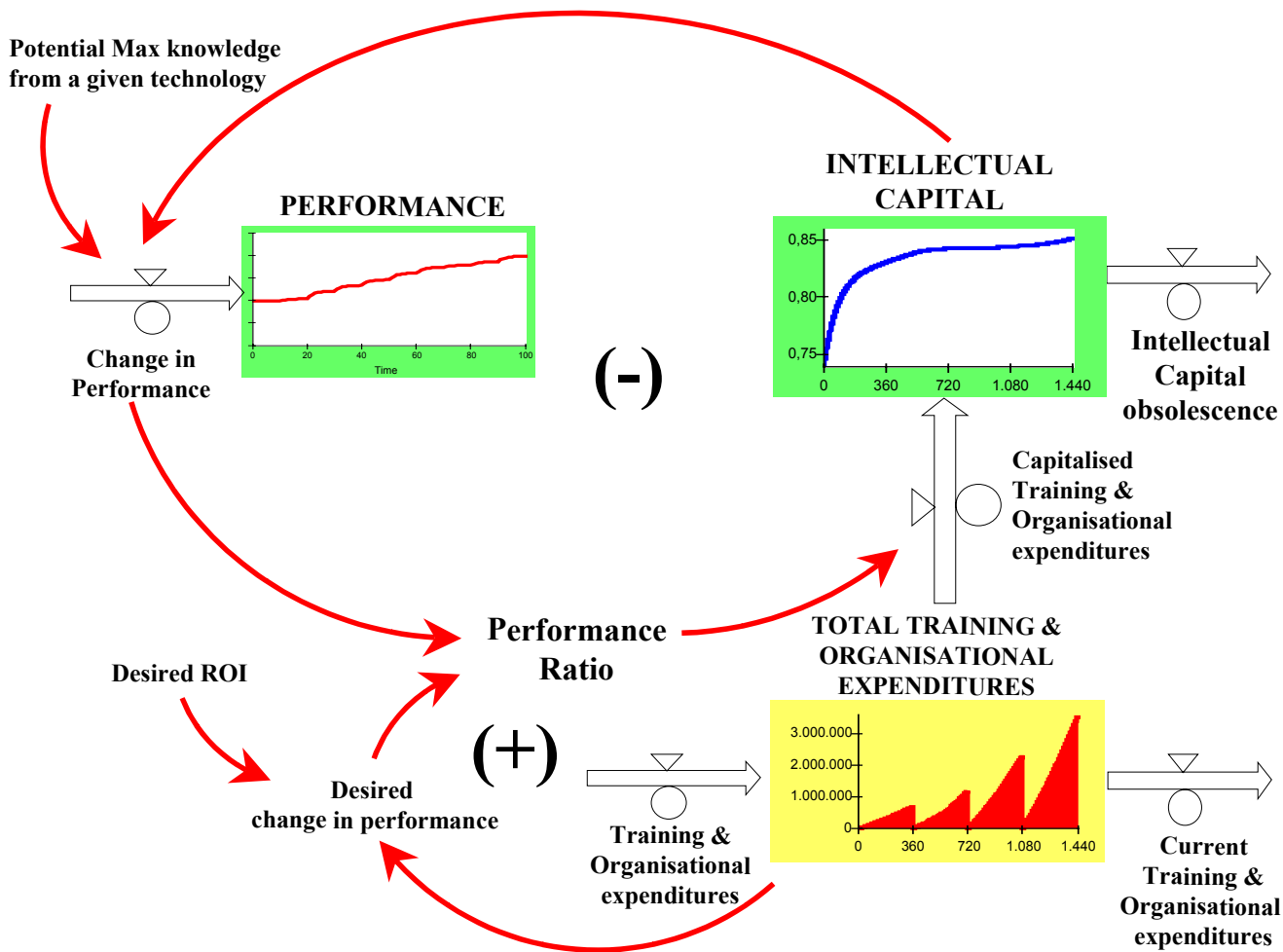Figure 3 – The building blocks of a scorecard for IC quali-quantitative assessment

Figure 4 – Intellectual capital dynamics portrayed by the ILE

INCOME STATEMENT (Euro/.000)

	FIRST YEAR	SECOND YEAR	THIRD YEAR	FOURTH YEAR
Sales revenues	2.271.473	4.035.072	3.365.443	2.656.569
Operating costs	792.515	1.216.483	1.092.478	952.711
EBITDA*	1.478.957	2.818.589	2.272.965	1.703.859
Depreciation	668.195	668.194	668.194	667.268
Operating income	810.762	2.150.395	1.604.771	1.036.591
Financial costs	173.246	48.328	0	0
Net income	637.516	2.102.067	1.604.771	1.036.591
Financial indicators				
Cumulated cash flow	490.738	1.953.680	1.979.810	1.189.532
Bank balances	-1.113.543	838.546	2.814.958	4.002.445
ROI	10%	25%	16%	9%
ROE	29%	48%	26%	13%
Other indicators				
Total employees				
Customer base				
Company Coverage				

FINANCIAL STATEMENT (Euro/.000)

	FIRST YEAR	SECOND YEAR	THIRD YEAR	FOURTH YEAR
Coverage investments	3.000.000	3.000.000	3.000.000	3.000.000
Organisational investments	334.535	334.535	334.535	334.535
Other long term investments	1.169.799	1.169.799	1.169.799	1.169.799
Accounts receivable	859.526	1.381.624	1.051.391	883.673
Positive bank balances	0	838.546	2.814.958	4.002.445
Total investments	5.363.861	6.721.107	8.368.639	9.390.452
Equity	1.528.621	3.627.701	5.230.828	6.267.419
Long term debts	2.147.659	2.263.012	2.352.846	2.422.805
Other long term de				
Negative bank bala				
Short term debts				
Debts for training				
Equity and liabilitie				

CASH FLOW STATEMENT (Euro/.000)

	FIRST YEAR	SECOND YEAR	THIRD YEAR	FOURTH YEAR
Net income	637.516	2.102.067	1.604.771	1.036.591
+ Depreciation	668.195	668.194	668.194	667.268
= Internal flow of funds	1.305.711	2.770.262	2.272.965	1.703.859
- Change in net working capital	295.082	263.882	-285.096	-82.981
- Change in non current investments	519.890	552.700	578.251	597.308
= Net cash flow	490.738	1.953.680	1.979.810	1.189.532

Figure 5 – Main accounting reports embodied by the ILE and portraying the first scenario results
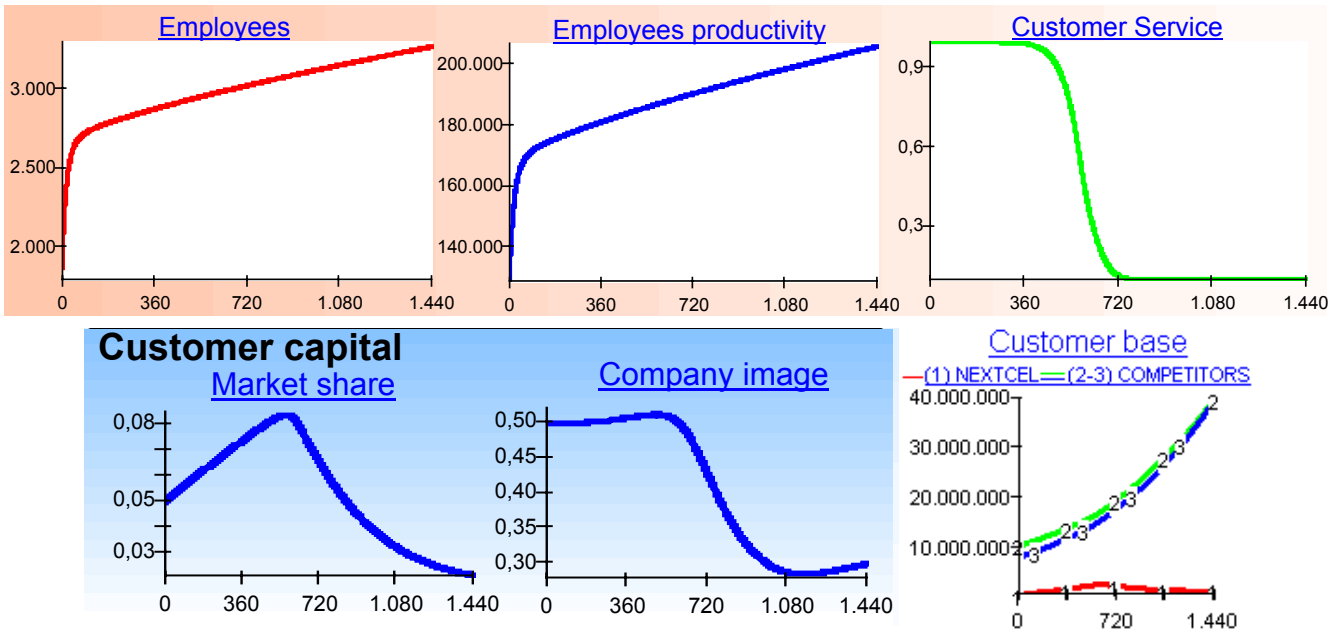
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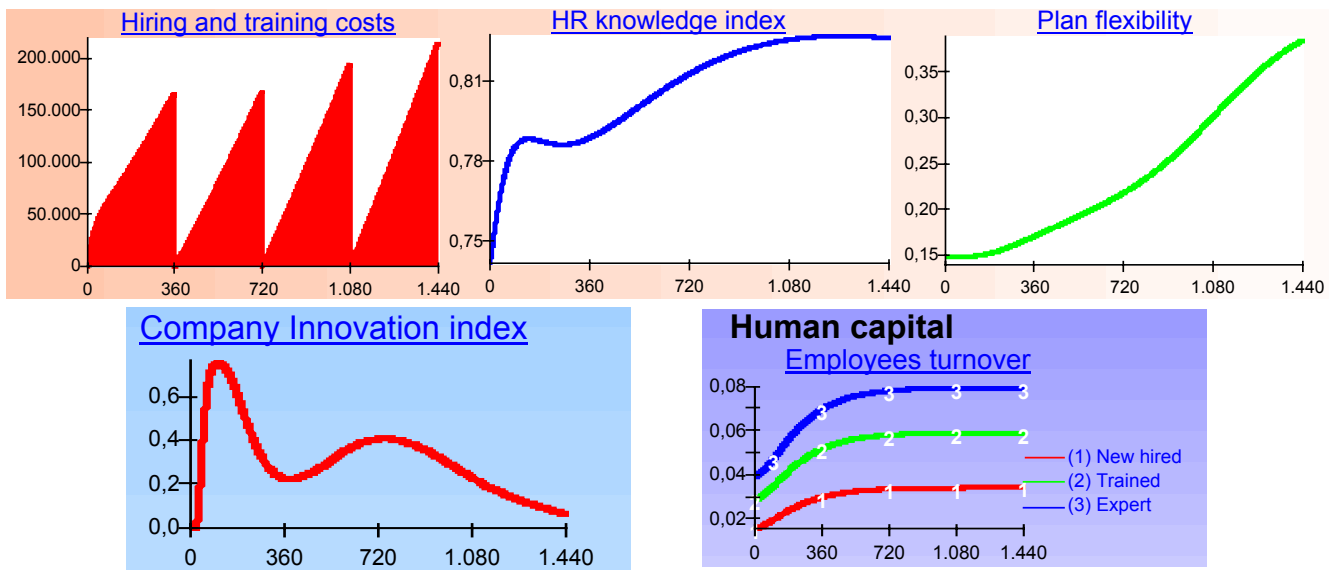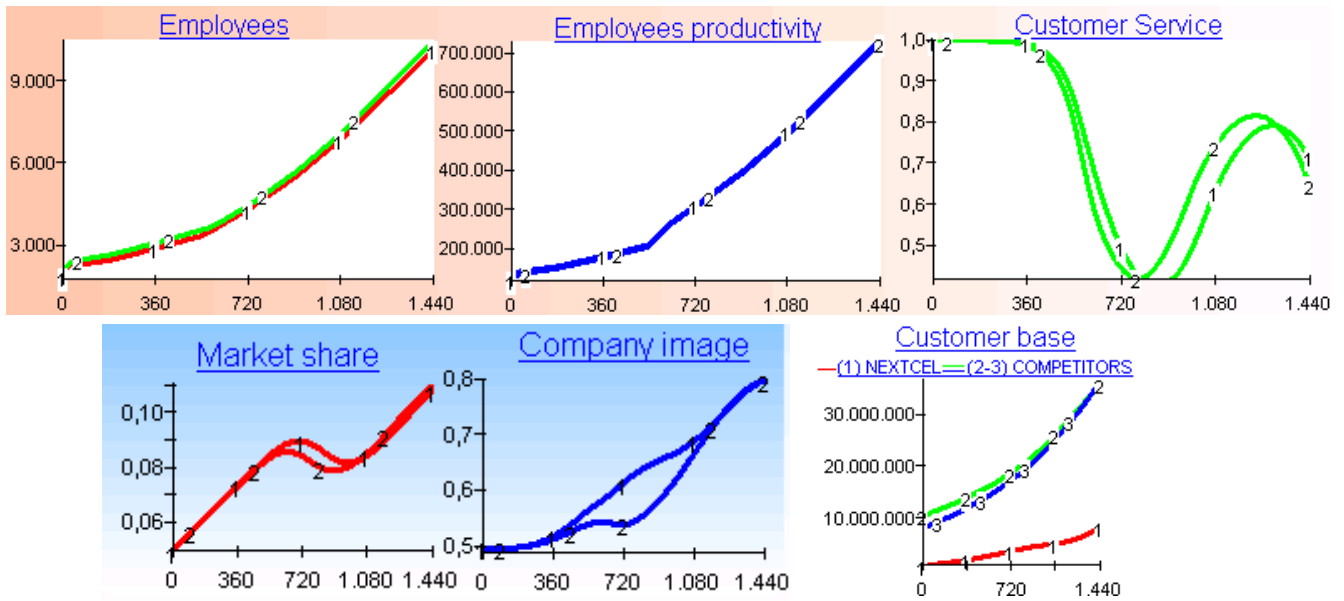Figure 6 – Effects of IC policies on employees productivity, service and customer capital in the first scenario

Figure 7 – Effects of IC policies on human capital, innovation, and plan flexibility in the first scenario.

INCOME STATEMENT				(Euro/.000)
	FIRST YEAR	SECOND YEAR	THIRD YEAR	FOURTH YEAR
Sales revenues	2.273.147	4.351.154	6.210.218	10.010.911
Operating costs	2.161.259	3.251.292	4.960.489	7.468.688
EBITDA*	111.887	1.099.863	1.249.729	2.542.223
Depreciation	668.195	683.484	738.576	749.098
Operating income	-556.308	416.379	511.154	1.793.125
Financial costs	216.890	263.278	219.995	147.492
Net income	-773.197	153.101	291.158	1.645.632
Financial indicators				
Cumulated cash flow	-537.429	23.434	481.452	1.144.455
Bank balances	-2.141.710	-2.117.561	-1.636.815	-492.885
ROI	0%	4%	6%	14%
ROE	0%	15%	45%	60%
Other indicators				
Total employees	3.594	5.334	8.445	12.354
Customer base	2.093.067	3.628.039	4.853.352	8.772.360
Company Coverage	50%	50%	50%	50%

Figure 8 – Income statement portraying the second scenario results *(run 1)*.

Figure 9 – Effects of IC policies on employees productivity, service and customer capital in the second scenario *(1 = run 1; 2 = run 2)*.
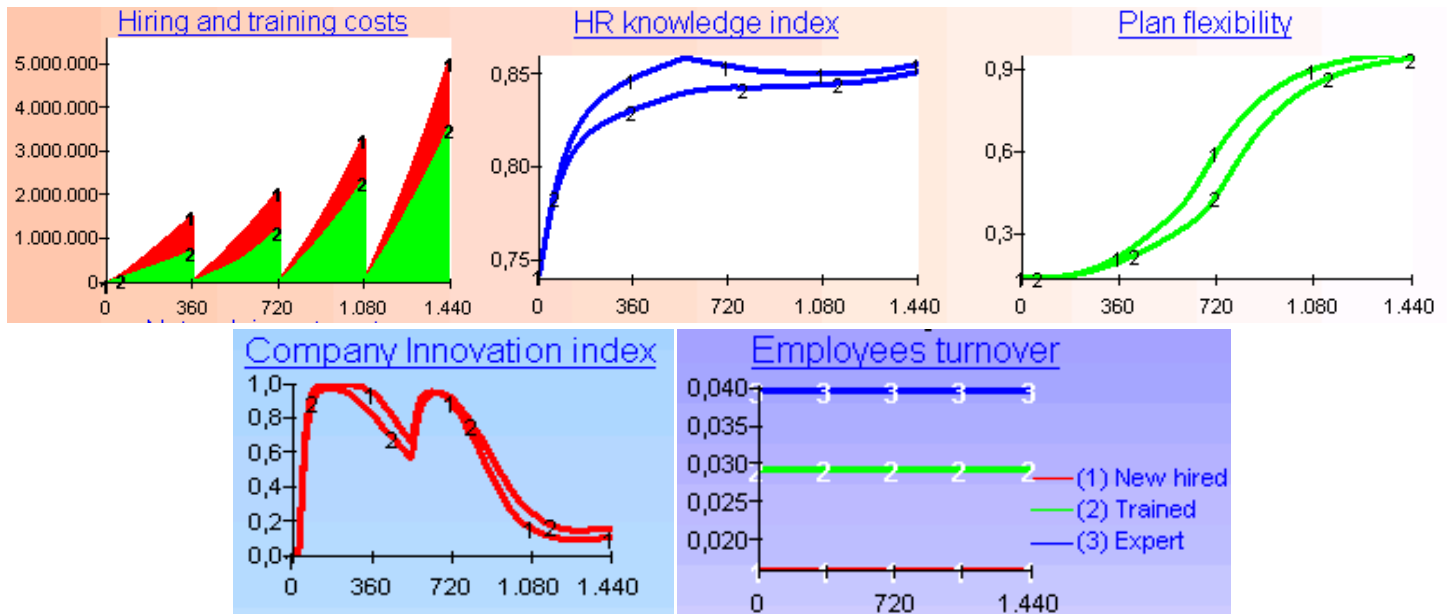

Figure 10 – Effects of IC policies on human capital, innovation, and plan flexibility in the second scenario *(1 = run 1; 2 = run 2)*.
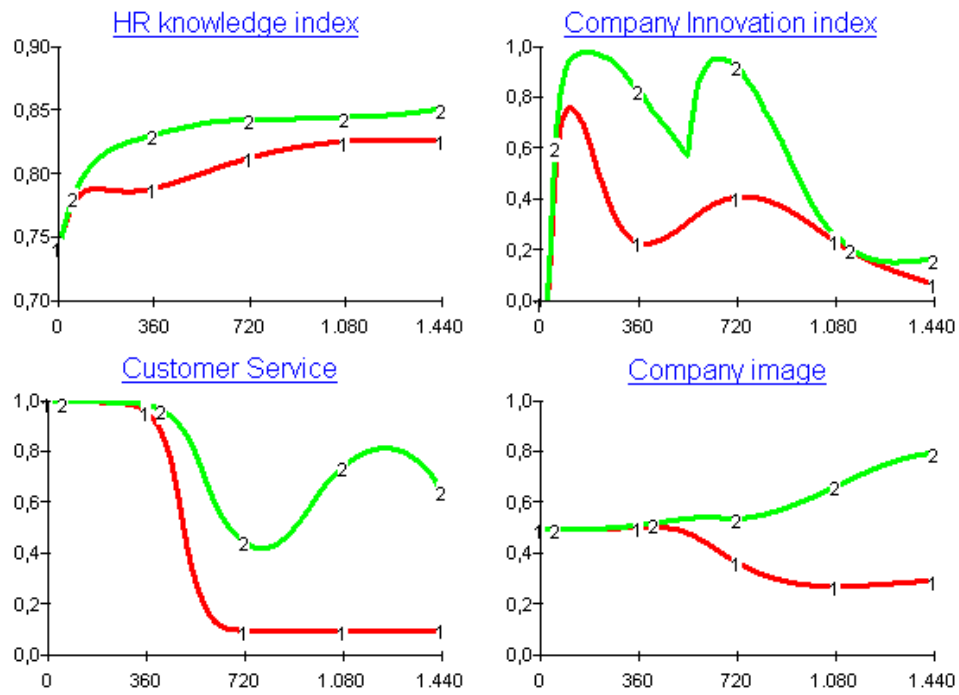
Figure 11 – The dynamics of key-variables related to the two scenarios *(1 = first scenario; 2 = second scenario – run 2)*.
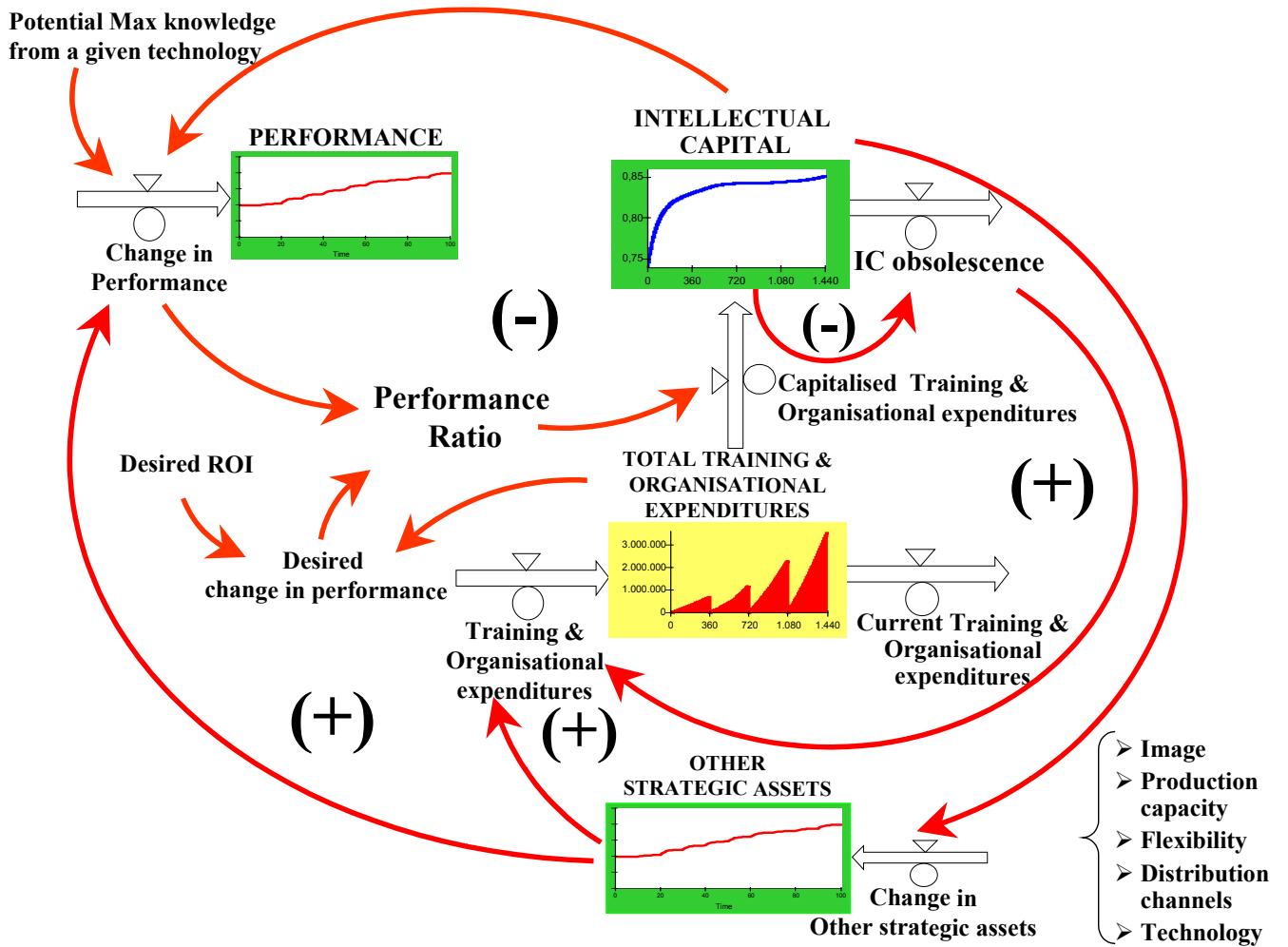
Figure 12 – A feedback view of accumulation and depletion processes of IC and other strategic assets fostering business growth.
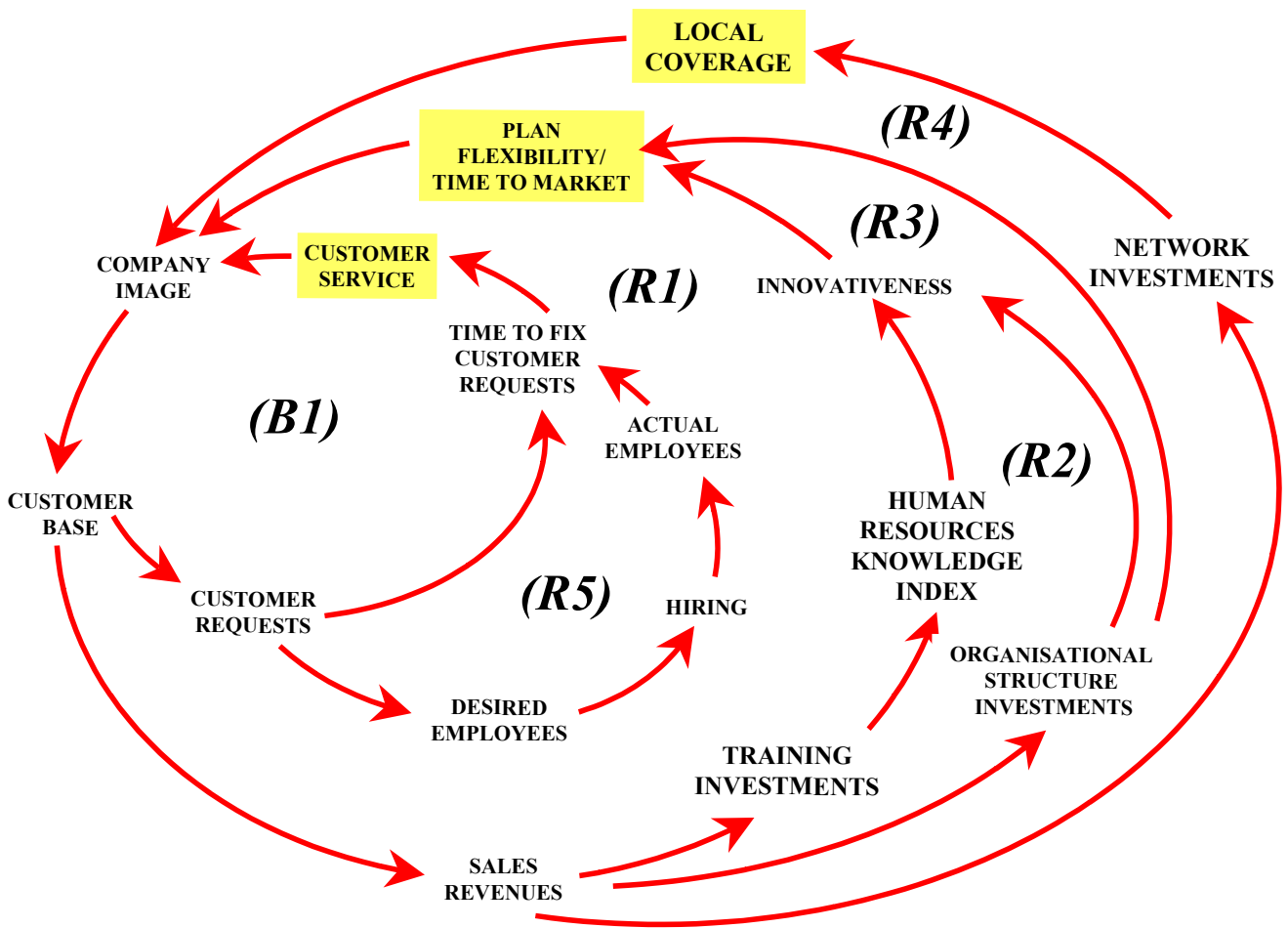
Figure 13 – Main feedback loops related to Intellectual Capital policies
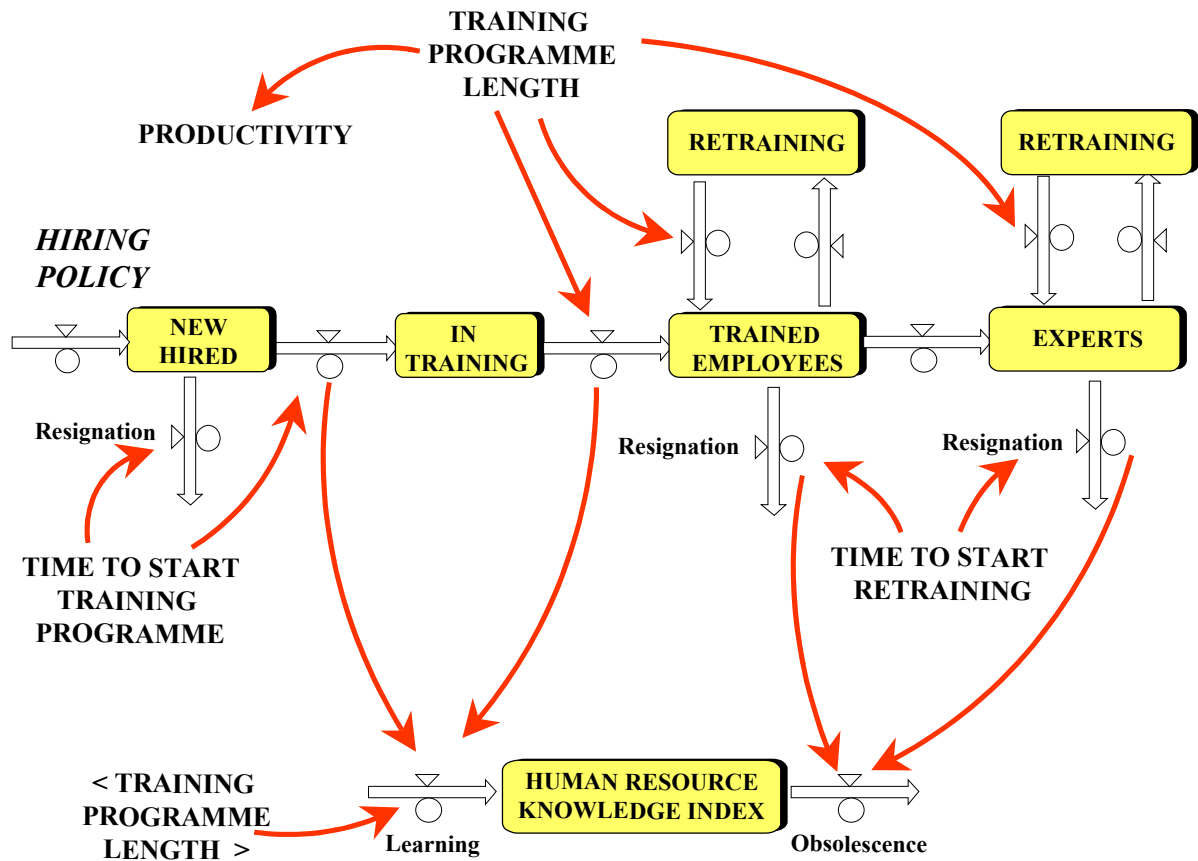
Figure 14 – A simplified picture of the model stock-and-flow variables and related policy levers affecting human resource knowledge index.
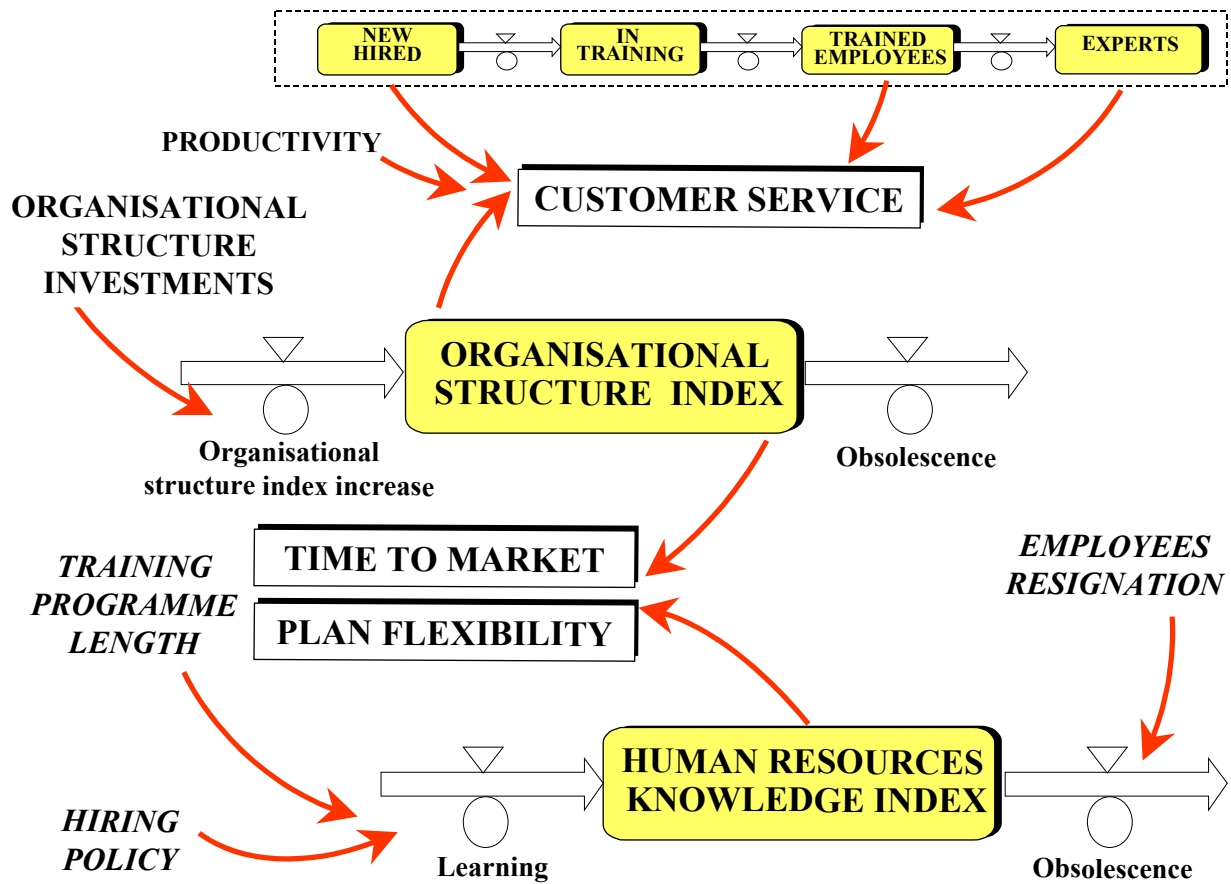
Figure 15 – A simplified picture of the model stock-and-flow variables and related policy levers affecting human and organisational resource indexes and performance indicators