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Use of the concept of Situation Room Analysis and the relevant enabling technologies to support collaboration in the IT Product development

A Thesis Submitted for the Degree of Doctor of Philosophy

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November 2006

Tactics is what you do when
there's something to do

Strategy is what you do when
there's nothing to do

Sawielly Grigoriewitsch Tartakower (1887-1956)

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Abstract

The research is entitled *'Use of the concept of Situation Room Analysis and the relevant enabling technologies to support collaboration in the IT Product development'.* It deals with the Situation Room (SR) concept which we aspire to employ as a central metaphor of the collaborative working environment (CWE) of the future, supporting personal and corporate requirements, work and management practices, organizational issues, and emerging enabling technologies.

Based on the SRA paradigm, and supported by scientific concepts and design methods from the areas of information systems, game theory and data mining, the research concludes to an integrated framework, capable to support decision making, as well as ubiquitous access, sharing and distribution of knowledge related to the product development process.

By means of five different product development application scenarios which serve as explorative cases for grounding the research hypotheses, we argue that collaborative decision making in the IT business domain will be able to build on and follow the Situation Room Analysis (SRA) metaphor and will be supported by an information- and knowledge-rich virtual SR. Such a SR can operate irrespective of space and time constraints, handle interactive and multidisciplinary content, support personalized communication and collaboration services, as well as intelligent decision support tools. These tools are orchestrated by a "virtual facilitator", allowing professionals to take the best shared decisions (in terms of various performance indicators) in a relaxed, enjoyable, stimulating, game-like learning environment.

The model of SRA has been presented to the workshop participants who were given the opportunity to employ SRA for 5 business application scenarios:

- *Problem Solving in Complex Product Development Projects*
- *Collaborative Authoring, Publishing and Delivery of Multimedia Content*
- *Individual Learning and Corporate Content Management in Industry*
- *Knowledge Sharing and Management in Professional Virtual Communities*
- *Augmented Reality and Experiential Systems in Remote and Rural Areas*

User-centred development methodologies have been adopted, based on the regular and recurring use of evaluation of research achievements - such as concepts, scenarios, prototypes and test services - with academic and corporate input.

Decision-making both as a method and as a practice in today's corporate environments is seriously suffering from many different suboptimalities. Some of these suboptimalities are structural, other metaphysical or of transcendal and ephemeral nature. For some others a framework that would comprise both organisational and technology aspects could be an answer to certain pitfalls and shortcomings currently faced.

Acknowledgements

By the time this research has commenced, it was envisaged quite differently in many aspects; as any real life and real world project, it had to come through a set of compromises most of them posed by the context in which this research was carried out.

Now to the people I feel I personally owe for this research; quite in contrast to endless lists in similar occasions, I need to mention two people only.

I start from Dr Roberts, my scientific supervisor – in a small world as it is the academic microcosm, Bob is an exceptional rarity. Though I am tempted to elaborate I shall not do this here and now; I constrain myself only in quoting John Steinbeck: "There is absolutely nothing to take the place of a good man". May God bless him to supervise several other young (and not so young) people's research works and projects and be as supportive and inspiring as with me.

My wife Maria Christoforaki – the most prominent person in my life – I thank her for everything she did in all these years that we are together. Quite funny for my agnosticism that I shall again need to mention Him: May God blesses her with many happy moments in her life.

1. Introduction

"An appealing vision of the evolution of computing is that the computer disappears – with the task and experience dominating, and the tools receding into the background."

Pingali and Sukaviriya (2003, p.317)

1.1. Rationale

Professor Thomas Davenport concludes in his recently published book that "*It is difficult to impose a new process on a large group of knowledge workers who don't want to work that way*" (Davenport 2005, p. 22). He continues by recognising that "*Too much of the work is invisible or is carried out in a way that can't easily be assessed or measured*" (p.23) and concludes noting that "*A process orientation implies design – we are not just accepting work the way it is, but trying to find better ways to perform it*" (p. 25).

Over the past 75 years, workplaces have changed dramatically; noisy mechanical adding machines and typewriters have been replaced by silent PCs. Global electronic communication now occurs round-the-clock without any "physical" transfer of paper documents.

Over the past decade, most firms have adopted work processes in which non-managerial workers are involved in problem solving and identifying opportunities for innovation and growth (Black and Lynch, 2004). Team work, employee voice, collaboration at work and similar organisational structures and management practices seem to be highly correlated with the unprecedented 'boost' in labour productivity the corporate environments have experienced since the second half of the 1990s.

Unfortunately, in many collaborative situations – meetings, conferences, corporate design rooms, etc. – a typical worker is more concerned with his or her task at hand and would rather use collaborative tools only to the extent they do not interfere with their work. Furthermore, collaborative tasks and design processes often involve the physical environment and physical objects as well as access to the information being stored in electronic form and delivered through electronic devices or display tools.

A growing literature on augmented collaborative spaces and experiential systems, as for instance in (Pingali and Sukaviriya, 2003), (Jain, 2003) and (Singh et al, 2004), has started to draw a picture where information is brought seamlessly into the context that people work and collaborate in; this scenario is built upon physical workplaces that are rich in sensors and display systems, employ distributed computational resources and multimedia data sources. Decision makers at all organizational levels are freed from the tedium of managing enormous volumes of disparate heterogeneous data and allowed instead to apply their senses directly, observing event-related data and only exploring the information of interest within the context of an event.

However, this experiential framework is far from being consolidated, and no experimental solution developed has reached marketability or wide application outside design laboratories.

The information that workers typically have to deal with in their daily activities is dramatically increasing, both in terms of the sheer amount as well as its variety of formats. While workers were traditionally able to deal with this complexity in a paper based system, current systems are not only required to deal with storage and access, but also to manage the complexities of retrieval of relevant information (to the exclusion of irrelevant information) and the combination of retrieved information in the generation of solutions and output. Typically this information resides in different systems and locations and is not easily combined and there is no single point of access or a workspace where information is created, combined, edited, saved and sent to those that require the results.

1.2. Concepts

A key issue in designing suitable working environments is to develop a generic framework for managing different types of data, information and knowledge (re) sources and media in a unified manner. There have been significant advances in storage, processing, and sensor technologies over recent years, allowing digital media of different types to be captured, edited and authored[1]. Yet as opposed to the increasing ease which such data can be collected with, problems related to the display and understanding of the information stored are becoming increasingly complex. More specifically, there is a need to capture the full semantics of information that may be spread across different media, each describing a specific aspect of the same informational entity.

In this respect, we experience the following paradox cutting across today's knowledge society:

- workers are using extremely advanced technology services and (potentially) content-rich applications in their personal lives,
- while their working environments remain obsolete and monolithic, both in terms of supporting tools, applications and media and of underlying metaphors.

The metaphors and the various conceptual schemes and mental representations that people use for carrying out most types of work tasks and job assignments, spanning from what we call 'simple' and 'everyday' to those we tend to regard as more abstract or sophisticated, and which work and the learning process in general are part of, have a great significance to the way tasks are carried out and work practices are developed for carrying out these tasks. By the use of such a nonmaterial or intangible culture (Lakoff and Johnson, 1980), which is inherent to any specific job assignment, being able to 'serve' it and to sufficiently express its characteristics, it is often possible to improve substantially the way a task is executed, no matter how abstract, complex, detailed or sophisticated may this be. That same nonmaterial or intangible culture also consists of all ideas, values, norms, interaction styles, beliefs and practices that are used by the members of a Collaborative Working Environment (CWE).

Huber (1991) has extended the decision making process (intelligence, design, choice) of Simon (1977) by two additional steps (implementation and monitoring). The process

[1] In the specific context of personal information management, this trend has significantly accelerated in the recent past with the introduction of affordable digital cameras, portable audio recorders, and cellular phones capable of supporting, capturing, and storing information as text (e-mails and instant messages), images, videos, and sound clips. See also (Singh et al, 2004).

is shown in Figure 1 that shows how the original three-step process of decision-making is extended to address problem-solving.

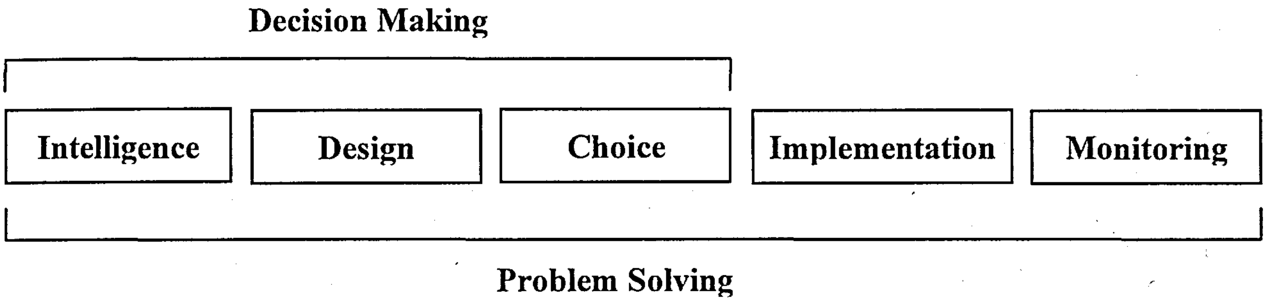

Figure 1 Components of the problem solving process

Problems/opportunities are first thoroughly investigated (*intelligence*), then alternative solutions are developed (*design*), then an alternative is selected (*choice*), then a solution is put into effect (*implementation*), and finally the implemented solutions are investigated and changes are made if necessary (*monitoring*).

The decisions particularly under investigation in this research may be time-critical "which-way-to-go" decisions of a strategic nature, or even "day-by-day", task-related decisions which are based on unpredefined conditions and requirements (from product specifications and restrictions, to technology, organization, cost and financial issues, and other internal and external aspects). The process underlying these decisions consists of a plurality of different intellectual activities that may be performed by single individuals or in groups.

In general, group decisions show better performances than decisions made by individuals. Advantages of group decisions are based on their higher qualitative and quantitative capacity, better possibilities for communication, interaction, and employment of methods, as well as an easier enforceability (Pfohl, 1977), (Brodbeck, 1999).

The core argument of this research is that the concept of Situation Room (SR) may act as the central metaphor around which the main personal and corporate requirements, work and management practices, organizational issues, enabling technologies, implied by the future, new and increasingly content- / media-rich CWEs can be modelled, framed and validated within several business domains to support the product development process.

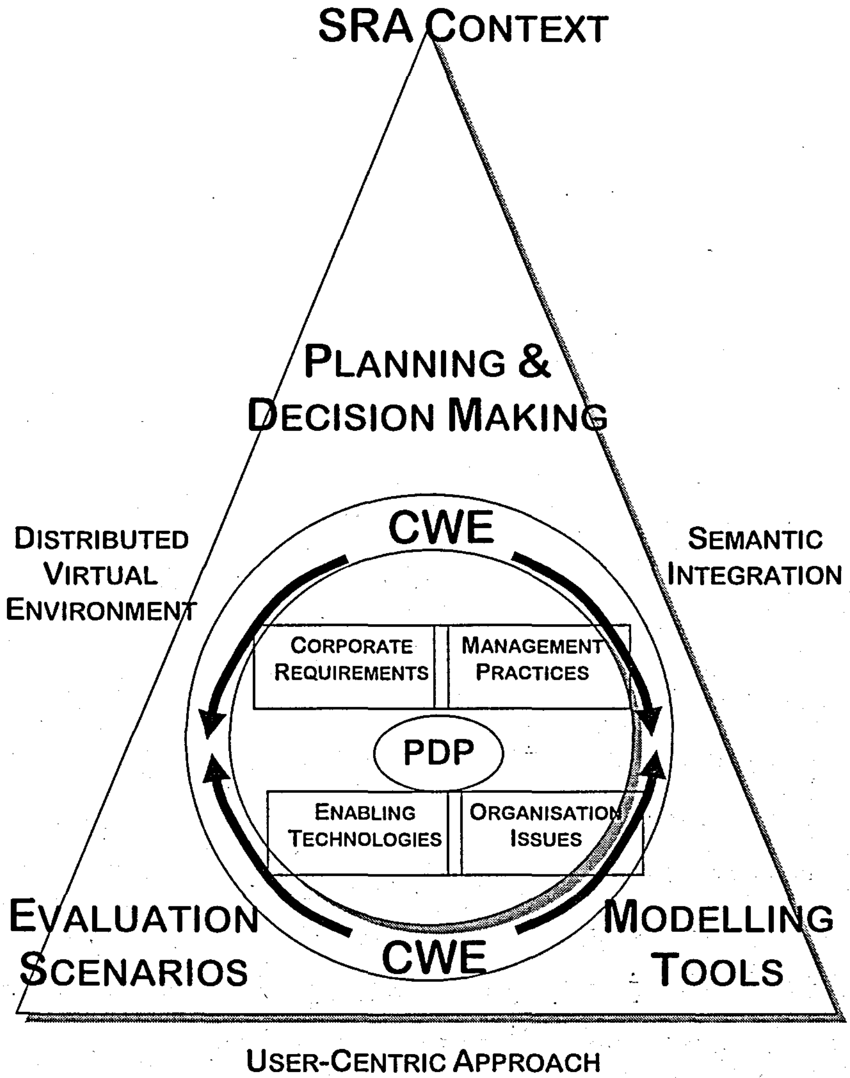

Figure 2 SRA context, underlying pillars and the application environment

Figure 2 aims to visualise the interaction of the main methodological pillars used in the research situated in the picture in the triangle vertices, while positioning them with respect to the application fields included in the circle, and the basic notions that acted as drivers for the research context which are shown in the triangle sides.

Historically, a SR is the intelligence analysis centre used to stay abreast of the latest intelligence reports and updates. Several resources and tools are typically available in such a room (such as whiteboards, maps, projection equipment, video, audio and telephony services, clocks etc.) which support the information flow and processing, and inform and enhance the dialogue and collaboration among the group members in their pursuit of an informed and shared decision.

Situation Room Analysis (SRA) is the decisional process taking place in a SR, based on available intelligence which allows senior officers to assess an evolving situation, take informed command decisions and to monitor and stay up to date with any new developments in the corporate 'battle field'. As an approach or methodology, aspects of SRA have been used for some time for crisis management in the military and civil disaster management domains. More recently, it has also started to be (re)applied in the business domain.

The key, and as well the appeal, of the SR metaphor lies in bringing the key personnel together with key, live information about the current situation and the availability of tools for the modelling and evaluation of scenarios and the ability to thus reach well-informed consensus decisions and subsequently observe their impact in the field prior to the next round of assessment, planning and new decisions until the problem is resolved. This is by very nature a CWE with a high degree of semantics, where modelling approaches are used to assess impact and reach decisions.

Consequently, the SRA paradigm implies an extensive use of semantic approaches as a powerful means to support the data fusion, modelling, scenario evaluation and decision making process. In fact, the SR-inspired ICT platform will be supported by semantic technologies to provide a semantic integration mechanism for the various components and their interoperability.

Based on the SRA paradigm, we proceed to the definition of a framework which can be used for developing a supporting IT infrastructure capable to assist the process of product development. We validated the research hypotheses in five different application scenarios which are targeted to the use of Virtual SRs for Decision Making.

Information on each of the five application scenarios and the related business domains is given in Appendix 1. There, after a short description of the overall context in which the "Virtual SR" was expected to contribute with the concepts and elements of SRA, a reference outline to a future / envisaged ('2015') scenario is also given.

1.3. Synopsis

Situation Room Analysis is proposed as an enabling approach to support collaborative IT product development.

The research propositions build on the results of 5 product application scenarios. There, we validate these research hypotheses and set the foundations for an SRA framework consisting of an SR model and its accompanying conceptual architecture.

The table 1 below summarises the characteristics of the conducted product application scenarios with respect to their particular contributions to the research agenda.

<table>
<tr><th></th><th>Scenario#1</th><th>Scenario#2</th><th>Scenario#3</th><th>Scenario#4</th><th>Scenario#5</th></tr>
<tr><td>Unique element</td><td>People coming from different disciplines
Existence of various suppliers and vendors</td><td>Increase of the residual value for digital media assets</td><td>Largely differing conditions of people's participation</td><td>Culture of sharing amongst experts</td><td>New and improved models of work</td></tr>
<tr><td rowspan="6">Common denominator</td><td colspan="5">← *Collaboration in teams of people* →</td></tr>
<tr><td></td><td colspan="2">*Lack of integration*</td><td></td><td></td></tr>
<tr><td></td><td colspan="3">← *innovations in the digital content industry* →</td><td></td></tr>
<tr><td></td><td></td><td colspan="2">*New social structures*</td><td></td></tr>
<tr><td>*Inclusion in the problem solving process*</td><td></td><td></td><td>*Inclusion in the problem solving process*</td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="2">*Remote presence and support for participation*</td></tr>
</table>

Table 1 Unique elements and commonalities amongst the employed product application scenarios.

2. Literature Review

2.1. State of the Art

In a physical SR, several enabling resources are usually made available (such as magnetic walls, maps, overhead projectors, wood panels hiding different audio, video and phoning systems, faxes, digital clocks etc.) in order to support the information processing, and to enhance face-to-face dialogue and collaboration among the team members for the pursuit of shared decisions. This type of SRs is quite common in the military and space missions agencies and also in crisis handling units (Rohall and Lahtinen 1996, Norris et al 2002). On the other hand, little use of the concept has been made in business environments so far[2]. Decentralized and virtual SRs are not known.

In the military domain, rapid development of sensor and communications technology has led to a huge increase in data being made available to decision makers. The time-critical nature of many decisions make it imperative to use the best methods of acquisition, storage and retrieval, as well as data and information combination, fusion analysis and display. Fusion of higher level information is still in its infancy, and needs to be further developed. Information design is an emerging academic discipline, in response to the modern challenges of information overload (Horn 1998, 1999, 2001; Tufte 1998 and 2001; Mayer 2001; Young and Lettice, 2002).

In the context of space missions, the goal of a *centralized* operations facility (the physical SR) used to be the concentration of all members of the operations team in as small an area as possible, in order to improve the communication among them; however, recent technological advances have provided with the alternative solution of a *distributed* operations facility, allowing selected staff from outside to participate in the meetings as required.

This evolution looks quite straightforward. In fact, it is hard to ignore the fundamental changes that have taken place in the business world over the last decade (Ridderstrale

[2] This extension is not uncalled-for: in both situations, a team collects and analyzes a lot of different kind of information, elaborates alternatives, prepares the selection of the best solution, ensures dissemination of the decision and its measures, and monitors their field application.

and Nordstrom, 2000). Rapid technological advancements have resulted in the 'connectivity' of people and the death of distance. Processes are no longer planned locally, specialists are dispersed globally and may have to be integrated *ad hoc* (Picot et al, 2003). The result is an increase in uncertainty and in unpredictability (Snowden, 1999) accompanied by new forms of co-ordination. This uncertainty, combined with an increasing necessity to innovate, allows the organisation to be more responsive to incidents as they occur.

A key challenge is how to bring together widely dispersed people, information and knowledge in such a way as to enable effective collaboration and make sound decisions, especially when people do not only work from the office but also virtually and remotely, utilising ubiquitous Internet access – at client's sites, from home, or on the move. Although various technologies, such as video conferences, exist and are used to some extent, experience shows that in critical situations they lack "intimacy" and effectiveness, requiring teams to spend precious time travelling to meet physically.

Some of the main implications confronting this challenge are how to balance and overcome:

- Supporting semantically connected, though technologically divided, content-rich media
- Critical information selection vs. information and data overload
- Virtual vs. physical, remote vs. co-located workplaces
- Personal vs. group / community vs. corporate decision making (priorities, goals, knowledge, ICT tools)
- Permeable vs. impermeable knowledge barriers in professional working experiences

Nowadays, there are several classes of information systems to support managerial and organizational decision making. Management Information Systems provide managers with information to accomplish organizational objectives (Davis, 1974), whereas Decision Support Systems directly support managerial decision making e.g. as it is the case in (Sprague, 1980). Group Decision Support Systems incorporate additional information and communication technologies and applications to effectively support decision-making in groups, while Electronic Meeting Systems use information technology to make group meetings more productive, facilitating communication and decision making (Dennis et al, 1988)[3]. Necessary analysis of (mainly market and financial) data can be made by Business Intelligence or Corporate Intelligence systems[4]. As most other modern decision support systems mentioned above, these BI-systems typically include OLAP, data mining, and data warehousing technologies.

An illustration of SR for business applications can be found in (Shaker and Gembicki, 1999). Other examples are the KISS "war room" by Global Linxs (Global Linxs, 2004), the Management Cockpit by SAP (SAP, 2004), or the Visible Process Organization by A.T. Kearney (Kearney, 2002).

The common focus for all these approaches is set on intelligence, that is information gathering and visualization; there is not much additional support for decision making or problem solving. However, the use of new media offers a new level of support to collaborative work. Problematic issues are easier to display, can be interactively modified, and stimulate discussions among participants. SRA can help to bring about faster decisions and it is also suitable for important management presentations (Schulz, 2002).

There have also been a number of significant projects that illustrate the complex relationship of people within their working environment: however, what is lacking is a critical perspective on the practices and philosophy of the working environment *per se*, and also an operational application of the insights gained from the collaboration experience[5].

In contrast to the office applications, where metaphors for direct manipulation have been formulated and are currently widely in use, affecting the style and work

[3] Overviews on information systems to support group meetings, decision making, and problem solving are given e.g. in (Eom, 2001), (Power, 2003), and (Krcmar et al, 2004).
[4] An overview for them is given in a market study by (Spath et al, 2003).
[5] For instance, Peszynski and Yoong (2002) have examined the use of communication systems such as email, audio-conferencing, and mobile phones in the collaborative decision making process. No disadvantages have been mentioned by the interviewed participants in the study about the use of mobile phones in the urgent decision making process, while the advantages of using mobile phones "*include the ability to multi-task and be anywhere and still be contactable*".

performance of millions of people, there has been little if no progress in the conceptualization of new metaphors for the work environment; most of the applications relying on new functionality or improvements by means of better (faster, more reliable, ...) technology, while the basic paradigms of interaction amongst the members of a CWE remain much the same as in the last 20 or more years.

2.1. A quick overview of epistemological issues: Basic assumptions and starting points

Although several of the existing approaches used to support product development are sufficient to create *an interactive space* for corporate stakeholders, there is every reason to look for new approaches.

In the classic Kurosawa film Rashomon[6], various witnesses provide completely contradictory accounts of a single event. The film does not indicate which recollection is correct; each account in turn is depicted equally realistically. The sense by the end of the film is that all we have seen is unreliable, and that no account is completely true (or completely false...).

Rashomon is deliberately and pointedly inconsistent, but uses this method to make a coherent and powerful statement. This is a capability which could be of particular relevance to a decision making activity, as it is for an interactive story, if it allows the decision making process to abandon the assumption of an explicit, unifying reality in favor of competing, possibly inconsistent realities. To the extent that inconvenient consequences of the decision maker's choices could be ignored, a decision based on such a *multiple reality model* could provide the decision maker with more freedom.

But the logical inconsistency found in Rashomon is not the only kind of multiple reality imaginable. A more subtle 'convolution' of reality occurs when the witnesses to an event view it in ways that are simply very different rather than contradictory. Rashomon's multiple realities are subjective but pretend to be objective (in order to convince the judge); dropping this pretense would allow each subjective reality to be

[6] A. Kurosawa, *Rashomon*, 1950.

judged and appreciated on its own terms. The same happens when facing different information sources – many of them contradictory to each other – within a collaborative framework, in which a synthesis on the different views is foreseen.

How would the multiple reality model work in practice? Realities could reflect different levels of semantics, different planes of analysis, etc. Moving from reality to reality may be intrinsically interesting enough that the viewer would have no further interactive ability; in any case, even simple aspects of the product development process could be related with respect to their significance by the number of separate realities in which they appear.

There is, however, a particular challenge inherent in the use of the multiple reality model when facing multi-party decision-making tasks: For the decision path to be satisfying, *a unifying force must be found to tie the pieces of the decision-making process together*, the way the investigation into the contradictory accounts does in Rashomon. The analyst must construct the multiple realities so that they interact with each other in some way. If done effectively, this interaction will do more than just hold the decision together; it will most likely serve as the vehicle for the central message of the decision-making process. This comes back to a sad reality many high technology companies are facing nowadays: they are not lacking on human resources to take or make decisions, but they are lacking all the necessary underlying constituents frequently described as 'soft skills', which can make decisions work for their organisations.

2.1.1. Soft skills

The list below is not all-inclusive for the types of soft skills that a decision maker needs to be successful (Bolton, 1979) (Joseph and Slaughter, 1999):

- **Communication:** This is, quite simply, the most important soft skill for all levels and types of a decision-making activity. Decision makers *must have* the ability to convey complex situations easily, clearly articulate what must be accomplished, contribute so that the team keeps moving toward a common goal, foster an environment that allows all other team members to communicate openly and honestly, admit their own mistakes without losing respect, negotiate, listen, facilitate, etc.

- **Organizational Effectiveness:** Decision makers need to understand the corporate culture, the organizational dynamics, and the individuals they are dealing with. With this understanding, they will be able to obtain resources more effectively, gain support, and build a stronger foundation for the effort.
- **Leadership:** Leadership is a virtue that is needed in critical and key decision-making situations. Decision makers frequently do not have direct authority, yet they do have direct responsibility. They must build authority through appropriate leadership, and this – if possible – in consensual ways.
- **Problem Solving and Decision-Making:** Resolving issues or solving problems is a large portion of what a decision maker does every day. Each phase of a situation has its own unique set of problems. Without strong problem-solving skills, the sheer volume of issues that are a normal part of every discrete case would soon overwhelm the daily work routine.
- **Team Building:** Building a team in the corporate environment is a challenge. Co-location is not easy and rarely occurs. More frequently a team is made up of borrowed resources from other functional areas within the organization and usually also has vendors and suppliers. Creating a team atmosphere where the team believes that "we are all in this together" is a critical component to success.
- **Flexibility and Creativity:** Having a proven framework to guide a decision maker is not enough. He must also adapt to the needs of the situation faced. Since every situation is unique, each may require different components, templates, tools, and techniques. Using the "decision maker's toolbox" effectively will assist in delivering a successful outcome.
- **Trustworthiness:** The decision maker must have the trust of all of the stakeholders involved in the environment his tasks are placed.

From the above, it is easy to identify that the decision maker as a human actor needs to be appropriately and adequately supplied with a set of 'conceptual schemas and mental representations' – which in the present case concerns the Situation Room metaphor – in order to better accomplish his task(s). Furthermore, it is again these 'conceptual schemas and mental representations' which shall act as the glue amongst a set of decision-makers that need to collaboratively proceed to a decision-making activity, while it is again these 'conceptual schemas and mental representations' which shall help in the organization and orchestration of different resources and resource types.

Similarly to the needs faced by the decision-maker, *companies now more than ever need explicitly defined ways to manage their decision-making activities as part of their broader intellectual capital and organize their learning capacities through them.* In an economy that has till now not yet recovered from the collapse of the dotcoms – and perhaps shall never again do so in the simplistically straightforward and easy-to-do ways envisaged by several stakeholders – the research concentrates on the use of a Situation Room as a powerful metaphor that takes into account the specifics of the corporate structure and capitalizes on the various intangible assets of the company.

2.1.2. The corporate structure

Having several first and second hand experiences in the success or failures faced from the more demanding and relatively complicated projects or tasks, to less complex and simple ones, the story has to do usually with the same ingredients:

- *People*, and
- *How these interact to each other* or with each other, and
- *How they perceive and analyse the world they live in*, the events that are taking place and to which they have or need to respond at, and
- *How they document their knowledge*, their wants, their goals, their history of what they did or they aimed to do, and,
- *How they access and make use of the documented knowledge* – be it theirs or someone else's , and finally,
- *How they manage to improve their behavior* either at the individual level or at the collective one, or – sometimes – at both through learning processes or other optimization processes.

However, to manage a coordinated behavior of individuals is a difficult – if not unachievable task at all. Even if people are working together for the same goal, and have all unanimously agreed to the same objective and target, it is in the human nature that they shall develop differentiations in regard to the means that each individual shall employ for meeting any specified end. Or, even in the case that there is agreement regarding the means, there will be different opinions on the instrumentations of these very specific means, the orchestration of all individuals around them, etc. This helps us come to the conclusion that the main difficulty concerns the synthesis of all these different 'resources'.

Though the starting point for us has been problems that appear in the corporate world, any type of 'problem' that involves most of the above components can be regarded as subject to the same need for being approached with a preferably simple and consistent method for modeling the problem and, secondly, trying to 'tackling' or 'solving' (with) this in the most easy or straightforward and - if possibly - unique way.

In interactive environments such as the workplace, to date we have two main types of management models[7]:

- *Theory X*, which refers to the authoritarian management style characteristic of scientific management; and
- *Theory Y*, which supports a participatory style of management.

Theory X was based on the premise that the average worker was basically lazy and was only motivated by money and neither wants or is capable of self-directed work.

This kind of model led to the specialization and division of jobs into simple tasks, with the aim of increasing worker production and consequently, increased pay. Meanwhile, (Jaggi, 1988) defined participatory management as "*a cooperative process in which management and workers work together to accomplish a common goal.*"

This second model was different from the first in that instead of top-down, directive control over workers who were perceived to be unproductive without close supervision,

[7] This goes back to 1960 and the pathmaking work of Douglas McGregor reported in (McGregor, 1985). McGregor there made his mark on the history of organizational management when he proposed the two motivational theories by which managers perceive employee motivation. He referred to these opposing motivational theories as Theory X and Theory Y. Each theory assumes that management's role is to organize resources, including people, to best benefit the company. However, beyond this commonality, they're quite dissimilar.
Quite recently, Heil et al (2000) revisited in a contemporary manner the area and provide information and evidence that is reflecting the networked economy era.

the new model stressed that giving the worker decision-making powers provided valuable input and enhanced employee satisfaction and morale. This second model came as a result of alternative theories that found workers not to be intrinsically lazy, but who were instead adaptive to their environment. Where a workplace lacks challenge, professional growth and other motivators, workers became lazy. When the situation was reversed, the proponents of this theory found workers to be creative and motivated.

2.2. The need to invest on intangibles

An important challenge in establishing lasting changes of culture and values in an organisation involves ensuring that organized learning processes are anchored within the organisation. Traditional courses and training are considered efficient, but it often seems as the long-term effect is missing. Furthermore, traditional courses are often used by the organisations to train their employees so they can perform better, but in the same ways as they always have done (Watzlawick et al, 1974; Argyris et al, 1985).

There are several positive aspects to both tactics, but if the goal of the learning is to gain new knowledge and to establish changes in behaviour as well as further learning in the organisation, it is important to use a strategy based on pedagogical theories and methods that take individual as well as organizational learning into consideration.

There is a saying: 'have hammers, will see only nails', just because you have a hammer in your hand. In the greater scheme of things, corporate decision-making includes more than scientific approaches and methods.

Hence, the results (observations, conclusions and theories) of one scientific discipline cannot be intelligently applied or implemented in disregard of other scientific theory. The scientific communities have organised themselves in disciplines (e.g. economics, political science, legal science or law, etc.). These might in turn be organised – or thought of – as some 'blocks' of sciences such as natural science, social science, human science etc. This internal organisation is especially visible in the academic training.

In such academic training, however, holistic understanding of science as just science runs the risk of being overlooked. This risk appears despite that theory of science may be part of the academic training in each of the disciplines. A student may learn about the very specifics of sub-theories and approaches developed, approved of, or otherwise adopted in the discipline he or she studies. When making the transition to the labor market, the student then develops into an intra-disciplinary practitioner.

This is an example of intra-disciplinary approach, which should be carefully distinguished from inter-disciplinary approaches. We could also say that intra-disciplinary approaches, including the theory and methods implied, constitute the toolbox that we equip the students with.

Because of their training, the disciplinary students might later – more or less automatically and thus probably unreflectedly – bring their intra-disciplinary approaches into their future research.

Our own experience working with decision-making processes dates back to the beginning of 1990. We have been closely involved with a wide range of different organisations in the research, the business software and the IT industry in general, and different types and levels of decision-making styles and cultures. In all these settings, we have been exposed to different learning strategies based on problem-based and project-organised approaches, and have experienced that they provided quite another learning outcome. We consider this Situation-Room learning approach an effective and motivating way to organise the kind of learning situations needed when working with changes in behaviour, strategies, and innovative processes in companies and organizations, as it is for the case of product development.

2.2.1. Knowledge-, resource- and intangibles-based views of the firm

Authors like Nonaka (1991) and Nonaka and Takeuchi (1995) Leonard-Barton (1995), Sveiby (1997) and Sveiby and Lloyd (1988), and many more, claim that knowledge is the most important resource. "*In an economy where the only certainty is uncertainty, the sure source of lasting competitive advantage is knowledge*" (Nonaka and Takeuchi, 1995, p.97). However, this does not mean that the *knowledge-based view* is a synonym for the resource-based view. The most important and fundamental difference is that the resource-based view only implicitly refers to knowledge, whereas the knowledge-based view gives extensive elaboration on the nature and definition of knowledge and the way it should be managed (Thompson Klein, 1996). Knowledge management literature can be seen as a further specification or extension (Bontis, 2002) of the resource-based view into a 'knowledge-based theory of the firm'.

Parallel and closely related, a more holistic perspective on the value creating resources of the organisation emerged. This intangible-based view of the firm is based on the work of authors like (Sveiby, 1997), (Stewart, 1997) and (Edvinsson and Malone, 1997). This so-called Intellectual Capital movement uses knowledge and intellectual capital interchangeably. Although closely related, the meaning of knowledge in this movement fundamentally differs from the definition of knowledge in the knowledge-based view of the firm. Intellectual capital, intellectual assets, intangible assets, intangibles, knowledge assets, knowledge capital or whatever term is used within this movement, refers to the traditional hidden sources of value creation (of which knowledge is just one). Hidden in the sense that existing management techniques do not have the methods or instruments to reveal them.

This intangible-based view of the firm inspired the intellectual capital movement to further elaborate on the nature of intangible resources and the way they should be measured and managed. This view serves as a starting point for application within the corporate environment.

This complies with Cohendet et al (1994) who suggests that an organization should be considered a processor of knowledge, and Fransman (1994) who uses the term 'repository of knowledge'. Less obviously, Daft and Weick (1984) and Daft and Lengel (1984) argue that organizations are systems of interpretation. They emphasize that, in order to deal with uncertainty and unfamiliar problems, organizations must develop processes and skills to interpret events, information and knowledge. With some prescience, they term this organizational process sensemaking. This is the process of gathering and interpreting a body of information potentially relevant to a problem, which involves cycles of:

- *Information gathering*: collect as many potentially relevant sources as possible
- *Analysis*: what kinds of thing have I got here?
- *Synthesis*: what kind of picture emerges?
- *Sharing*: share the results with colleagues
- *Re-use*: has this already been done, and can we make use of it?

The sensemaking activities can be broken down into a set of tasks, each with its associated costs. Thinking in terms of costs can help to highlight bottlenecks in the flow of information and dependences with other people and other information.

Weick (1995) presents a detailed theory of sense making in organizational contexts, particularly those characterized by novelty or other forms of description. He suggests that individual and group activities are inextricably intertwined. Weick's work is compatible with constructivist perspectives of knowledge, in that situations become "real" only through the interpretive processes of sense making which reveal how different parties construe the situation. Choo (1999) summarizes three-step processes that are central to sense making:

- *Enactment*: the process by which individuals in an organization actively create the environment which they face.
- *Selection*: the process by which people in an organization generate an enacted environment that provides a cause-and-effect explanation of what is taking place.
- *Retention*: enacted or meaningful environments are stored for future retrieval upon occurrence of new equivocal situations.

According to Weick, people engage in sensemaking in two main ways. Belief driven sensemaking takes place through arguing (creating meaning by comparing dissimilar ideas) or expecting/confirming (creating meaning by connecting similar ideas). Action-driven sensemaking involves people committing (engaging in highly visible actions to which they have commitment) or manipulating (acting to create an environment that people can comprehend).

Weick addresses the social dimensions of knowledge sharing by drawing on Wiley's work (Wiley, 1988) which suggests that there are three levels of sense making above that of the individual:

- *Inter-subjective*: synthesis of self from I to We
- *Generic subjective*: interaction to create meaning at the group or organizational level
- *Extra-subjective*: meaning attains the strength of culture –'pure meanings'.

Bringing these concepts together, therefore, Weick sees organizational sense making as the drive to develop generic subjectivity through arguing, expecting, committing and manipulating. These social dimensions converge with Nonaka and Takeuchi's (1995) view on the role of socialization in transforming tacit to explicit knowledge.

Figure 3 below schematically depicts a core assumption that is made in the research, namely that differences in the corporate process grid, the corporate culture and the capacities and skills 'inhabiting' the company usually result into different understandings of the faced situations and in our case result into different products conceptualisations, at first, and realisations later.

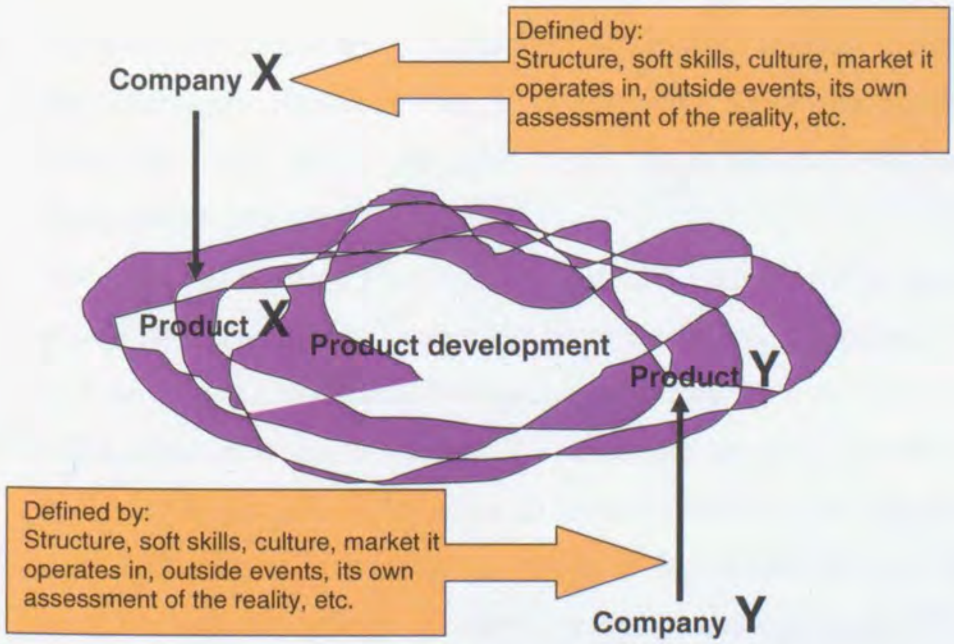

Figure 3 Though the development process may be the same, different companies are led to varying products, as the result of multiple parameters.

2.2.2. Intellectual capital as a metaphor

One aspect that has been discussed a lot in recent years, and that touches on the Knowledge Management issues, is the value of intellectual capital (IC) (Edvinsson and Malone, 1997). Stewart (Stewart, 1997) defines IC as the combination of patents, processes, management skills, technologies, information about customers and suppliers, and experience. Over the years, businesses have found it difficult to contend with and account for intangible assets. The debate and discussions between the accounting profession, regulators and users of accounts attest to this. Therefore, this is a major reason for measuring IC to identify and utilize previously unrecognized assets. The increased use of IC measuring and reporting programmes is also attributable to the waning of accuracy in market valuations, the drive to decrease internal efficiencies and need for measures to achieve a specific company-related goal.

Intellectual capital is a *metaphor*, because it describes the importance of all the intangible resources by stating the ability to use the human mind (intellectual) and financial wealth (capital), with which it can be compared.

It is not only about the ability to use the human mind or financial wealth. In fact, the word *intellectual* goes beyond the brain and *capital* goes beyond finance.

- The word *intellectual* refers to intangibles in general. It refers to both human and nonhuman resources. So, it is not only about the people, their knowledge and skills, but also about organisational processes and relationships with the customers.
- The word *capital* refers to financial wealth. However, the essence of the phrase intellectual capital refers almost to the opposite. Intellectual capital goes beyond the traditional accounting principles. It is no longer relevant whether resources can be expressed in monetary terms or not. Moreover, it is also no longer relevant whether an asset is owned by the organisation or not. What matters is whether the resource is available or not. Does the company have access to it in order to realise its strategic goals? That is the main qualifying characteristic.

The phrase 'intellectual capital' also makes a strong reference to the word 'important' or 'strategic'. The literal meaning of both words refers to the importance of the 'head'. If we look at the meaning of the word 'capital' in the dictionary it often distinguishes the important from the ordinary (e.g. capital city, capital punishment, capital letters, capital importance). In business language 'important' is frequently translated by 'strategic'. In this sense intellectual capital refers to intangibles that are of strategic value to the company. It is strategic in the sense that they contribute to creating organisational value and achieving organisational goals. In other words, intellectual capital is about *strategic intangible resources.*

Companies provide many different types of services to their employees and stakeholders; the interactions between the abstract entity of a corporation and its people are mostly process-based and can be categorised as follows (Lenk and Traunmueller, 1999):

- structured procedures or routines,
- semi-structured decision processes and
- negotiation-based case-solving.

(Capurro, 2004) furthermore states that what can be managed is information or explicit knowledge and that implicit knowledge can only be "enabled". In this context, **explicit** means that it can be clearly observed and expressed (and also digitalised), as opposed to **implicit** knowledge that can not be directly formulated (skills, experiences, insight, intuition, judgment, etc.) When knowledge is explicit, it can be represented as declarative or procedural knowledge. We are aware that in the domain of cognitive sciences, the distinction between procedural and declarative models is related to the brain memory system - see for example (Ullman, 2001), but here we used these terms here in a limited sense, as defined in computer science:

- Declarative knowledge components represent facts and events in terms of concepts and relations.
- Procedural knowledge components describe actions to be taken in order to solve a problem step by step.

For cases where knowledge is implicit and cannot be formalized, we introduced the concept of distribution: knowledge can be individual or collective, and in both cases components identify who has this knowledge or where it can be found. Finally we added a set of metadata (know-where, know-when, know-who, etc.) that describe these knowledge-components and that make it possible to manage them.

2.3. Information systems research

Introduction and utilization of information systems as a strategic tool into organizations' culture and strategic thinking is a widely addressed topic that in the research bibliography has been approached several times from the perspective of enterprise engineering. This has been the case of – amongst others - the Information System Architecture Framework (ISA) developed by Zachman (1987), as it evolved in a period spanning from its first occurrence in 1987 till its further refinement and elaboration by 1992 (Sowa and Zachman, 1992). Also, the TOVE Project developed at the University of Toronto and reported in evolutionary forms in (Fox and Gruninger, 1994, 1997 and 1998), and the Enterprise Project developed by the Artificial Intelligence Applications Institute of Edinburg University and reported by Uschold and King (1995) and Uschold et al (1998).

Especially the latter make extensive use of the notion of ontology/ies both as a conceptual term to help users organise the atomic relationships of the particular entities and relationships within their models, as well as a mechanism to organise representations with the help of appropriate specialisation and inheritance relationships. Of course, for each case positioning of the ontology concept takes place by taking into account the different aims that each user has been setting.

For strategic decisions senior management need information about markets, customers and technology development in their industry as well as changing economic circumstances, amongst others. Bovet and Martha (2000), for example, argue that decision support systems have a critical role to play in supporting longer term, strategic decisions across highly interdependent 'value networks'. However, such information systems have rarely satisfied this information requirement and Ward and Peppard (2002) suggest that the main reasons for this include the paucity of external information included in the systems, the rawness of the data and its lack of context. This latter point, in particular underlines the requirement for knowledge as opposed to just information as extensively addressed in (Huplic, 2002) and (Skyrme, 1999).

Furthermore, and despite the decline of the dotcoms and a feeling of euphoria that has dominated the field, and the overall slowdown in growth rates for the IT industry, in these last years we experience an expansion of the traditional borders for both the knowledge management and the ontology *industries*, and a willingness in sharing human knowledge within communities of practice.

On the other hand, there is now a critical mass of lessons and experiences to many people both from academia and the industry with projects that have been taking up a great deal of resources (money as well) on work that could be marginally useful to anyone, while also its residual value could have been doubted even before start of the project. Investments on documentation and creating very large ontologies might be part of such an activity.

A 'new' formative approach might make this effort pay off in an expected way. What are now confused issues over scope and viewpoint are resolved suddenly. The Cyc ontology is a good test example of what might be done and what are the problems with a massive 'static' ontology. What is also interesting to examine is a comeback that was experienced for this work by means of exploiting the advent of Web services and the Semantic Web; as the latter are described by domain ontologies, they also "*highlight the bottleneck to their growth i.e. ontology mapping, merging, and integration*" (Reed and Lenat, 2002).

McElroy (McElroy, 2002) shares an experience he had from a conference on knowledge management (KM), where "*attendees could be heard grumbling about what they felt was the event's myopic obsession with technology. 'Document management and imaging – that's all I've seen and heard about here', one man complained. He then amplified his discontent and shared his broader disappointment with knowledge management as a whole: '...an idea that amounts to little more than yesterday's information technologies trotted out in today's more fashionable clothes'.*" (p. 205)

Due to the huge number of activities of an enterprise, which have to be supported by an IS, it is more and more difficult to obtain a pertinent global view of an IS, to distinguish its different parts and to identify the overlaps between these parts (Léonard, 2003). It is henceforth indispensable to reason in term of *components* and in term of overlaps between these components. It is a question of method to work with models of cognitively human size. In the research, a component based IS engineering approach is taken, that to be effective, has to address in a global approach the different levels of the IS.

2.3.1. On ontologies and knowledge sharing

A body of formally represented knowledge is based on a conceptualization: the objects, concepts, and other entities that are presumed to exist in some area of interest and the relationships that hold them (Genesereth and Nilsson, 1987).

A conceptualization is an abstract, simplified view of the world that we wish to represent for some purpose. Every knowledge base, knowledge-based system, or knowledge-level agent is committed to some conceptualization, explicitly or implicitly.

An ontology is an explicit specification of a conceptualization. The term is Greek (ο ν τ ο λ ο γ ί α) and borrowed from the discipline of philosophy, where an ontology is a systematic account of existence. For knowledge-based systems, what 'exists' is exactly that which can be represented. When the knowledge of a domain is represented in a declarative formalism, the set of objects that can be represented is regarded as the universe of discourse. This set of objects, and the describable relationships amongst them, are reflected in the representational vocabulary with which a knowledge-based program represents knowledge. Thus, we can describe the ontology of a program by defining a set of representational terms.

In such an ontology, definitions associate the names of entities in the universe of discourse (e.g., classes, relations, functions, or other objects) by means of:

- *human-readable text* describing what the names are meant to denote, and
- *formal axioms* that constrain the interpretation and well formed use of these terms.

In the research, the problem of usage of ontologies is addressed as a means for supporting collaborative decision-making activities in what it is called a Situation Room Analysis framework. Using ontologies is a problem because the different / various parties to a common ontology may use different representation languages and systems. For this, we shall elaborate later in this Chapter.

Knowledge based systems and services are expensive to build, test, and maintain. A software engineering methodology based on formal specifications of shared resources, reusable components, and standard services is needed. We believe that specifications of shared vocabulary can play an important role in such a methodology.

Several technical problems stand in the way of shared, reusable knowledge based software. Like conventional applications, knowledge based systems are based on heterogeneous platforms, programming languages, and application protocols. However, knowledge based systems pose special requirements for interoperability. Such systems operate on and communicate using statements in a formal knowledge representation. They ask queries and give answers. They take background knowledge as an input. And as agents in a distributed AI environment, they negotiate and exchange knowledge. For such knowledge level communication, we need at least conventions for specification of the content of shared knowledge. Proposals for standard knowledge representation formats, as for instance this in (Genesereth and Fikes, 1992), are in general independent of the content of knowledge being exchanged or communicated.

Ontologies can be used for conventions of the content specific specifications. Looking back at what took place in the field, research has been exploring the use of formal ontologies for specifying content specific agreements for a variety of knowledge sharing activities such as e.g. for concurrent engineering applications.

A long term objective of such work has always been to enable libraries of reusable knowledge components and knowledge based services that can be invoked over networks. And it is that now, with the proliferation of distributed Internet-based applications and the advent of Web services, such objectives can be realised.

Consider the problem of reusing a knowledge based corporate business planning application. Such an application takes descriptions of objects, events, resources, and constraints, and produces possible action plans that assign resources and times to objects and events (*who* does *what* and *when*). Although it may use some general planning algorithms, like all knowledge based systems the planning aspect would depend on a custom knowledge base (in our case it is the particular company culture which may be regarded as the particular domain theory to be used as background knowledge) to fulfil the task. The knowledge base may contain some knowledge generic to the planning task, and some that describes the domain situations in which the planner is to run.

If one wished to use the planning system for some new corporate product or service, one would need to adapt an existing knowledge base to a new application domain, or build one from scratch. This requires, at a minimum, a formalism that enables a human user to represent the knowledge so that the planning application can apply it. Furthermore, the developer needs to know the kinds of information given as inputs and returned as outputs, and the (different) kinds of domain knowledge that is needed by the application to perform its task.

If the planning program were offered as a service that could be invoked over the network, or if a large planning problem were contracted out or outsourced to a set of cooperating agents (in our case, we regard them as the team of collaborating Situation Room participants), *then one would need an agreement about the topics and the modes of conversation that agents are expected to understand.*

Underlying these content specific agreements are *ontological commitments*: agreements about the objects and relations being used amongst the different agents. In the case of using multiple agents, a common ontology can serve as a knowledge level specification of the various types of ontological commitments; it defines the vocabulary with which queries and assertions are exchanged among agents[8].

[8] However, the axiomatization in an ontology does not need to provide a complete functional specification of the behavior of an agent. Common ontologies typically specify only some of the formal constraints that may hold in the domain of discourse of (a set of) agents. They do not say which queries an agent is guaranteed to answer. Thus, a commitment to a common ontology is a guarantee of consistency, but not completeness, with respect to queries and assertions using the vocabulary defined in the ontology.

Ontologies are thus to be regarded like conceptual schemata in database systems: they provide a logical description of shared data, allowing the various application programs and databases to interoperate without having to share data structures. And in the same way that in a natural language we use a finite, well defined vocabulary for composing a large number of coherent sentences, we build on ontologies to support the action space of applications in some predefined application domain.

Gruber (1994) has set a set of design criteria for ontologies. His starting statements are that "*Formal ontologies are designed. When we choose how to represent something in an ontology, we are making design decisions. To guide and evaluate our designs, we need objective criteria that are founded on the purpose of the resulting artefact, rather than based on a priori notions of naturalness or Truth. Here we propose a preliminary set of design criteria for ontologies whose purpose is knowledge sharing and interoperation among programs based on a shared conceptualization*" (p. 309). Gruber sets the stage for his five principles which are clarity, coherence, extendibility, the minimal encoding bias and the minimal ontological commitment.

According to the same author, "*an ontology should require the minimal ontological commitment sufficient to support the intended knowledge sharing activities. An ontology should make as few claims as possible about the world being modelled, allowing the parties committed to the ontology freedom to specialize and instantiate the ontology as needed. Since ontological commitment is based on consistent use of vocabulary, ontological commitment can be minimized by specifying the weakest theory (allowing the most models) and defining only those terms that are essential to the communication of knowledge consistent with that theory.*" (p. 312)

2.4. Product data management techniques

Techniques for the detection of correlations among products, like association rules' discovery, are applied to find information entities frequently purchased together so that recommendations can be formulated even if no similar users can be found. Taxonomies or ontologies of information entities are exploited to generalise from individual items to item groups or types, so that recommendations on new items can be expressed even if there are no ratings for them. Some very recent results are reported e.g. in (Jin et al, 2005; Li and Zaiane, 2004a & 2004b; Zhou et al, 2004). Despite these valuable advances, several problems still remain unsolved, thus preventing the wider exploitation and adoption of recommendation engines.

First of all, the notion of recommendation impact is not adequately formalised, so that a business enterprise cannot assess in advance whether the investment on a recommendation engine will be value-adding: E-metrics for user retention, loyalty and lifetime value maximisation as reported in (Cutler, 2000; Eighmey, 1997; Lee et al, 2000) have been designed to evaluate the performance of a web site and might be refined to evaluate an installed recommendation engine as well but cannot be applied to decide among different recommendation engines before installing them.

Methods for the comparison of recommendation engines do exist (Cosley et al, 2002), (Geyer-Schulz and Hahsler 2003), (Karypis 2000). However, methods based on user feedback as in (Geyer-Schulz and Hahsler, 2003) are not appropriate for the a priori assessment of a recommender's expected influence. Comparison methods that rate recommenders on accuracy, i.e. on whether they predict the purchase or item acquisition actually done by the user are not appropriate to assess recommendation impact, either: A recommendation engine that suggests to the user the item that he would have selected anyway does not create any value. In SRA, we intend to identify the factors that influence the affinity (or receptiveness) of users towards recommendations for different (types of) recommendations.

Recommendation engines may be based solely on collaborative filtering and data / web mining, i.e. on intelligent systems. However, recommendations can also be provided by human experts in the form of ratings or product reviews (Basu et al, 1998). Such recommendations can be observed as indirect collaborations among the users (Carenini et al, 2003). Richardson and Domingos (2002) have shown that some of those users can become nodes of influence and thus have a large impact on the performance of an institution. The realisation of a recommendation environment with a critical mass of human reviewers is a lengthy and high-risk process though. So, it is necessary to investigate under which circumstances users are more suitable to receive human recommendations than those delivered by an intelligent system and understand the factors that influence the quality (and thus the receptiveness) of recommendations by humans. A recent survey on this subject can be found in (Chen and Pu, 2004), albeit evaluation of alternative methods is beyond the survey's scope. The decisive factors of reputation and trust are discussed in (Josang et al, 2003; Ziegler and Lausen, 2004) they may play a similar role as the widely studied reputation of sellers (Ba and Pavlou, 2002; Melnik and Alm, 2002; Resnick and Zeckhauser, 2002; Shapiro, 1983).

Hence, SRA will consider recommendations by data mining methods and by humans and identify the factors affecting the impact of either type of recommendation. Game theory (Fudenberg and Tirole, 1991; Moulin, 1986) is an appropriate basis for experimentation and analysis on this subject.

To this purpose, we build upon prior expertise; more specifically:

- Web mining and evaluation of web sites (Berendt and Spiliopoulou, 2000; Berendt et al, 2004b; Pohle and Spiliopoulou, 2002; Spiliopoulou, 1999 and 2000a; Spiliopoulou et al, 2000b; Spiliopoulou and Pohle, 2001; Spiliopoulou et al, 2003)
- The design of games for the discovery and analysis of interaction patterns among people (Mueller et al, 2002a; 2002b; 2004; 2005a; 2005b).

2.4.1. Recommendation engines upon changing patterns

Recommendation engines and in fact much of the research on human-web-interaction have been assuming that the Web is static. Since both web sites and user preferences are subject to change, there is a lot of recent research on the adaptation of systems interacting with a web user.

Many works in this research thread are based on user-feedback. While this is a reasonable requirement for the adaptation of personalised services like user-tailored query engines, it is inapplicable to a recommendation engine that should pursue the business goals of a corporate SRA infrastructure in an unobtrusive way.

Moreover, adaptation to *concept drift*[9], as pursued e.g. in (Hulten et al, 2001; Koychev, 2002; Fan, 2004; Widyantoro and Yen, 2005), is not a desirable objective for the case of an SRA recommendation engine: The introduction of new information items and the removal of items from the portfolio is expected to affect SRA user behaviour; these effects should be detected, analysed and interpreted. Hence, in SRA we concentrate rather on methods that detect changes in user patterns, namely in preference clusters, profiles, association rules for info entities purchases etc.

The Incremental DBSCAN algorithm of (Ester et al, 1998) extends the DBSCAN clustering algorithm by a component that deals with record insertions and their effects on the contents, centroids and borders of clusters. In this approach, there are different types of cluster members; a cluster disappears when all its so-called 'strong' members have migrated. In principle, they track the movement of the strong cluster members as new data are added in order to decide when a cluster vanishes (Ester et al, 1998). Aslam et al. (1999) formalise clustering as the problem of covering graphs with star-shaped dense subgraphs, enumerate the types of impact a record insertion or deletion may have on the covering graph, and then propose an algorithm that adjusts the covering graph(s) accordingly. Similarly to Incremental DBSCAN, this algorithm adjusts the clustering scheme whenever a new record is inserted.

The DELI Change Detector of Lee et al uses a sampling technique to detect changes that may affect previously discovered association rules and invokes an incremental miner to modify the patterns as needed (Lee and Cheung, 1997; Lee et al, 1998).

Ganti proposes the DEMON framework for data evolution and monitoring across the temporal dimension (Ganti et al, 2000). DEMON focuses on detecting systematic versus non-systematic changes in the data and on identifying the data blocks (along the time dimension) which have to be processed by the miner in order to extract new patterns. However, the emphasis is on updating the knowledge base by detecting

[9] In the real world concepts are often not stable but change with time. Typical examples of this are weather prediction rules and customers' preferences. The underlying data distribution may change as well. Often these changes make the model built on old data inconsistent with the new data, and regular updating of the model is necessary. This problem is known in the literature as *concept drift*, and it usually complicates the task of learning a model from data and requires special approaches, different from commonly used techniques, which treat arriving instances as equally important contributors to the final concept.

changes in the data, rather than detecting changes in the patterns. The closely related framework FOCUS of the same group is designed to compare two datasets and compute an interpretable, qualifiable deviation measure between them (Ganti et al, 1999a). Finally, the CACTUS algorithm exploits summaries upon datasets as the basis of 'well-defined' clusters, which can then be discovered by only two passes over each of the datasets under consideration (Ganti et al, 1999b). For pattern comparison in SRA, we exploit and expand the prior technology reported in (Bartolini et al, 2004). There, a general framework for the assessment of similarity between both simple and complex patterns is proposed, covering patterns whose structure consists of other patterns, e.g. a set of clusters (clustering), a cluster of association rules

The two-component property introduced in FOCUS is adopted, expressing patterns in terms of a structure and a measure component. Major features of this framework include the notion of structure and measure similarity, the possibility of managing multiple coupling types and aggregation logics, and the recursive definition of similarity for complex patterns through the similarity of the simple patterns they contain. This framework extends FOCUS (Ganti et al, 1999a), which is limited to the comparison of patterns for which the so-called Greatest Common Refinement (GCR) can be defined.

2.4.2. Static pattern management

In the inductive database framework of (Imielinski and Mannila, 1996) and (De Raedt, 2002), both data and patterns are stored at the same layer and treated in the same manner. Under this approach, patterns are represented according to the underlying model for raw data. Traditional SQL-based query and manipulation languages for relational data are then extended and powered with ad-hoc operations for pattern extraction, manipulation and retrieval. Within this framework, knowledge discovery is considered as an extended querying process, thus pattern generation corresponds to a query returning patterns over data stored in the transactional database.

In particular (De Raedt, 2002) has proposed a constraint-based language for pattern maintenance in inductive databases. This language provides at least two types of constraints for pattern extraction: syntactical or derived from the specifications of the evaluation function. Based on the proposed constraint theory, the mining phase corresponds to a constraint-based query over the raw database using the previous defined constraints (or logical combinations of them using OR and AND connectives). Other manipulation operations, such as the insertion of a-priori patterns, are delegated to the underlying DBMS, since an integrated architecture is exploited. Types of patterns that have been investigated mainly in the context of data mining are item sets, association rules, episodes, data dependencies, clusters, etc. However, no support for temporal management and pattern hierarchies is provided.

Inductive databases intend to represent both data and patterns under a common framework. So pattern storage depends on the storage of the underlying raw data. In the case of relational databases, for example, this suggests using tables to store the patterns. The appropriate design of the representations scheme can enhance the management of these objects. On the other hand, in the pattern-base approach, patterns are stored in a separate-from-data pattern base. In (Bertino et al, 2004), a benchmark pattern base has been developed to demonstrate alternative storage solutions, namely the relational, the object-relational, and the semi-structured (XML) approach (Hahn, 2003). The comparative study showed that the XML solution usually outperforms the other two, in terms of ease of implementation, pattern characteristic exploitation, query expressiveness and extensibility.

In SRA, we exploit more on the XML paradigm for the storage and retrieval of patterns, also combining ideas from the PMML proposal (PMML, 2004). The idea builds on the notion of a unified framework for the representation of heterogeneous patterns, relying on a three-level architecture (database, pattern base and intermediate layer). The proposed logical model for patterns (Rizzi et al, 2003) provides the representation of arbitrary and heterogeneous patterns, by allowing the SRA user to specify its own pattern types. It provides support for both a-priori and a-posteriori patterns and allows the user to define ad-hoc mining functions to be used to generate a-posteriori patterns. Under this modelling approach, pattern quality measures are explicitly represented, as well as relationships between patterns and raw data that can be stored in an explicit or approximated way. Moreover, the definition of hierarchies involving pattern types has been taken into account, in order to address extensibility and reusability issues.

A pattern manipulation language (PML) has been defined by (Theodoridis and Vassiliadis, 2004) to support the main pattern manipulation operations, such as insertion, deletion, and update of patterns, as well as a pattern query language (PQL), supporting cross-over operations. An extended model for pattern representation has been also proposed in (Terrovitis et al, 2004). Such a model addresses the need for temporal information management associated with patterns. In this way, it becomes possible to exploit and manage information concerning pattern semantics and temporal validity, including synchronisation. Furthermore, the previously proposed PML and PQL have been extended in order to be able to cope with temporal features during pattern manipulation and querying (Catania et al, 2004).

2.4.3. Pattern evolution and temporal pattern management

In SRA, patterns are observed as temporal objects, the changes of which should be signalled to a human expert user according to some a priori specified interestingness criteria. The subject of interesting changes between correlated association rules has been addressed in (Chakrabarti et al, 1998). They partition the time axis into time slots in such a way, that pairs of association rules co-occurring in an unexpected way are identified.

Berger and Tuzhilin (1998) elaborate on the discovery of interesting repetitions (re-appearances) of a pattern across a series of events, whereby a pattern is interesting if the ratio of its actual by expected occurences exceeds a given threshold. Pattern discovery is based on temporal predicates, supporting the operators NEXT, BEFORE_k (with k being a given number of events) and UNTIL. The model of Karimi and Hamilton (2003) on the discovery of causality relationship among events further delivers a particular form of interesting temporal rules for the context of temporal classification. 'Interestingness' models for sequences of events are further addressed by the same authors in (Hamilton and Karimi, 2005). However, both works, as well as further studies on simple or complex types of events, focus on correlations among events belonging to the same rule rather than on correlated rules.

Close to the works of (Berger and Tuzhilin, 1998; Chakrabarti et al, 1998) are the temporal mining studies of (Chen and Petrounias, 1999; Pechoucek et al, 1999), where the focus is on the discovery of the maximum valid interval for a rule, subject to statistical constraints. In the survey of (Roddick and Spiliopoulou, 2002), contributions on the discovery of temporal patterns among patterns (rather than data) are discussed under the topic 'higher-order mining'. Although there is no explicit emphasis on the concept of 'interestingness', it is pointed out that a change in the statistical properties of an association rule or a frequent sequence is a phenomenon of potential interest (Roddick and Spiliopoulou, 2002).

A model for interesting rule changes across the time axis is proposed in (Liu et al, 2001). This model distinguishes among stable rules that exhibit no variation, rules that show a clear trend and semi-stable rules that stand between the other two types. The dataset is partitioned, the partitions are analyzed separately and heuristics are used to juxtapose the statistics of the rules across the partitions and assign them into one of the three categories.

For the temporal aspects of pattern management and the identification of those pattern changes that are interesting, SRA builds upon prior work on pattern evolution, namely on modeling patterns as temporal objects whose content and statistics may change (Baron and Spiliopoulou, 2001; 2002; 2003; 2004) and on the interestingness measures of pattern 'stability', 'persistence' and 'slope' proposed in (Baron and Spiliopoulou, 2005).

2.4.4. Intelligent advisor components

Intelligent advisors, namely data mining and web mining algorithms delivering user preferences and usage patterns, need to be developed, including the case of a navigation patterns' discoverer, business-oriented evaluation models and methods for the incorproration of background knowledge into the web mining process (Spiliopoulou, 1999; Berendt and Spiliopoulou, 2000; Spiliopoulou, 2000a; Spiliopoulou et al, 2000b; Spiliopoulou and Pohle, 2001; Pohle and Spiliopoulou, 2002; Berendt, 2004b).

Reinforcement Learning (RL) needs to be used to update the recommendation function and to select new recommendations. In this context, it is anticipated that an SRA Engine shall work on the dimensions Content, User, Time, and Value (possibly on a subset of these dimensions) and deliver general recommendations of the form (Content, User, Time) → (Content, Value).

In RL (Sutton and Barto, 1998), a set of states with admissible actions is considered, obtaining a reward after each transition from one state into another state. The aim of RL algorithms is to maximize the sum of all rewards. Thus, for a recommendation engine, the states are formed by the tuples of the dimensions (Content, User, Time) and the actions are (Content, Value). The reward can be defined in different ways, depending on the business case. This is a topic of investigation depending on the relative positioning that the SRA usage may have within a corporate environment. For example, similar to the recommendation engine of a web shop that tries to maximize the total price of the visited products, especially when added to the shopping card (Thess and Volkmer, 2004). In this case the aim is to maximise the value of the purchases for information and decision items 'traded' within the Situation Room. RL algorithms are based on state-value functions and corresponding action-value functions which assigns the expected cumulated reward to each state under an action taken. Once the action-value function has been computed, the optimal policy can be derived which defines the recommendations.

To incorporate Reinforcement Learning into an SRA Engine, we may consider Dynamic Programming methods for offline learning, Temporal-Difference Learning methods for online learning, and Monte Carlo methods for batched online learning. Through their common action-value function all these learning modes can be seamlessly combined. A certain research importance needs to be given in developing robust approximation schemas of action-value functions (Peng, 1993; Tsitsiklis, 1994; Dietterich and Wang, 2002) for the recommendation engine's dimension model mentioned above.

The Reinforcement Learning method can be observed as a combination of intelligent advisor and sophisticated aggregator. However, to allow for a seamless incorporation of further advisors, a rudimentary aggregator needs also to be implemented (Dietterich and Wang, 2002) which lies outside the scope of this research.

2.4.5. Relation with standards

Existing data mining de-facto "standards" mainly deal with the representation of data mining and models (also called patterns) in order to support exchange among different applications. Examples include Predictive Model Markup Model (PMML, 2004), Common Warehouse Metamodel (CWM, 2001) and Java Data Mining (JDM, 2004).

Among them, PMML is the most popular and major vendors of commercial data management and data mining products attempt to be compliant with it (Oracle 2005; IBM 2005; Microsoft, 2005).

PMML is an XML-based language aiming at sharing data mining models between PMLL compliant applications. Currently, PMML supports the basic data mining models (association and sequence rules, clusters, decision trees, regression models, etc.) and since Version 3.0 some compositions of mining models. However, it does not provide temporal management and pattern hierarchies (e.g. cluster of association rules).

2.5. Impact and implications to the research

With respect to the design of a corporate Situation Room as a form of a common, corporate intangible asset, we see a need to answer three general questions:

- At the abstract level: *what* are the strategic goals of the corporate Situation Room to be established within the organisation?
- At the structural level: *who* is doing the work and *which* resources are available?
- At the descriptive level: *how* does the organisation interface with the Situation Room, changing already existing and operational procedures and the overall culture?

The followed approach for discovering classes of 'decision models' in the addressed field of product development is hypothetico-deductive and consists of the following three phases:

- Decision-making modelling,
- unification of individual decision-making models, and
- discovering decision-making model classes.

Based on an investigation of relevant literature in the areas of intangible assets, information systems research, game theory and knowledge management, we are now able to profile a set of elementary requirements that we set as prerequisites for the model to be presented in the next Chapter, and which will be framed by means of the conceptual architecture presented in Chapter 7:

- SR must be networked as close to real-time as possible, so that its users do not argue based on out-of-date information.
- SR must be collaborative, so that its users can discuss, interact and work on specific aspects of the overall product development procedure, and then integrate their results (what we shall later refer to as support of a synthesis).
- SR must support 'transient data', so that its users can 'talk about' any issue. Also, it must support more 'permanent data', such as the key factors and arguments influencing the decision. The more permanent data needs to be archived so that the rationale for the decision can be reconstructed later. The more transient data should either not be archived, or at least be archived in a different place, so that it does not get in the way of using the archive effectively (which is often a problem with archived mailing lists or newsgroups).
- Most importantly, it must aid in the overall decision-making process, so that its users understand whether a given comment is a proposal or a consequence, a measure of goodness or supporting data, etc. In other words, it needs to support and 'understand' the semantics of the decision-making process.

As will be shown in later parts of the research, decision-making has not been approached as a collection of models, although it produces them - it has been treated rather as a method of discovery. The latter also forms the basis for exploiting the notion of a Situation Room as a powerful metaphor for *multi-party collaborative decision-making*.

2.6. Synopsis

In the chapter we identify through the conducted literature review the need for an interactive space to support product development by means of multiple realities decision models.

Such a space should provide interoperability on the semantics of the information assets used amongst the various corporate users and participants, in terms of appropriate tools or applications.

Further processed review material can be found in Appendix 7 in terms of an elaborated discussion of multiple-reality decision-making issues in the corporate environment (A.7.1) and a note regarding the contexts and interactions of decision-making (A.7.2). For consistency reasons they were not regarded as important to include in the main body of this research though they in general form essential part of it.

3. Development and operationalisation of the theoretical model

3.1. Overview of the model

An important feature of SRA application is that it involves corporate users in all stages of the product development value chain. In this respect, SRA application is considered a means of furthering the development of and for realising the vision of corporate intelligence. The requirements for realising the vision are multi- and inter-disciplinary approaches, and research, evaluation and demonstration activities involving key people who will have to use such an intelligence infrastructure. SRA application will also help to provide a structure for existing corporate activities, and the means to enable such activities to develop.

Successful research and development in corporate intelligence needs a new approach based on the involvement of those that will be affected by the presence of such systems. This observation also applies to the later activity of developing and introducing new commercial products and services.

In the language of developers, those affected by the presence of corporate intelligence are commonly referred to as users. However, it should not be forgotten that these users are human beings. And humans are complex. They have needs and preferences, fears and worries, likes and dislikes. They can behave in both rational and irrational ways. They have physical and mental characteristics, and emotions. People are both individuals and members of larger groups. There is no standard user.

The age of the standardised information product or decision-making service has already passed. While many commodity items will continue to be produced in large quantities, the future will see a greater focus on customisation of products and services – especially these that relate to intangible goods and services. This point alone could serve as a justification for bringing potential users into the process of research and development and new product creation.

In personal communications with several corporate users, these have expressed the view that business intelligence will not be widely accepted and used, unless users are deeply involved in the shaping of these technologies. And this is not just a matter of *show and tell.* Developers need to do more than just bring new technologies to users to ask them what they think. A novel two-way relationship needs to be established between those that develop new technologies and those that have to use them. Corporate users should be integrated into the processes of SRA application research and development, and form part of the innovation process, a source of ideas, and not just a resource to evaluate ideas. This is a novel and challenging task.

The above implies a profound change in the processes used by researchers and developers. Businesses and the industry will need to adopt new ways of working and also to deal with culture change. The challenges are significant, but so is the potential payback measured by competitive advantage in global markets and the social acceptance of corporate intelligence.

Situation Room Analysis application has been proposed as one means of addressing the challenge of creating a multi-party collaborative and human-centred approach to research and development in corporate intelligence.

We recognize a set of 7 problem areas in which improvements to the process of product development is needed. These have been identified both as part of an interactive process with IT industry groups throughout the conduct of the five application scenarios we have performed, and as described in Chapter 4 regarding the research methodology. The results have been appropriately examined and assessed with respect to their relative importance on the impact of the product development process performance.

For each of the selected problem areas, we juxtapose a set of five research hypotheses; each of them forms a unique proposition that is related in some prescribed way with the others. The model enables for the interactions of the propositions with the different problem areas to be examined in terms of the impact and the type of qualitative implications they may have to the addressed field.

Beyond all other issues, we consider that the main elegance of the theoretical model we are to deploy is its simplicity:

- 5 research hypotheses validated in each of
- 5 explorative application scenarios to support the relevance and utility of SRA in regard to
- 7 problem areas which have been identified collaboratively with users and stakeholders.

Below in Figure 4 we depict schematically the relationship of the above. More specifically, we show that the same set of the five hypotheses has been used for all five scenarios and the results were examined with respect to each of the seven identified problem areas.

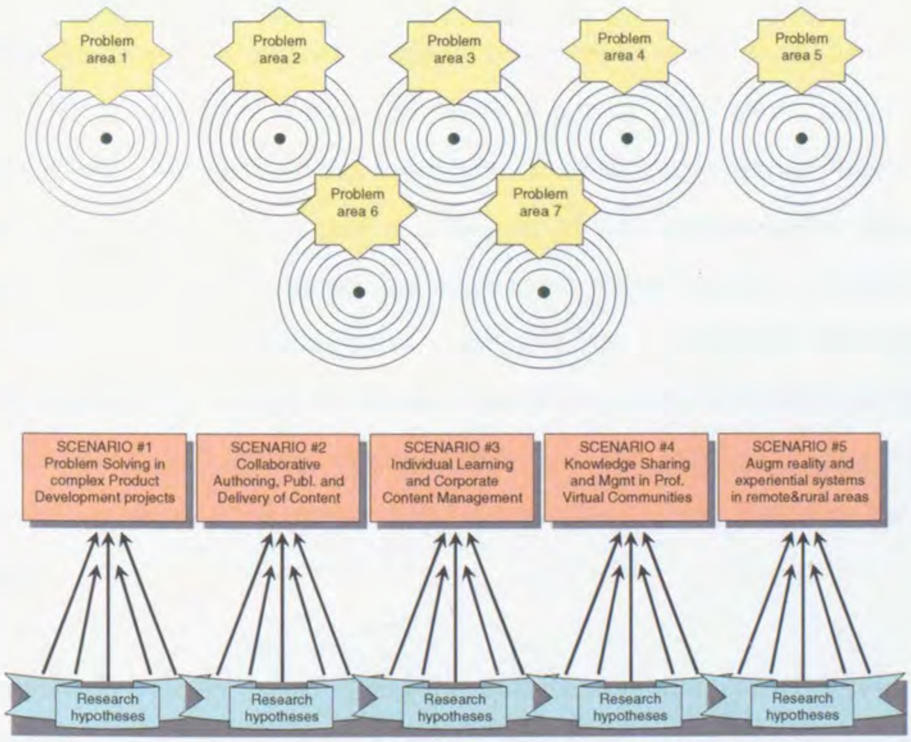

Figure 4 The main constituencies of the theoretical model.

We elaborate on the problem areas in the next Section 3.2, and present the research hypotheses in Section 3.3.

3.2. Problem areas

Companies operate in an increasingly difficult competitive environment. There are greater expectations from customers for products and services that better match their needs and aspirations. Other market regions continue to exert competitive pressure to perform better in all aspects of business operations, including customer focus. Furthermore, new product concepts are continually emerging and this creates some novel difficulties. Applying tried and tested market research techniques to customers who lack any knowledge of proposed new product concepts is not easy. Moreover, there is a developing view that future products will not be fully defined at purchase, but will evolve with users as their needs change and new developments emerge. One aspect of the vision of corporate intelligence is the focus on placing employees at the centre of technology and product / service development. Interaction will be through natural and intuitive interfaces.

It is true that the subject of corporate user involvement in corporate decision making is not a new idea. It has been advocated many times in the past in several different contexts. However, never before has there been such an imperative to involve users in all stages of research, development and design of new technologies, products and services. There is an opportunity so that SRA application becomes a normal business practice. Business and social needs point to this as a new requirement. The time and the circumstances appear to be right for a concerted effort to help industry to adopt a multi-party, collaborative and human-centred approach to researching and developing corporate intelligence, and the products and services that will be based on the emerging technologies.

SRA application is a means of achieving this user participation. There will be a number of benefits from undertaking this type of user driven research which we structured in 7 problem areas, i.e. areas which are facing suboptimalities and which seek for improvements:

1. reducing the barriers to the development and take-up of corporate intelligence;
2. improving industrial competitiveness;
3. supporting emerging industrial practices;
4. developing new ways of undertaking research;

5. delivering improved education and training to the corporate (white-collar) workforce;
6. assisting technology integration;
7. involving all levels of the workforce in research and development.

3.2.1. Reducing the barriers to the development and take-up of corporate intelligence

Not everyone is an early adopter of new technologies. Some people like having the latest technologies in their workplaces. However, many people are either suspicious of new technology, or in some cases frightened by it. Concerns about security, safety and privacy as well as a decentralization of control and command structures are widespread. Europeans in particular seem less inclined to accept new technologies that their counterparts in the United States and the Asia-Pacific region (Howells et al, 2004).

There is a danger that these problems will become barriers to the adoption of corporate intelligence in Europe. At best these barriers may appear in the form of reluctance of people to buy and use products and services based on corporate intelligence such as the SRA application. Other market regions may then see this as an opportunity to develop better products and thus take the lead in the development and implementation of corporate intelligence (Lindemann and Reichwald, 1998). At worst, people may become actively disposed against the concept of corporate intelligence, and then seek to have developments stopped. SRA application has the potential to be a vital tool in this corporate continuous learning process.

3.2.2. Improving industrial competitiveness

Many times the view has been expressed that technology, and the ownership of the associated intellectual property, does not generally provide the basis for sustainable competitive advantage (Lubit, 2001). Why is this so? The reason is that technologies are often in the public domain, so they can be analysed. Once understood, alternative technology can be developed. Competition often ensures technological progress, but also often brings about competing solutions.

Recognition of this fact has led many enterprises to seek competitive advantage in areas that are harder to copy. Examples are organisational design, company culture, and business processes. Often there are *intangible aspects* to these. Usually they are less visible to competitors and the difficulties of achieving a good fit between organisation, culture, and processes and the business environment, makes copying hard.

Research, development and design processes involving users can become a source of sustainable competitive advantage, because user involvement is hard to bring about and hard to copy. Involving users in these processes requires knowledge about how to successfully achieve this. Know-how is intangible, and the intangible is a source of wealth in a knowledge-based economy (Peszynski and Yoong, 2002). SRA application therefore, can serve an important role in helping enterprises to develop these processes, thus contributing towards the development of sustainable competitive advantage.

3.2.3. Supporting emerging industrial practices

Since the early 1990s there has been an increasing emphasis in companies – especially in Europe - on customer focus. Japanese practices in this respect have been studied and copied. New product development processes have been redesigned, both to reduce time-to-market and to improve the definition of customer requirements. Techniques such as quality function deployment have been introduced to complement more traditional techniques such as customer questionnaires and focus groups. There has also been a growing interest in a number of other areas related to customer focus.

One of the better known of these is mass customization (Pine, 1993). This seeks to offer customized products and services at mass production costs. But there are other techniques that look to create a different relationship between companies and customers. One of these is known as expeditionary marketing (Hamel and Prahalad, 1991). This technique is aimed at minimising the risks associated with opening up markets for novel products, especially those where customers have no notion of the proposed product concept. The aim is to determine the precise configuration of product functionality that customers will value and to establish the hurdles that need to be overcome to achieve the combination of price and performance that will open up the market for the new product.

The technique involves an iterative approach to product design and launch. A product is quickly created and then launched into the market. Testing of its reception and establishing what needs to change to achieve the right combination of features, price and performance then follows. The product is then quickly redesigned and re-launched. The process continues until the right combination has been achieved or until it is judged that the product is unlikely to succeed.

The process requires close working with groups of customers, or users, but another technique, called co-creation, has even more profound implications for relationships with customers. The problem with market research is that it limits firms to addressing customers' existing frames of reference. Co-creation with customers addresses this fundamental problem.

Co-creation seeks to develop a continuing and intertwined relationship between a firm and its customers. It works to define not only short-term customer requirements, but also the exploration of new opportunities using customers' perceptions of future requirements. It also seeks to collect from customers' their own ideas about how products can be redesigned or improved. An important underlying tenet is that it is not always possible to establish fully, in advance of product design, customer needs. Instead, needs and solutions emerge together rather than one following logically on from the other. SRA application is capable to provide opportunities to companies to support these novel practices and assistance to ensure their wider adoption.

3.2.4. Developing new ways of undertaking research

An important characteristic of modern research, development and new product creation is its multidisciplinary nature. An essential ingredient in most projects is a multidisciplinary team.

Multidisciplinary approaches are concerned with using ideas from a range of disciplines and the application of these ideas to the solution of design problems, or technology developments. This provides valuable information flow among different professions, new insights and usually better results.

Multidisciplinary approaches however, largely maintain the existing divisions between knowledge domains. An increasing amount of research however is adopting an interdisciplinary approach, and this usually opens up entirely new perspectives and research topics. Interdisciplinary activities are concerned with the areas between disciplines, and applying insights from these areas to solve design problems and to create new visions, new ideas and new opportunities. Interdisciplinary work has the potential to create new research domains (Thompson Klein 1990 and 1996; Rhoten, 2003). Multidisciplinary approaches offer significant opportunities to achieve superior corporate intelligence performance: world-class products for a global marketplace.

Interdisciplinary approaches have the potential to open up entirely new avenues of research in corporate intelligence. This is the potential for SRA application. It can provide a multidisciplinary environment for the development of corporate intelligence products and systems, with all the benefits that multidisciplinarity brings. However, it can also be interdisciplinary research, creating and exploring new visions and undertaking pioneering research in novel and unexplored areas.

3.2.5. Delivering improved education and training to the corporate (white-collar) workforce

SRA application will provide an opportunity to develop and deliver, to industry, education and training for the workforce of all levels. Most of the education and training that will be delivered by organisations or schemes participating in SRA application will be related to how to work with users (Scholz-Reiter et al, 2003). However, this will need to be related to processes. In addition to learning about methods and tools and techniques, usability, human-computer interaction, interface technologies, etc., the education and training activities will also address design method, research and development methods, and new product development processes (Polanyi, 1966). Inherently therefore, education and training activities focused on user aspects, will also lead to improved awareness and knowledge of these methods and processes.

An important spin-off from these education and training activities will be increased awareness of corporate intelligence in general, and the importance of placing people at the centre of developments. Armed with these insights and knowledge, new workers and employees will also be better equipped for roles as both developers and users of corporate intelligence.

3.2.6. Assisting technology integration

Integration of components and systems for product development purposes continues to be a difficult and quite not trivial task. This is a challenge that will need to be addressed by SRA application. Creating realistic user environments, where corporate intelligence technologies and systems can be tested, validated and demonstrated will require integration of technologies from different suppliers. New technologies and prototypes will also need to be integrated into established infrastructures within the existing business process grids (Card et al, 1998). SRA application will therefore be a driver for technology integration and this will be an important secondary benefit from the activities of the organisations involved.

3.2.7. Involving all levels of the workforce in product research and development

Involving all levels of the workforce in research and development programmes and bringing technology closer to them has emerged as an important issue that will need to be addressed in the years ahead (Argyris and Schön, 1996). SRA application, by the nature of the topic and remit, can form an important component in future plans to increase corporate workers involvement in research and development activities.

3.3. Research propositions

The metaphors and the various types of conceptual schemas and mental representations that people use for carrying out most types of tasks, spanning from what we call 'simple' and 'everyday' to those we tend to regard as more abstract or sophisticated, have an increased significance to the ways these tasks are carried out, to the practices that are developed for carrying out these tasks, as well as to the overall 'culture' that characterizes them. With the use of such appropriate metaphors, conceptual schemas and mental representations, which appertain to a particular task, being able to 'serve' it and sufficiently express its characteristics, it is possible to improve substantially the way such a task is executed.

The usage of concepts and metaphors used in the context of military applications, as it is the case with the proposed *Situation Room*, is likely to prove extremely useful and rewarding for application in the field of business and the business processes. An important element, which marks not only the usefulness and utility but also the value of this particular concept of the Situation Room, is the facilitation of the corporate learning process. Both the use of the concept of Situation Room and its accompanying framework for application in the corporate process grid and decision making activities, as well as the contribution they make to the increase of the corporate knowledge capital, can be regarded as essential intangible assets of a company (or an organization), and as such they can be assessed and valuated by means of quantitative and qualitative approaches.

The above sets the stage for what shall be the subject of the research propositions or hypotheses.

Below in Table 2 we present all five hypotheses in tabular form.

	Hypothesis statement
Existence hypothesis	The metaphors and the various types of conceptual schemas and mental representations that people – either as individuals or as members of a team – use for carrying out most types of product development tasks, spanning from relatively 'simple' and 'straightforward' ones to those we tend to regard as more abstract, sophisticated or complex, have an increased significance to the ways these tasks are carried out, to the practices that are developed for carrying out these tasks, as well as to the overall 'culture' that characterizes them.
Improvement hypothesis	With the use of such appropriate metaphors, conceptual schemas and mental representations, which appertain to a particular task, being able to 'serve' it and sufficiently express its characteristics and idiosyncrasies, it is possible to improve substantially the way product development is executed.
Business-as-War hypothesis	The usage of concepts and metaphors used in the context of military applications, as it is the case with the proposed Situation Room, is likely to prove extremely useful and rewarding for application in the area of product development in the IT sector, as well as in the wider area of related business processes.

Learning hypothesis	An important element, which marks not only the usefulness and utility but also the value of this particular concept of the Situation Room for support of the product development process, is the facilitation of the corporate learning process.
Corporate capital hypothesis	Both the use of the concept of Situation Room and its accompanying framework for application in the corporate product development process grid and decision making activities, as well as the contribution they make to the increase of the corporate knowledge capital, can be regarded as essential intangible assets of a company (or an organization), and as such they can be assessed and valuated by means of quantitative and qualitative approaches.

Table 2 The five hypotheses of the research.

In the next paragraphs, what we shall do in this section, concerns a first-level, preliminary pass over the research propositions under examination. As any 'pre-processing' activity, it aims to provide a more fine-grained 'clear-cut' itemization of the entities (in the present context, these are the postulates, hypotheses and assumptions we have been making), and – if possible – a rough positioning within the overall research field.

We shall comment on all of them after their quoting.

3.3.1. First hypothesis

> *The metaphors and the various types of conceptual schemas and mental representations that people – either as individuals or as members of a team – use for carrying out most types of product development tasks, spanning from relatively 'simple' and 'straightforward' ones to those we tend to regard as more abstract, sophisticated or complex, have an increased significance to the ways these tasks are carried out, to the practices that are developed for carrying out these tasks, as well as to the overall 'culture' that characterizes them.*

We use three different terms interchangeably – and the aim is to exploit the semantic 'additivity' caused by joining their notions. What we support here is that:

What we tend to call or recognize as:

- either metaphors
- or conceptual schemas
- or mental representations

and which people use for practicing product development tasks which again span

- from 'simple' and 'straightforward'
- to 'more abstract, sophisticated or complex'

are forming an important part of the (relative) success that people have in performing these tasks.

This success, again, may refer

- either to the actual level of e.g. physical performance of an action
- or to some practice that is developed for performing that action
- or, finally, to the 'culture' that underlies this particular action.

We can call this first hypothesis ***Existence hypothesis***, as it makes the assumption that there exists this linkage between mental abstractions and people's tasks as participants of a product development process. Causality or dependency relationships are of further interest, as the main point to be examined here is whether this claim is holding in actual – or not.

Regarding this, Smilowitz (1996) states that since (the now regarded as legendary) "*Visicalc's metaphorical ledger and the Xerox Star's desktop metaphor, interface designers have been incorporating metaphors into user interfaces. User interface (UI) guidelines for most of the popular operating systems encourage the use of metaphors in interface design. They suggest that applications should build on the user's real-world experience by exploiting concrete metaphors thereby making applications easier to use. Surprisingly little research supports the popular belief that metaphors in user interfaces facilitate performance.*" (p. 74)

In her research, Smilowitz explores the use of metaphors in interface design, concentrating on the case of World Wide Web and the Web browsers. Having conducted a series of experiments, she came up with the conclusion that though UI metaphors can facilitate users' interactions, however, various metaphors are not equally effective, some are no better than non-metaphoric interfaces.

Having in mind the time that her research appeared (late 1996) and how the Zeitgeist was at that time, her investigation on issues such as the integrality of a particular metaphor are important and support the appropriateness of the posed research questions.

3.3.2. Second hypothesis

> *With the use of such appropriate metaphors, conceptual schemas and mental representations, which appertain to a particular task, being able to 'serve' it and sufficiently express its characteristics and idiosyncrasies, it is possible to improve substantially the way product development is executed, no matter how abstract, complex, complicated, sophisticated or detailed this is.*

This second hypothesis – we call it ***Improvement hypothesis*** as its central meaning is that:

People / companies can significantly improve the way they perform product development tasks, independently on their complexity, difficulty or other related characteristics, if they have access to or are driven by:

- either an appropriate metaphor
- or an appropriate conceptual schema
- or an appropriate mental representation

Reversing the way we stated this above – but not changing the logical order, this reads like:

- If people / companies have access to an appropriate metaphor, then they can improve the way they perform a product development task (that the metaphor relates to or explains or describes)

In case this statement is true, it holds also the (conditional only) validity of the complementary statement, like:

- If people / companies do not perform successfully a product development task, then this is possibly because they have not had access till now to an appropriate metaphor

It is obvious that the main argument here relates to the facilitating ('enabling') nature of an appropriate metaphor. And because 'appropriate' as a term may make people feel uncertain about its meaning, we actually mean *good* metaphors.

Donald Norman, an internationally established and legendary figure in the area of human factors and design has been touching this issue in (Norman, 1988) and in its later revised appearance (Norman, 1990). There, on exploring the matter of usage of metaphors and adoption of conceptual models, amongst others he states that metaphor is both useful and harmful, providing the explanation that the problem with metaphor is that not all users may understand the point. Worse, they may take the metaphor too literally and try to do actions that were not intended. Still, this is one way of training users. It is for this, according to Norman, that coherent conceptual models are valuable and, in his opinion, necessary, but there still remains the bootstrapping problem; how does one learn the model in the first place? - why by conventions, words, and metaphors.

On this topic, several years later in (Norman, 1999) he defines the 'design space' with the following constituents:

- The Conceptual Model
- Real Affordances
- Perceived Affordances
- Constraints
- Conventions

And recognizes that we should neither confuse *affordance* with *perceived affordances* nor confuse *affordances* with *conventions*. According to Norman, *affordances* reflect the possible relationships among actors and objects: they are properties of the world, while *conventions*, on the other hand, are arbitrary, artificial and learned. Once learned, they help us master the intricacies of daily life, whether they be *conventions* for courtesy, for writing style, or for operating a word processor. Designers can invent new real and *perceived affordances*, but they cannot so readily change established social *conventions*. Know the difference and exploit that knowledge. Skilled design makes use of all.

3.3.3. Third hypothesis

> *The usage of concepts and metaphors used in the context of military intelligence applications, as it is the case with the proposed Situation Room, is likely to prove extremely useful and rewarding for application in the area of product development in the IT sector, as well as in the wider area of related business processes.*

This forms the third hypothesis – we can call it the ***'Business-as-War' hypothesis.***

What it is about here may lie at the level of intuitive interpretations of the business field related to the preparation for the launch of the new product, the market intelligence exercises performed, the investigation for finding the final way to address the market and customers, etc., and analogies that can be drawn between this field and war-making activities.

For instance, according to one approach we would look at the *similarities only*:

One starts a war for achieving certain goals and benefits, but he has to:

- pay some costs for this;
- set priorities;
- organize plans of attack to the enemy;

- also define the enemy (this rather happens at a different, more intellectually-driven level)
- ensure his position
- hopefully end the war or start a new one

It is obvious that a war in this example can be regarded as an *economy*[10] – in the same way also that it is viable to regard a business as an economy too.

Last but not least, it is always tempting to find differences even between different wars or different businesses; and what we use to say is that 'this war is different from some other', or 'this is a different business', but in all cases we agree that they both share some common characteristics which help them to belong in the same class of war or business.

This hypothesis is not new and is not an innovation to refer to this. It has appeared several times in the literature, and there is an interesting corpus of information and research in this field. For instance, central gravity to this issue is given in (Smith, 2002). There the author recognizes that adaptation to the Information Age will require changes in the following four dimensions:

- mission space (what the military will be called upon to do),
- environment (the conditions, constraints, and values that govern military operations),
- concepts (the military business model or the way we do what we do), and
- the business side of the DoD[11] (the way the organization supports value creation).

Effects-based Operations (EBO) is about the first two of these four dimensions while Network Centric Warfare (NCW) addresses the last two. Hence, EBO and NCW form a synergistic treatment of military transformation. They deal with the why, what, how,

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[10] Webster's On-line dictionary provides, though as third option, the following definition for the word economy: "The system of rules and regulations by which anything is managed; orderly system of regulating the distribution and uses of parts, conceived as the result of wise and economical adaptation in the author, whether human or divine; as, the animal or vegetable economy; the economy of a poem; the Jewish economy" (http://www.webster-dictionary.org/definition/economy).

[11] The U.S. of America *D*epartment *o*f *D*efense.

and support of military operations. While the author who comes from the military discipline continues with extensive coverage of the addressed application area and provides further evidence on this, it is interesting to compare with the claim that is made in the article of another author (Fuller, 1993) that comes from the business world and where it is recognized that it is no secret why companies fail: the failure starts at the top. "*CEOs and their senior executives know the problems; in fact, in the privacy of their offices, they'll volunteer them to you:*

- *'We have the information in the company. But we don't seem to get it to the right place',*
- *'We get the information to the right place. But then we can't seem to make the choices we should',*
- *'We're okay at choosing what to do, but we're too damned slow. By the time we pull the trigger, the target's moved',*
- *'We know what needs to happen. But we never seem to execute. I never see action.'*

For some companies, the list of symptoms includes bad habits that slowly erode performance: rivalries in the executive suite, endless turf consciousness, resource struggles between business units. In short, functional boundaries drive a wedge between managers who should be on the same side but who act like the Army, Navy, and Marines competing to see who leads the invasion. In these cases you hear sentiments like, 'We can't pull together, we're always pulling separately. There's too much internal friction around here.'" (p.42)

In every struggling large company, according to (Fuller, 1993), the symptoms are the same. It's all just a matter of where it hurts worse. And the author concludes identifying that in the life-or-death quest for strategic change, business has much to learn from war. Both are about the same thing: succeeding in competition. Even more basic, both can be distilled to four words: informed choice / timely action. The key objective in competition - whether business or war - is to improve your organization's performance along these dimensions:

- To generate better information than your rivals do
- To analyze that information and make sound choices

- To make those choices quickly
- To convert strategic choices into decisive action

Together they represent informed choice / timely action.

Independently on whether we agree or not to the core matter (i.e. how much are these two activities of business and war close to each other), we agree that we can use the metaphor of war to approach the field of product development. This, in turn, may trigger two questions which we should by now have expected to appear, concerning the holding or not of the two first hypotheses namely of the *Improvement Hypothesis* and the *Existence Hypothesis*.

Supporting evidence for both can only be given using indirect means:

- Regarding the linkage to the second hypothesis, given the above analysis, we could come to the idea that the third hypothesis is a special case of the second hypothesis, namely that the business-as-war concept is a facilitator for performing better a product development task. Namely this of doing business, by means of using material and food for thought and analysis and examples and past cases from a different field, namely this of war making.
- Regarding the linkage to the first hypothesis, simply by backtracking, we can judge that the *Existence Hypothesis* holds, as the result of the 'existence' and the holding of the *Improvement Hypothesis*.

Even if the approach we use seems iconoclastic or unorthodox, there is no doubt that we have built a sequence of steps and thoughts where the third one appears as a product of specialization of the previous two.

3.3.4. Fourth hypothesis

An important element, which marks not only the usefulness and utility but also the value of this particular concept of the Situation Room for support of the *product development process, is the facilitation of the corporate learning process.*

What we left totally out from the analysis in the previous hypothesis was the reference we make to '*the proposed Situation Room*', which we regard as an '*extremely useful and rewarding* [metaphor] *for application in the field of corporate product development processes*'.

Now, as part of the fourth hypothesis we need to support that:

The metaphor of a Situation Room, as a special case of a business-as-war conceptualization:

- except from being useful in general, bringing utility and (helping a company) creating value with respect to product development tasks, it also
- facilitates the overall corporate learning process.

In the literature in this area, several authors such as Argyris (1977), Argyris and Schön (1978) and Leavitt and March (1988) have used different definitions or models of organizational learning or have not rigorously defined their terms.

From this perspective, the research and the Situation Room proposition are dedicated to helping organizations become better learning systems – which shall affect also their product development capabilities as well. In this respect, we adopt the definition of the Society for Organizational Learning (www.solonline.org) according to which organizational learning is regarded as "the capacity or processes within an organization to maintain or improve performance based on experience".

As in (Nevis, 1987), we assume that all organizations engage in some form of collective learning as part of their development; the creation of 'culture' and the 'socialization' of the corporate members and employees in this culture rely on learning processes to ensure an institutionalized reality. In this sense, Nevis recognizes that it may be redundant to talk of 'learning organizations', and concludes that all learning is not the same; some learning is dysfunctional, and some insights or skills that might lead to useful new actions are often hard to attain. The current concern with the learning organization focuses on the gaps in organizational learning capacity and does not negate the usefulness of those learning processes that organizations may do well, even though they have a learning disability.

It is in this context that we propose the use of Situation Room as a medium to accommodate and as a vehicle to host successfully the learning needs of a company, and hence we aspire to provide sufficient evidence of the claim made in this fourth hypothesis which we shall call the ***Learning Hypothesis.***

3.3.5. Fifth hypothesis

> *Both the use of the concept of Situation Room and its accompanying framework for application in the corporate product development process grid and decision making activities, as well as the contribution they make to the increase of the corporate knowledge capital, can be regarded as essential intangible assets of a company (or an organization), and as such they can be assessed and valuated by means of quantitative and qualitative approaches.*

According to (Quinn, 1992) "*there is little question that the 'intangibles' of databases, peronal know-how, technological understanding, communication networks, market knowledge, brand acceptance, distribution capabilities, organizational flexibility and effective motivation are the true assets of most companies and the primary sources of their future income streams*". (p. 94)

The organizational learning perspective on the approach to the Situation Room pays attention on the learning process as a central function. As defined by several sources, learning consists of constructing new knowledge (understanding) through taking in and processing information through the cognitive structures of the brain.

According to Argyris and Schön (1996), 'learning' is correcting errors (including surprises, and wrong predictions). One corrects them by adjusting the data or revising the cognitive structures that produced the failed expectations. Knowledge, produced through learning, flows through organizations to become output, usually combined with physical product, and it is a part of every process. Knowledge, therefore, makes up a significant part of the fabric of the organization.

Nonaka and Takeuchi (1995) have developed and propose a theory of the successful Japanese company that centers on the processes of creating knowledge, especially new product ideas and designs. Their theory of organization includes a theory of knowledge, to make a compelling case. More specifically, they recognize that people do not just receive new knowledge passively; they interpret it actively. Thus what makes sense in one context can lose meaning when communicated to people in a different context. The major job of managers is to direct this confusion toward purposeful knowledge creation. Both senior and middle managers do this by providing employees with a conceptual framework. Middle managers serve as a bridge between the visionary ideals of the top and the often chaotic reality of those on the front line of business.

We call this fifth hypothesis the ***Corporate Capital Hypothesis***.

Below in Table 3 we identify for each of the five research hypotheses a set of focus aspects which shall be treated during the validation exercise to take place as part of the five business application scenarios.

	Focus aspects
Existence hypothesis	• General. Validity - True or false? • Examination of conditions related to its application (sector-, context- or other parameters-specific) • Distinction between people as individuals and as members of a team • Single metaphor or groups / sets of metaphors • Metaphor nature and connotations • Sharing of metaphor qualities • Imposed or enforced vs voluntarily adopted metaphor • Simple vs complex metaphors • Simple vs complex tasks • Development of practices for task accomplishment
Improvement hypothesis	• Metaphor fits to a product development task or not

	• Metaphor affordance matters for product development • Improvement of product development through metaphor • Verification in different settings: abstract, complex, complicated, sophisticated or detailed ones • Choice of improvement indicators – qualitative and / or quantitative • Cost – benefit matters
Business-as-War hypothesis	• Analogy drawing between 'war' and 'product development' • Orchestration of product development activities in a war-like fashion • The long view: Corporate mission and strategy, market geopolitics, the corporate economy • The short view: Resources utilisation and coordination, increase of corporate product development capacity
Learning hypothesis	• Does the concept of Situation Room facilitate corporate learning at large? • Does the concept of Situation Room facilitate learning regarding product development? • Returns of the learning curve • Learning fit to corporate context and culture • Learning fit to specifics of the area addressed by the product or the addressed market
Corporate capital hypothesis	• Is the corporate Situation Room an intangible asset of the company? • Or simply a 'tool' to support product development? • How can the valuation of this asset take place? • Can it support the valuation of the corporate product development process? • Can it support the valuation of each product itself?

Table 3 Hypotheses related with the search items and the investigation procedures

In the rest of this Chapter, we discuss some other important issues of the model characteristics which affect the overall research. Below, we also present in tabular form elements of relationship between research hypotheses and the problem areas and (Table 4) and the case studies and the problem areas (Table 5).

Problem areas / Research hypotheses	Reducing barriers to corporate intelligence	Improving industrial competitiveness	Supporting emerging industrial practices	Developing new ways of undertaking research	Delivering improved education / training to workforce	Assisting technology integration	Involving all levels of the workforce in product R&D
Existence hypothesis			Is SRA in a position to support novel and 'emerging' practices of work?			Does the application of SRA apply to complex business process grids? And/or to the creation of new realistic userenvironments?	
Improvement hypothesis	Will SRA application have the potential to be a vital tool in the corporate intelligence process?		And also improve the productivity, the efficiency and the gains?		Workers better equipped for the roles of developers and users of corporate intelligence		
Business-as-War hypothesis				Are multi- and inter-disciplinarity positively affecting the corporate product development 'wars'?			SRA as a support instrument for concentrating the commitment and engagement of the entire workforce

Learning hypothesis		Does user involvement for SRA operation lead to learning?			Learning is now part of the core business process of the workers		
Corporate capital hypothesis		Does SRA operation help increase the corporate intellectual capital? In a business sense-making way?					SRA as aggregator for the corporate *human* capital

Table 4 Research hypothesis and the identified problem areas

Problem areas / Application scenarios	Reducing barriers to corporate intelligence	Improving industrial competitiveness	Supporting emerging industrial practices	Developing new ways of undertaking research	Delivering improved education / training to workforce	Assisting technology integration	Involving all levels of the workforce in product R&D
Problem Solving in Complex Product Development Projects	Support for collaborative process planningand execution		Use of novel practices to improve problem modelling and solving		Use of problem patterns and the use of stereotypical situations to support training		Problem-oriented workforce involvement
Collaborative Authoring, Publishing and Delivery of Multimedia Content	Content exchange organised in sessions according to trust features		Repositioning of the traditional roles and interactions between authoring, production and distribution		Novel methods and paradigms for content presentation and manipulation		Tools and enabling applications to support involvement
Individual Learning and Corporate Content Management in Industry	Team learning curve improvement		Situation- and SR-ownership for the individual and the team		Situation-based performance indicators for individual and team training		Experimentation with alternative models of learning
Knowledge Sharing	Increase of team	Value creation in	Practicing of emerging		Sharing of training		Novel practices for

and Management in Professional Virtual Communities	intellectual capital assets	professional communities	industrial practices as part of SR sessions		experiences amongst (groups of) professionals		sharing and management of knowledge
Augmented Reality and Experiential Systems in Remote and Rural Areas	Empowering remote workers to participate		Support for new types of industrial production in remote areas		Augmented SR notion		

Table 5 The identified problem areas with respect to the research application scenarios

3.4. Discussion

A central issue related to the model relates to the practical employment and application implications this will have in terms of a new method in the addressed field of product development. Though in our 'common' and daily language, we refer to the term method, for the *scientific* method there is the definition of "*a process by which scientists, collectively and over time, endeavor to construct an accurate (that is, reliable, consistent and non-arbitrary) representation of the world*" (Kuhn, 1962, p. 142), it is not outside the scope of the present research to use the term method for denoting the process of gaining knowledge through ordered, systematic and repeated experimentation.

In this respect, it is rather straightforward to see that the formality needed for approaching the traditional four steps of the scientific method listed below are out of the scope for the research case:

1. Observation and description of a phenomenon or group of phenomena;
2. Formulation of a hypothesis to explain the phenomena;
3. Use of the hypothesis to predict the existence of other phenomena, or to predict quantitatively the results of new observations;
4. Performance of experimental tests of the predictions by several independent experimenters and properly performed experiments.

Thus, for the context of the research the term that better serves our purposes is **framework**. The CERN Engineering Data Management Glossary (CERN, 2001) defines the term framework as "*an extensible structure for describing a set of concepts, methods, technologies, and cultural changes necessary for a complete product design and manufacturing process. [...] Frameworks provide a mechanism that guides users through a proper order of steps, applications, and data conversions via a common interface to the process being followed.*" (p. 27)

Furthermore, a guide is given in terms of a roadmap on applying the approach for the establishment and operation of such a corporate Situation Room, with extensive reference to functionality and technology infrastructure issues. This last part concerns the provision of a roadmap that can help the application of the concepts and tools presented in the research for establishing corporate Situation Room. The term roadmap, originally denoting a travel itinerary, is now used more often to designate a simplified policy, strategy or action plan.

Though there have appeared in the market several 'roadmapping' applications, from setting scientific research agendas to industry direction to product and technology plans, they all follow a common format and help guide developers and users to critical decision points.

A common framework also guides the construction of a roadmap, making sure that it sets a clear future objective and answers the critical 'why-what-how-when' questions that define and explain a clear action plan for reaching the particularly set objective. For our context, the roadmap consists of four parts adopting the structure used by (Phaal et al, 2001):

- The first part defines the domain of the Corporate Situation Room roadmap, the corporate and the team's objectives, and their strategy for achieving those objectives - *the why* part of a traditional roadmap. This part may often extensively build and make use of market and competitive assessments as well as any other corporate applications. It is addressed as part of Section 6.4 related to the Situation Analysis Model (SAM) and the first two of the constituent building blocks, namely the situation environment and the organisational infrastructure.
- The second part defines direction, or the corporate and the team's plans - *the what* part of a traditional roadmap. The direction includes challenges, the architecture and evolution of the team's solution, and measurable performance targets to achieve the objective. It is addressed again as part of Section 6.4 related to the Situation Analysis Model (SAM) and the last two of the four constituent building blocks, namely underlying goals and strategy and the assessment.
- The third part describes the evolution of technologies that will be used to achieve the objective - *the how* part of a roadmap. As a complement to this, a *technology roadmap* defines here the technologies that are used to

implement each part of the Corporate Situation Room architecture. This is addressed in Chapter 7 of the research.

- The fourth part defines the action plan and risks - *the to-do's* of the roadmap. The action plan identifies key development actions, resources required, risks, and technology investment strategy. This is also addressed in Chapter 7 as part of Section 7.6 devoted to the run time environment of the SRA architecture.

3.5. Synopsis

We presented the 5 research hypotheses; each of them relates to the investigation we have made as part of the literature review and own research and experiences from the addressed field of product development, and which has converged to the recognition of 7 problem areas, in which the proposed framework for Situation Room Analysis is expected to have a positive impact.

4. Research methodology

4.1. *Setting the context*

In the research, we came across a set of different methods that have been examined with respect to their appropriateness and adequacy to the research field. This short overview is not exhaustive, but serves as a starting point for conduct of the research. It should be mentioned that in this first section we only limit ourselves to the objective presentation of methods examined and not taking a position with respect to them. Our choices and the approach taken are described extensively in Section 4.2 where we elaborate on the methodical tools we employ and Section 4.3 where we analyse the approach taken.

4.1.1. Methods involving the user

This section lists methods that have been designed specifically to involve the user in the development of software, specifically requirement analysis that involves systems with a user interface. Each method is briefly described.

- *User-centred design* (Gulliksen et al, 2001). Not only are users involved, but also in their own context. Emphasis is on iterative short cycles and prototypes. User-centred design is multidisciplinary.
- *Participatory design* (Kuhn and Muller, 1993). The goal is to work directly with users in designing computer systems that are a part of human work. Participatory design is rooted in Scandinavian countries with strong labour unions and democracy in the workplace. It has then moved on to other parts of the world. Muller et al (1993) give an overview of participatory design practices and thereby answer questions such as: who participates with whom and in what? Where do they participate in the development lifecycle? What are the appropriate sizes of groups? The users participate in the design and are not merely a subject of research.
- *Co-creation* (Garrett, 2003). Designers and users are partners in design, and users participate actively in the design, not only as evaluators, but also as designers. End-user programming, where users write their own programmes may be classified under this method.

- *Contextual design* (Beyer and Holtzblatt, 1998) have different parts: contextual inquiry; work modelling; consolidation of work models through affinity diagrams; work redesign; user environment design; mock-up and test with customers; and putting the new design into practice.
- *Activity theory* (Bertelsen and Bødker, 2003): What sets activity theory apart is that it takes into considerations the capabilities of the individual groups instead of addressing the generic user. It concerns itself also with collaboration of humans instead of focusing only on one user's work. There is also strong focus on artefacts and their role in work activities.
- *Scenario based development of human-computer interaction* (Rosson and Carroll, 2002). Scenarios are used throughout the software development, first in requirements analysis and then through design, documentation and evaluation. Scenarios describe a sequence of interactions between a user and a computer, its contexts, and users' mental activities such as goals, plans and reactions. Trade-offs are a fundamental aspect, as well as prototypes.

4.1.2. Research Methods

The methods listed in this section are more general research methods than those listed in the previous section and much broader than those used for the development of software. The first two are research methods categories.

- *Qualitative research* (Taylor and Bogdan, 1998). This is gaining more popularity, perhaps because of the need to do contextual work. Grounded theory is an attempt to make analysis from qualitative data more formal. Qualitative research still lacks connection to *formal* work products needed by engineers.
- *Quantitative research* (Weller and Romney, 1988). This is suitable when there is a need to measure something quantitatively with numbers, in an objective manner.
- *Action research* (Anders, 1991). This is iterative, and humans are not seen as subjects, but are actively involved.

- *Soft systems methodology* (Checkland, 1999). This method is applied to what Checkland describes as human-activity systems where desirable ends cannot be taken as given.

4.1.3. Quality of human-computer interaction

Usability is traditionally defined as effectiveness, efficiency, and satisfaction, but this understanding may be changing to aim for empathy, fun, motivation, trust and aesthetics, and competitiveness. When evaluating a design, other measures except from usability may be interesting, such as usefulness and intention to use. Davis (1989) (Venkatesh and Davis, 2000) has proposed a Technology Application Model that subjectively measures these aspects with a set of questions.

There is a need to specify the quality of use or quality of human-computer interaction, that is to say, measures against which ambient intelligence can be evaluated. The evaluation can be seen as formative, that is to say, giving further input into the development, or summative, that is to say, verifying that targeted qualities have been reached. Quality models for human computer interaction should not be viewed in isolation, but along with other quality attributes such as security, reliability, portability and maintainability. These quality attributes no doubt affect ease of use.

Several evaluations methods are in use, such as heuristic evaluation and user testing (think aloud protocol), but without assurance that they work for different application areas and complexity. Evaluation methods can be divided into predictive, user-based and model-based techniques. They can be either manual or automatic and be tailored for different types of platforms or domains. Practitioners will demand that human-computer interaction research be founded with empirical studies of these and other methods.

4.1.4. Models

A model is a description of a system and its interaction with other systems. Initially the model describes what problem systems should solve, and then it can be gradually refined to describe how the system solves the problem. Finally when operational, the system can be viewed as a model of some domain behaviour and characteristics.

Models can be informal or formal (or semi-formal) the first one often suitable to show users, but the latter more appropriate for engineers. Examples of informal models are prototypes of various kinds, text scenarios, storyboards, sketches, props, etc. Formal models can be divided into several categories depending on what they describe, that is to say, cognitive processes, software systems, or interactions between these. Other categories may be useful to describe other systems in ambient intelligence, for example, biological, natural, or physical systems.

Examples of cognitive models are concurrent task trees (Paterno, 2003), cognitive work analysis (Vicente, 1999) PUMA, GOMS, SOAR and ACT-R (see for example, the overview by Dix and Abowd (2004)). Examples of software system models include state models, ontology, activity and collaboration models, and use case models. Interactions are modelled with dialogue and communication models. Different languages are used to describe those models, for example, diagrammatic semiformal like Universal Modelling Language (Larman, 2002) or formal ones Z, VDM, B, ASM and Petrinets to name a few.

4.1.5. Development lifecycles

A development lifecycle organises different fundamental software development processes into phases and prescribes in what order they are carried out. In addition, a lifecycle may describe to what extent the software development processes are relevant and how they are implemented.

The current trend in software development lifecycle is in-line with the waterfall model, where there is a strict sequence of phases, is being replaced with more iterative and incremental lifecycles. The spiral model is risk driven as is the Unified Software Development Processes, which is additionally architectural and user-centric. Recently a class of lifecycle methods, such as DSDM, Extreme Programming (XP), Feature-based Development and a range of others have been termed as Agile Development (Cohen et al, 2003).

4.1.6. Emerging approaches

There are other emerging approaches that are of interest. The methods investigated or applied in Experience and Application Research also need to be suitable for the characteristics of ambient intelligence. It is suggested that the methods take ambient intelligence into account and consider the following:

- *Community-centred:* Focuses on human-human interaction mediated by technology includes, for example, distributed cognition that emphasises the interaction between humans as well as with other phenomena in the environment;
- *Problem oriented:* Finding solutions to problems instead of being purely technology driven. A balanced view is aimed for between problem and technology that iterates between the two poles;
- *Context-dependent*: Carried out in context for systems sensitive to context;
- *Mobile and transparent*: Entities are able to move between communities and cultures and changing roles;
- *Inclusive*: Tailored towards individuals, taking into account learning, growth and the changes of individuals;
- *Etc.*

4.2. Choosing the tools

The basis for organising the methodology we use in the research has been the work of Van Aken on *Management research based on the paradigm of the design sciences* (Van Aken, 2001). The reason for this is twofold:

- When starting the research, there has been a set of working hypotheses that we have made and which guided the conduct of the first preliminary results. As progress was being made, the lack of a strictly methodical framework that would take a route "by rigorous testing and grounding" was not considered as something that we assessed as value adding at that point. In contrast to this, we were more convinced that the value of the research was mainly to be found in characteristics that do not lie in the field of analytical experimentation. This reason correlated strongly with the following:

- Independently on this lack, we were in search of neighbouring areas with which the research would strongly be enhanced, either in terms of exploiting paradigms dominating the other neighbouring field, or in terms of validating the residual value that the research would have if applied in such an environment.

This investigation of other fields brought us to the area of intangibles. Having in mind that Situation Room is such a corporate intangible asset, an immaterial resource that can positively or negatively differentiate a company or an organisation with the competition and the market, we came across the work of Andriessen (Andriessen, 2004).

The author had relied on his work on the methodological framework of Van Aken as this was initially presented in (Van Aken, 2001). Going more into the details, we recognised that this same work was of high utility to the developed context as well. While many research studies are fixing the absence of a methodology in an artificial way, by means of e.g. adapting or collating parts of methodologies that add to the complexity and decrease the capacity to reuse the results of the research in other contexts, the fit of *Management research based on the paradigm of the design sciences* was proven to be extremely successful. (Looking back, we now see that there was a chance factor to this, of course; as many interesting things in life.)

According to Van Aken, the nature of the products of a given research programme is largely determined by its research paradigm, namely the combination of: research questions asked, the research methodologies allowed to answer them and, finally, the nature of the intended research products. There are obvious challenges in coping later with the methodology issue in a research exercise, and the table 6 below answers the differences in the positioning of the research in the current case of the use of the methodology (right column) and in the case we had tackled with this question in an earlier phase of the research (left column):

	With an early methodology	*During the course of the research*
Research question:	How can we organise multi-party collaborative decision-making activities	How can companies exploit the metaphor of a Situation Room to organise their knowledge-intensive product development tasks and activities
Research methodology:	Description-driven leading to the formulation of the Situation Room Analysis 'theory'	Prescription-driven in order to develop research products which can be used in designing solutions for real world problem solving
Intended research products:	Application(s) and implementation(s) of SRA	Development of knowledge to solve at least a class of product development problem[12]

Table 6 Early vs late methodology approach adoption.

Van Aken refers to the work of Beyer and Trice (1982); the latter give an in-depth analysis of the process of utilising management research results, where they distinguish between:

- adoption, i.e. the decision by decision-makers within the user system to use certain research results, and
- implementation, i.e. the actual use of the research results by members of the user system.

Another distinction made in (Pelz, 1978) is between instrumental and conceptual use of scientific knowledge; according to this distinction:

- instrumental use involves acting on research results in specific and direct ways, while in case of
- conceptual use the results are used for general enlightenment on the subject in question.

Similarly to Van Aken, in the research, primary interest is put on the *adoption* of management research results and management theory for *instrumental use* as shown in Table 7 below.

	Instrumental	*Conceptual*

[12] In Van Aken's own words: "Nor is it a plea to develop recipes, but rather a plea for the development of *tested and grounded technological rules to be used as design exemplars* of managerial problem solving."

Adoption	✓	
Implementation		✓

Table 7 Types of methodology usage in this research.

Referring once again to Van Aken's above mentioned work, the mission of a design science is to develop knowledge for the design and realisation of artefacts, i.e. to solve *construction problems*, or to be used in the improvement of the performance of existing entities, i.e. to solve *improvement problems*.

It is in this respect that each time a professional sets out to solve a unique and specific problem for a client, or in conjunction with a client, he or she does so by using the *problem solving cycle*, also called the regulative cycle (Van Strien, 1997). This cycle consists roughly of:

- defining the problem out of its "messy" context,
- planning the intervention (diagnosis, design of alternative solutions, selection),
- applying the intervention and
- evaluating.

The essence of professional work is designing, planning an action in advance or during the action and the outcome of this process is a design, which can be defined as a representation of a system or process to be realised.

In general, a professional will make three designs:

- an *object*-design, the design of the intervention or of the artefact; this is in our case the case of the Situation Room metaphor;
- a *realisation*-design, i.e. the plan for the implementation of the intervention or for the actual building of the artefact, which in our case corresponds to the aspects that related to the adoption of the Situation Room for a 'class of managerial problems', and finally
- a *process*-design, i.e. the professional's own plan for the problem solving cycle; or, put differently, the method to be used to design the solution to the problem, which in the case of the research corresponds to the

instrumental use of Situation Room as a means to improve corporate performance in the selected domains.

The typical research design to study and test technological rules is the multiple cases: a series of problems of the same class is solved, each by applying the problem solving cycle. Design knowledge is built up through the reflective cycle:

- choosing a case,
- planning and implementing interventions (on the basis of the problem solving cycle),
- reflecting on the results and
- developing design knowledge to be tested and refined in subsequent cases.

In developing and testing a technological rule through the multiple case and in analysing its effectiveness through the cross-case analysis during the reflective cycle, one can gain insight in the indications and counter-indications for the application of that rule and hence also in its particular application domain.

As a technological rule is typically not totally general, but applicable to a certain application-domain, a class of problems, a key criterion for distinguishing research results is justification; more specifically, the effectiveness of an algorithmic technological rule (applied as a recommended practice) can be proven conclusively in deterministic terms. But the indeterminate nature of heuristic rules - and most technological rules in the field of management will be heuristic - makes it impossible to provide such conclusive proof. However, through multiple case-studies one can accumulate supporting evidence which can continue until "theoretical saturation" has been obtained (Eisenhardt, 1989a and 1989b).

Below we elaborate on the main elements of the research methodology.

4.2.1. User involvement

The idea of involving users in development activities is of course not entirely new. The issue of user involvement and participation has arisen in different contexts over many years: organisational design, architectural design, software engineering, town planning, and so on. Software development is another field where much has been written about user participation. As far back as 1977, (Gane and Sarson, 1977) were advocating the need to improve involvement of users in software development. They proposed a spiral method for this purpose. Similar ideas then reappear in later years (Floyd and Keil, 1983) and (Boehm, 1988).

In the area of human-computer interaction, an approach called user-centred design regards the early involvement of users as a basic principle. The focus is generally on early testing and evaluation with users to ensure that a system is designed to meet their needs. The problem of understanding and defining user needs and expectations is at the centre of design, and the difficulties of this are discussed in the design literature. Various tools have been devised to assist designers, such as quality function deployment. But there are also others, and direct involvement of users is one of these. Novel design processes have been developed to deal with this.

Most people are aware of stage-based sequential design methods, where one phase follows on from the proceeding one, with iterations between steps. For some design problems a stage-based sequential process is satisfactory. But there are circumstances where they are not, and for these, other approaches such as incremental or adaptive design methods can be used. The spiral software development methods mentioned above, are examples of adaptive design methods.

An important tool in many of these methods is prototyping.

4.2.2. Experience prototyping

Prototyping has played an important role in most examples of user involvement in design. Prototypes provide a tool for classical evaluation of users' reactions to systems and their satisfaction, and they can be a useful way to measure the effectiveness and efficiency of users' tasks. Prototypes can further be used to observe cognitive tasks, such as users' attention and perception. They allow developers to test new ideas either in a laboratory setting or in more realistic contexts. Prototypes come in different forms. First there are full prototypes that contain complete functionality, but provide less performance than a completed system. Second there are horizontal prototypes that demonstrate operational aspects but do not provide full functionality. Finally there are vertical prototypes that contain full functionality for a restricted part of the system.

There are also different types of prototyping methods. Requirement animation prototyping uses tools that assist designers to demonstrate design possibilities to users. Rapid or throwaway prototyping focuses on collecting information on requirements, recognising that initial requirements may be inaccurate and therefore need to be checked with users. Prototypes, once finished with, are then discarded. Evolutionary prototyping seeks to build a system in an evolutionary way, with refinements being added over time. In this way the final design emerges over a period of time. This should be contrasted with incremental prototyping, where the system is built one step at a time, but to a design established at the beginning. Developers have to choose which prototyping methods and tools to use, and how much time and money can be invested in prototype development, based upon the objectives of constructing the prototypes.

Prototypes enable an approach called *experience prototyping* (Buchenau and Suri, 2000). This provides the opportunity for design team members, users and other interested groups to gain first-hand appreciation of existing or future conditions. Experience prototyping can be used to understand existing user experiences and their contexts, analyse and evaluate new designs, and communicate ideas to designers and stakeholders. Experience prototyping tests user interaction with technology. It involves users actively engaging with a prototype and examines how they use it. There is emphasis on the way people communicate in the presence of the prototype in a natural environment. A key aspect of experience prototyping is the way user group behaviour is observed with tangible interfaces, so that users can reflect on the design and improvise. Experience prototyping places emphasis on the quality of users' interactions and experience, and less on the pure functionality and technology of the solution. Therefore the approach is well suited to the goal in ambient intelligence of addressing users' needs in the context of socio-economic problems and activities.

As corporate intelligence scenarios become more complex, it is also possible to see how further development of the experience prototyping approach can make an important contribution towards making highly innovative, yet complex and abstract ideas, physical and understandable.

Nevertheless, a number of research challenges must also be addressed for experience prototyping to fulfil its promise. In particular there is a need to:

- integrate prototypes with model-based user interface design, thus satisfying both users and developers;
- develop a lifecycle for prototypes supporting different abstraction levels and fidelities;
- annotate prototypes with higher level information such as the results of performances, user testing, expert evaluation and participatory evaluation;
- develop exploration and evaluation methods of prototypes that integrate cognitive processing, system tasks and the interaction between them.

SRA application can provide the means of implementing experience prototyping, and further developing the concept, in the context of corporate intelligence research and development. For this, we elaborate in the next section regarding the facilities needed for such an implementation of experience prototyping.

4.2.3. Facilities for experience prototyping

To solve a problem in a particular domain, there is a need to build a system that will be introduced into the domain. The system may replace some work already performed in the domain by other systems or manually, or the system introduces new tasks that were not possible to perform previously.

To understand what problem is to be solved, skills and tools are needed to quickly understand the application domain, that is to say, *analysis* tools. These tools abstract the problems and yet describe contextual or situated details. Tools will help developers define the scope of the problem. Different types of contexts are considered: temporal, spatial, social (actors), technological, organisational, etc., and in each case the scope within each context is examined. Some problems are already obvious, but others need to be detected to create innovation. Part of the problem definition is analysing the criteria according to which solution will be validated.

Knowledge management and elicitation tools are needed. Either existing knowledge resources are built upon, or knowledge is elicited through observations, interviews, surveys, and questionnaires that produce qualitative and quantitative data. Tools are needed that help do this more automatically than before. For example, pattern detection of behaviours, eye tracking, sensors, etc. Tools are also needed to transform the qualitative and quantitative knowledge into more formal domain or problem models.

Traditionally, analysts extract this knowledge from the domain, but SRA application can also enable users to suggest problems that need to be solved: pushing problems to designers. This can be organised as a problem library, much like a science web that accepts questions about science and technology. When the new system is introduced to the domain, it will interact with the domain, for example, receive input and produce output. To understand how other actors (systems or humans) in the domain will activate the new system, and react to it, tools and techniques are needed to understand the interaction.

When a new system is built to solve the problem, it needs to be built based on current science and technology. However, it is also necessary to look ahead and see how the new system can advance knowledge, increase effectiveness, efficiency or satisfaction.

To sketch a solution for a problem, abstract ideas of what information it will use, what information it produces and what goals it has, will be produced. These are conceptual ideas of the new system. Experience prototypes have been used to test ideas by asking actors to execute the tasks. Prototypes are used for artefacts and can indeed be very abstract in the beginning and then evolve to more detailed ones at the design stage. To build the system *synthesis* tools are needed, for example, models of the new systems. The models need to be capable of being validated.

Prototypes are one type of a model. Scenarios or storyboards are another type. Models of entities, navigation or contexts are yet another. There will be several types of models to describe different aspects of the system. When the system is installed into the domain there is a need to validate a previously built model. To install the system *validation* tools are need. The validation tools need to record the actions of the system and reactions of the interacting systems. The validation tools need to feed data to the models for comparison. The inconsistencies between the expected behaviour of the models and the actual ones will either stimulate updates of the models or the interacting systems. Thus the feedback in the validation phase is a problem that needs to be worked on more heavily. Digital libraries and validated web resources in general will be an important tool.

The scope of the design will be different in SRA application than previously, because it will enable *collaborative* design among groups and this will also span interdisciplinary teams. The tools of SRA application will be different because intelligent processing of empirical data will be needed, and the aim should be to use this as a basis for automatic design and validation. SRA application also emphasises strong *visualisation* of experiences. More complex criteria will require tools that can evaluate different design solutions to meet many and sometimes, conflicting, criteria. Also, action research will be used and this will turn industrial partners into a laboratory. Activity theory will also be important, placing the emphasis on the artefact.

4.2.4. Challenges

If user involvement in research, development and design is recognised as being important, then why is it not widespread industrial practice? One reason suggested for this is the cost and effort argument.

User involvement adds costs and effort to the process. But is this true? Or is it the case that user involvement changes the cost-effort profile over the lifecycle of a product? Perhaps it shifts cost and effort that arise in after sales activities such as customer services, maintenance, etc. up-front to the research, development and design departments? Perhaps it increases costs and effort up-front, but reduces them across the full lifecycle of the product?

Another suggestion is that involvement of users has never been institutionalised into the education system and the values of society. As a result, the idea has never taken root. Industrial society is founded on specialisation and division of labour. There are many of these: managers and workers, business executives and technical experts, strategist and implementers, technologists and social scientists, and so on. The separation of designer and user is just one of these divisions. It is possible therefore that until the integration of users and designers is institutionalised, the matter of user involvement will continue to be discussed into the future. Whatever the reasons for user involvement not being a widespread industrial practice in the way envisioned, there is certainly a barrier to acceptance that needs to be addressed. This implies dealing with important but challenging matters such as culture, norms and values, departmental budgets, and cross-departmental working.

4.3. Overview of the research approach

A research approach was designed and adopted at the beginning of the research process that built on the approach of (Roberts, 2002) in order to provide structure and guidance for the work to be undertaken.

The diagram given in the Figure 5 below outlines the main components of the research approach:

1. **Researcher's corporate decision-making experience:** The perceptions, beliefs and interpretation of the researcher were inevitably influenced by previous experience, which included earlier industrial experience as a research assistant, subsequent consultancy experience with decision science and technologies and recent research management in both the academia and the industry.
2. **Literature search:** An in depth initial literature search was carried out in order to determine the questions that were most significant for the topic.

   As the research progressed the literature was revisited to further explore emerging themes as well as to ensure an understanding of new developments in the topic area.
3. **Underpinning theories:** Game theory provided a theoretical structure for insights into the impact of multi-party collaboration on both intra- and inter-organisation relationships and offered an economic perspective on the organisational decision-making relations.

   Ontologies also provided a valuable contextual setting for the enabling role they may have in organising and documenting collaboration while intangibles management and reporting as well as knowledge management and learning theories provided a means of understanding the implications of the Situation Room application processes within the corporate environment.

4. **<u>Questionnaire:</u>** An initial questionnaire was used in the context of focus groups with participation from industry. This provided initial data on the perception of the benefits and issues concerned with early implementation. The questionnaire was followed up by interviews to follow up some of the responses that needed further clarification.
5. **<u>Interviews and observation:</u>** Semi-structured interviews were carried out with various stakeholders. These were iterative in that different aspects were revisited over a period of time and also in the sense that follow on interviews sought to clarify issues raised through observing stakeholders and the questions and concerns that they raised at meetings and workshops.
6. **<u>Documents:</u>** A variety of documents ranging from internal memos to company newsletters provided a useful source of information on the expected benefits and the culture of the organisations.

   Valuable insights were gained by examining the gap between the language of the documentation and the actual practice in implementing collaborative multi-party decision-making.
7. **<u>Workshop sessions:</u>** as described separately in Section 4.4 below, the role of the undertaken workshop sessions during which the 5 explorative application scenarios were explored has been central not only to the testing of the hypotheses and the building of the SRA theory, but also for grounding the research findings. It is one thing to give the 'right' answers to a question, and another equally important matter to ask the 'right' questions. In this respect, the involvement of practitioners from the industry to the conducted application scenarios, did not only increase the credibility of the research results, but also enriched the original research field.
8. **<u>Hypothesis testing and theory building:</u>** A number of hypotheses formulated from the literature search were tested against the findings and conclusions. This enabled further insight into the acquired material by bringing to bear for comparison purposes the key aspects from the literature as well the specific findings of the individual cases.

This process enabled an element of theory adaptation and the incremental development of a framework that highlights the holistic nature of the interdependencies concerned with multi-party collaborative decision-making in the corporate environment.

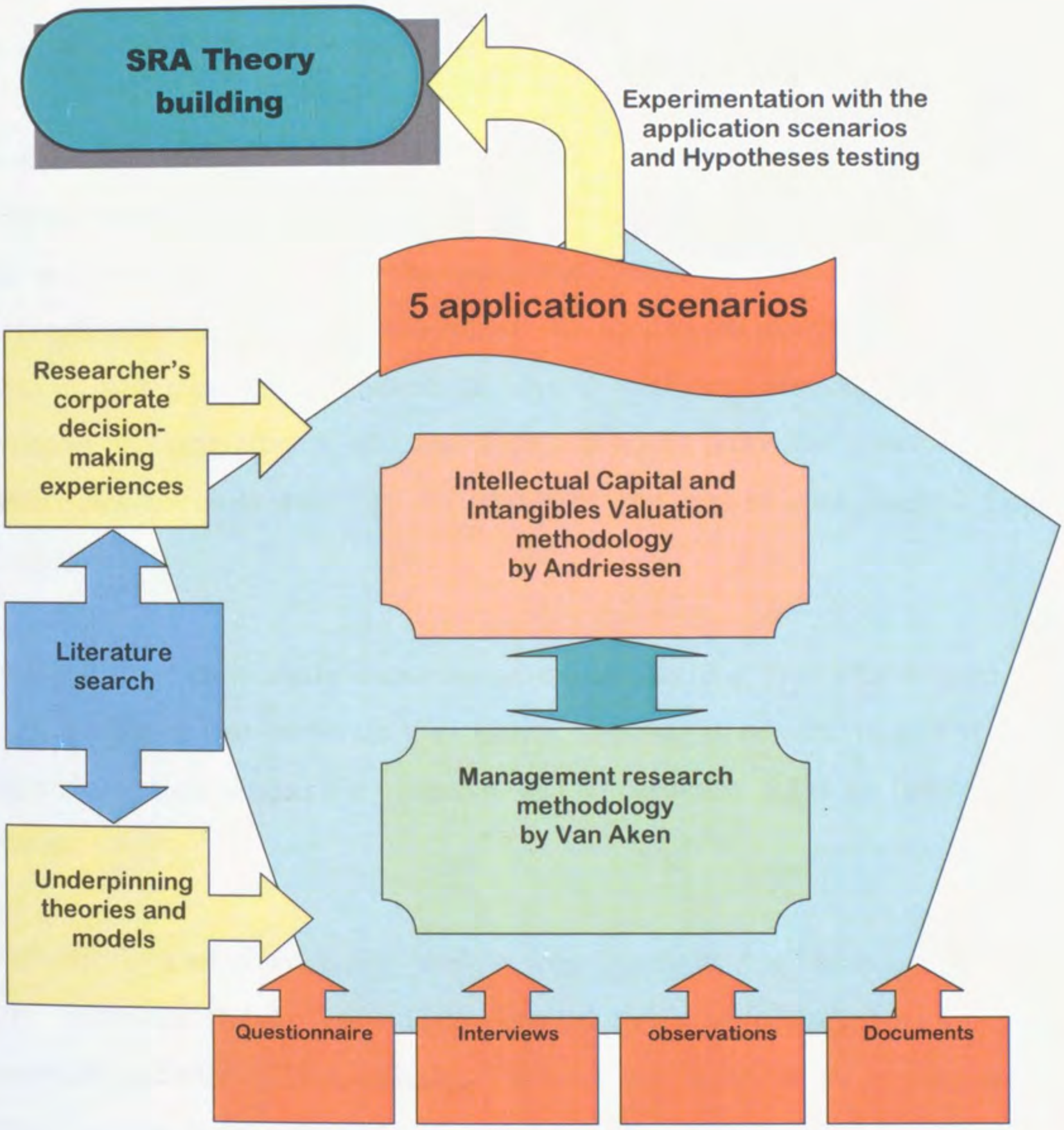

Figure 5 Main components of the research approach.

4.4. Organization of the workshop sessions

The literature review aimed to determine the questions that were most significant for the research topic, and enabled a set of sharper and more insightful hypotheses to be developed about the research area, in which the initial literature search was supplemented by further reading as the research continued.

In parallel to the literature review an initial questionnaire was developed, which is included in Appendix 2, and which provided initial data on the perception of the benefits and issues concerned with the implementation of Situation Room Analysis in the corporate environment. The questionnaire was used as the main tool for collecting information, was used in the context of several workshop sessions with industry professionals and practitioners, and was followed up by individual communications and interviews to close the gap for some of the replies that needed further clarification.

This was felt to be particularly important given the fact that the methods used were primarily qualitative and exploratory in nature, and that an eclectic mix of theories, models and methods guided the research within particular areas as deemed most appropriate.

More specifically a set of workshop sessions were jointly held in Thessaloniki, Greece with the Innovation Relay Centre Help-Forward (www.help-forward.gr) where we had invited an audience of 23 companies. The table 8 below provides an overview for the roles as well as the number of the participants in the workshop.

Nr.	*Title of the participating organisation*	*Area of business*	*Role of the participant in the organisation*
1.	Institute of Agrobiotechnology, Centre for Research and Technology - Hellas	Research	Research Project Manager
2.	Hellenic Phosphate Industry S.A.	Industry – fertilizers and chemicals	Vice President
3.	Controla S.A.	Industry – embedded and integrated systems	Director of Research
4.	PYRAMIS S.A.	Industry – kitchen and	Production Manager

		house utensils	
5.	MEDI FOODS S.A.	Industry – food processing and wholesales	Sales Director
6.	VORIOELLADIKI AHEPEY	Industry – financial services	Service development Director
7.	Technic for Life Ltd.	Industry - medical implants	Project Manager
8.	VITRO Hellas S.A.	Industry -	Sales Director
9.	Nitrofarm Ltd.	Industry – nitrous fertilisers	Business development area manager
10.	ARI Ltd.	Industry - adhesives	Director of Research
11.	Hatzopoulos S.A.	Industry – flexible manufacturing and packaging	Production Manager
12.	Hellenic Logistics Society	Industry – not for profit association for ligistics applications	Liaison Officer
13.	AMPELOOINIKI S.A.	Industry – wine industry consultants and technology brokers	Director of Research
14.	EYATH S.A.	Industry – water supply	Director of Technical Services
15.	MEVGAL S.A.	Industry – dairy products	Production Manager
16.	Institute of Telematics and Informatics, CERTH	Research	Project Division Manager
17.	MINOS S.A.	Industry - boiler manufacture and sales	General Director
18.	ELITHERM S.A.	Industry – copper piping and heaters	Production Manager
19.	AMASA S.A.	Industry – frozen fish processing	Financial Director
20.	Xifias S.A.	Industry – salted fish processing	Management / Shareholder
21.	SYFA Kavalas	Industry – pharmaceutical cooperative	General Director
22.	Heletel Ltd.	Industry – e-commerce service solutions	Management / Partner
23.	ELVITIL S.A.	Industry – telcom cable manufacturer	Management / Shareholder

Table 8 Participating organizations in the workshops and roles of the individual participants

The Greek IRC Help-Forward (Hellenic Project For Wider Application of R&D) is a strategic alliance between Industry & Research in Greece; the respective shareholders are the Foundation for Research and Technology – Hellas (FORTH) from the research side, and the Federation of Greek Industries (FGI) and the Federation of Industries of Northern Greece (FING) from the industry side.

Its aims comprise the promotion of transnational technology transfer to Greek Small and Medium-sized Enterprises, the utilisation and exploitation of research results, the economic growth and employment through use of new technologies, the strengthening of the links between research, industry and finance, and last but not least the promotion of innovation in enterprises and entrepreneurship in research centres.

The Help-Forward IRC is member of the European network of Innovation Relay Centres (IRCs). The first Innovation Relay Centres were established in 1995 with the support of the European Commission. The aim was to create a pan-European platform to support innovation and trans-national technological co-operation in Europe with a range of specialized business support services. IRC services are primarily targeted at technology-oriented small and medium-sized enterprises (SMEs), but are also available to large companies, research institutes, universities, technology centres and innovation agencies.

For the purposes of our research and the need for a tight coupling of the research with industry and business input, the IRC Help-Forward was assessed as an ideal vehicle for providing the linkage with the industry. For doing this, we chose to adopt an adaptation of the *case-study* approach that made use of a set of workshops to organize a hand-on application of the SRA concepts and methods, with the participation of a representative set of industrial audience. The latter had the opportunity to experience a hands-on exposure on SRA by means of participating in the shaping of 5 product development application scenarios.

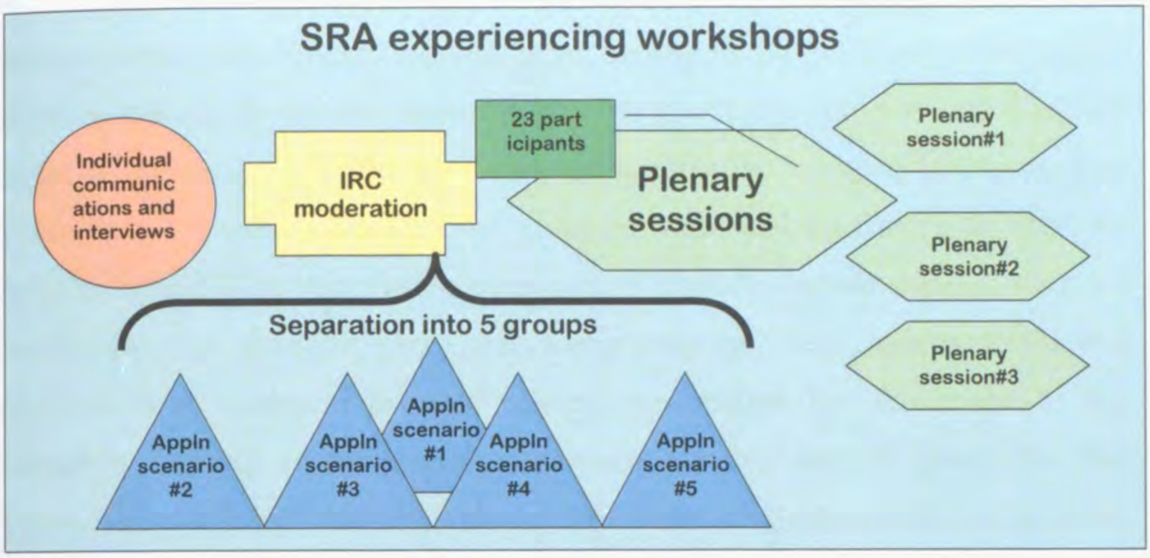

Figure 6 Modalities used for the SRA experimental sessions.

Figure 6 above depicts schematically the relative positioning of the different 'modalities' that were used for the conduct of the workshops. More specifically, it was through the IRC moderation that our communications with the 23 participants have taken place in the form of the three conducted plenary sessions. In each of them the separation into different groups for work in each of the five different application scenarios has taken place, while individual communications and interviews with the participants and their colleagues in their own working environments has taken place in a different time.

According to (Klein and Myers, 1999) the case study research method is the most widely used qualitative research method in IS research and also argued that the method is particularly appropriate for the study of IS development, implementation and use within organisations. In arguing against past criticisms of case studies as having insufficient precision (i.e. quantification), objectivity and rigour, (Yin 1994) claims that major criticisms of case study research are misdirected and that case studies are the preferred strategy when 'how' or 'why' questions are being posed, when the investigator has little control over events and when the focus is on a contemporary phenomenon within some real life context.

Yin also argues that case studies can be generalised to theoretical propositions rather than to populations or universes. The case study does not represent a sample and the goal is to expand and generalise theory through analytical generalisation rather than to enumerate frequencies through statistical generalisation. Yin (1994) points out that the case study strategy should not be confused with qualitative research and that case studies can be based on a mix of qualitative and quantitative evidence. In this research the case study method has been used to cover contextual conditions as they are believed to be highly pertinent to the phenomenon of study. In their study, Eistert and Kramer (1996), for example, claim that case studies may help unearth details that would have been neglected in other research approaches. For this research, this advantage is believed to more than compensate for any lack of generality. The Situation Room Analysis implementation process in a single company can be much better understood if the history and specific circumstances over a given period in time are taken into consideration.

The case study's unique strength is its ability to deal with a full variety of evidence such as documents, interviews and observations. The multiple perspectives, methods and observations in the studies also provide a strategy of triangulation to add rigour, breadth and depth to the investigation. (The assumption, for example, that a corporate employee speaks reliably on behalf of the company i.e. the principal-agent problem is addressed through cross-referencing to company documentation concerning methods and principles of working.) The simple fact that what people say and what people do is not necessarily the same thing is also taken into consideration through observation and cross checking with the perspectives of others involved in various transactions in different settings. Evidence from the case studies highlighted many instances of the disparity between the language used to articulate the desire to collaborate and the corporate reality of how decision-making is exercised in implementing the practice. However, sufficient evidence has been collected that supports the efficacies of using SRA as a collaboration infrastructure for carrying out multi-party IT Product development.

A strong emphasis on qualitative research has been taken as the research seeks to describe and understand how people make sense of their world. Walsham (1993 and 1995) emphasises the research value of interpretive case studies and places the importance of generalising in context by asserting that the validity of an extrapolation from an individual case or cases depends not on the representativeness of such cases in a statistical sense, but on the plausibility and cogency of the logical reasoning used in describing the results from the cases, and in drawing conclusions from them. Such an interpretivist approach leads to the possibility of generalisation in terms of development of concepts, generation of theory, identifying specific implications and contribution of rich insight. Part of the research process involved capturing data on the perception of the 23 subjects involved. This is particularly pertinent to the study as different stakeholders have different perceptions of a system based on their different agendas and with perspectives emanating from different organisational cultures.

Efforts were made to overcome the multiple sources of analytical bias that could weaken or invalidate findings. Miles and Huberman (1994) identify three main potential biases. These include

- holistic fallacy where events are interpreted as more congruent than they really are,
- secondly elite bias where too much weight is given to data from high status respondents and, finally
- the loss of perspective through being co-opted into the world of the respondents.

However, the risk of analytical bias was marginally relevant to our case as the main aim from our side was to expose them to the framework of Situation Room Analysis as this is presented in the following Chapters, and have them taking active part in the assessment and hypothesis validation exercise, according to which the participants would be able to conceptualise problems and situations faced within their daily work, for which the learning process is extremely demanding.

Working in small groups of 4 to 6 persons, three passes were conducted on the same questions with certain activities or discussions taking place before and after each one and aiming to increase the participants' capacity of relating the concept of SRA to situations with which they are familiar in their individual working environments. Though critics of small-group learning often point to problems related to vague objectives and poor expectations for accountability, we felt that this was the most efficient approach to employ, as experienced also by the work and methods used by (Andriessen, 2004).

Initially the group members were exposed to the concept of SRA, and were given a brief introduction, ask some general questions that helped them better understand what does this have to do with, feel more comfortable with the terminology used, etc. After this first step, they were asked to fill out the questionnaire of Appendix 2, which relates to the validation of the research hypotheses. After completion, they worked extensively with the entire group on improving the understanding of the terms and notions of SRA, developed some example cases and supplied the participants with enough information to apply this in their contexts of work, and they were asked to answer the questionnaire of Appendix 2 for the second time, without having access to their previous answers.

Finally, they separated in 5 groups with assignments for each of the 5 application scenarios, and the task to organise their group communications fully using the SR concepts and methodologies. After this, they were asked to answer the questionnaire of Appendix 2 for third time.

There are obvious changes in the answers they provided which is a very normal thing to happen, and which, according to our opinion strengthens the validity of the results.

In the next Chapter 5 we present the results we received from the participants. There are two ways to look in the results:

- ***Examine the change between each different step***, i.e. the progress and evolution between the 1st initial pass to the 2nd and 3rd ones. This is the more expected way to look at the results and reasoning can take place in a straightforward fashion.
- ***Examine the change within each of the five groups*** regarding each of the three steps, and especially the discrepancies appearing after the separation into the 5 groups with respect to the application scenario assigned to each of them. As already mentioned above, while the first two passes were common for all participants, the last pass was completed after the

participants were grouped in 5 mini-teams each of them responsible for one of the five application scenarios.

The difference in this relates to the application field, its nature and specifics that are different for each case.

The table 9 below provides an overview of the techniques employed for each of the 5 application scenarios. It is easy to see that there is a certain degree of overlap amongst them; customization and adaptation for each of the application scenarios was driven either for practical mainly reasons or for purposes related to coherence and comprehensibility.

Application scenario Employed means	Problem Solving in Complex Product Development Projects	Collaborative Authoring, Publishing and Delivery of Multimedia Content	Individual Learning and Corporate Content Management in Industry	Knowledge Sharing and Management in Professional Virtual Communities	Augmented Reality and Experiential Systems in Remote and Rural Areas
Elements of data collection	• Focus group plenary sessions • Semi-structured interviews • Informal interviews • Documented – evidence-based – review • Memos • Videos and file notes • Press cuttings • Other archival data	• Focus group plenary sessions • Semi-structured interviews • Informal interviews • Video files • Other archival data	• Focus group plenary sessions • Semi-structured interviews • Informal interviews • Observation • Documented – evidence-based – review • Memos • File notes • Other archival data	• Focus group plenary sessions • Observation • Documented – evidence-based – review • Memos • File notes • Other archival data	• Focus group plenary sessions • Informal interviews • Memos • File notes • Other archival data
SR topics	• Nature of the product development process • Personal perceptions • Ideal perceptions • Situation as-is in the corporate environment • Perceptions of optimality • Perceptions of suboptimality • Use of collaborative	• Nature of the product development process • Personal perceptions • Situation as-is in the corporate environment • Use of collaborative mechanisms – internal or external • Resources leverage (human, technology, capital,	• Nature of the product development process • Personal perceptions • Ideal perceptions • Situation as-is in the corporate environment • Perceptions of optimality • Perceptions of suboptimality • Use of collaborative mechanisms – internal or	• Nature of the product development process • Personal perceptions • Ideal perceptions • Situation as-is in the corporate environment • Perceptions of optimality • Perceptions of suboptimality • Use of collaborative mechanisms – internal or	• Nature of the product development process • Personal perceptions • Situation as-is in the corporate environment • Use of collaborative mechanisms – internal or external • Resources leverage (human, technology, capital,

	mechanisms – internal or external • Role of metaphors • Role of soft skills • Role of culture • Perception(s) of / on performance (team and corporate level)	organisational) • Role of metaphors • Facilitators and barriers to exploration of significant episodes (reference scenarios)	external • Role of metaphors • Role of soft skills • Role of culture • Facilitators and barriers to exploration of significant episodes (reference scenarios) • Perception(s) of / on performance (team and corporate level)	external • Resources leverage (human, technology, capital, organisational) • Perception(s) of / on performance (team and corporate level)	organisational) • Role of metaphors • Facilitators and barriers to exploration of significant episodes (reference scenarios) • Perception(s) of / on performance (team and corporate level)
Information acquisition	Representative selection of focus group participants from industry including: • IT project personnel and R&D staff • Key corporate team members • Project managers • Researchers / scientists • Consultants	Representative selection of focus group participants from industry including: • IT project personnel and R&D staff • Key corporate team members • Project managers • Researchers / scientists • Consultants	Representative selection of focus group participants from industry including: • IT project personnel and R&D staff • Key corporate team members • Project managers • Researchers / scientists	Representative selection of focus group participants from industry including: • Project managers • Researchers / scientists • Consultants • Field practitioners and end users	Representative selection of focus group participants from industry including: • IT project personnel and R&D staff • Consultants
Validation procedure	Individual for each member, followed by a 'batch' validation by the entire group	One procedure same for all members of the focus group	Individual for each member, followed by a 'batch' validation by the entire group	One procedure same for all members of the focus group	One procedure same for all members of the focus group

Table 9 Summary of the techniques and information acquisition approach for the 5 application scenarios.

4.5. Synopsis

We presented and justified the methodology that we followed to conduct the research which builds on user involvement and experience prototyping. The methods used were primarily qualitative and exploratory in nature. The research was conducted through a direct and prolonged contact with participants from the industry in a selected set of five application scenarios, and as part of equal in number focus groups, in order to gain an integrated overview of the validity of the research propositions.

The approach taken is holistic and makes extended use of input from end users to validate the research hypotheses and support the proposed SRA concepts, as shown in the next Chapter.

5. Research findings – results from the workshop sessions

Based on the description provided in Appendix 1 for each of the selected business domains on which the product development application scenarios are focused, and the outline of a reference future ('2015') scenario, participants of each group related with the corresponding application scenario had to organise information on the addressed field. This involved the development of new product for the application area under consideration by means of employing the SR concept and guiding principles of application, in form of a service accessible by the corporate users involved in the process of new product development.

Below in Section 5.1 we present the results of the hypothesis testing and validation procedure. More elaborate material that was produced during the workshop sessions in terms of the ideas, opinions and 'collective content' that were created during them can be found in Appendix 6. For completeness reasons, we have supplemented the material with references to related bibliography and improved the structure to improve readability and further processing. Due to resources limitations, not all scenarios are equally developed, as for practical reasons the depth of analysis work was not sufficient to cover all five of them. However, and for consistency reasons we preferred to cover a larger variety of different application contexts, in order to better examine the limits of SRA application and gain more insight on the true adoption possibilities.

Section 5.2 present the conclusions drawn. Section 5.3 reports on an assessment exercise that was carried out parallel to the application scenario workshop sessions and which provides some first valuation of the utility of the SRA application in the corporate environment.

5.1. Hypotheses testing and validation

We came to the idea of structuring the hypotheses testing by means of a workshop-based approach as described in Chapter 4, instead of the (simpler and easier to organise) type of an investigation based on the distribution of the questionnaire to a set of recipients. The reason was that this would invaluably enhance and exploit the most important element of a Situation Room namely the interactivity part. It was a fortunate event the availability of resources from the Innovation Relay Centre Help-Forward that enabled the organisation, the hosting, the conduct of the workshops, as well as the post-workshop secretarial support.

As described in Section 4.4 regarding the organization of the workshops, there was a clear guidance to the participants that was helpful for us to recognize and separate the validity of each of the hypotheses made.

The filled out questionnaire can be found in Appendix 3. Comments and remarks on the results for each of the five hypotheses accompanied by comments and some preliminary conclusions are provided in the next Section.

5.1.1. First hypothesis

At first, we recognise that the three iterations in the completion of the questionnaire, as organised, i.e. initially, after a first exposure to the SRA concepts and finally after the participants have performed an SR session as part of their particular application scenario group, were of value as there is an obvious change in the attitudes of the respondents, in favour of the proposed concepts.

Below, we present the chart of question 1.1 that in general concerns the familiarity with the notions of metaphor.

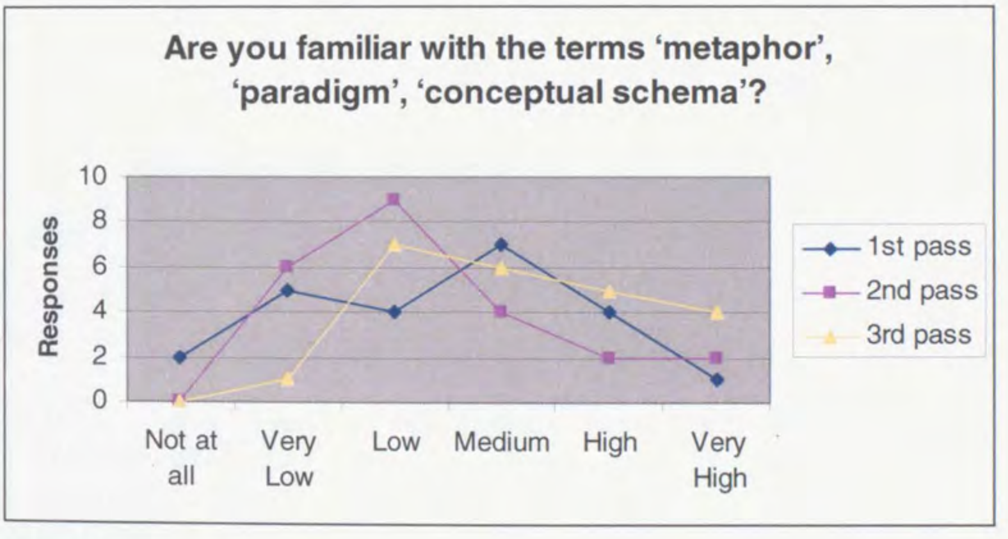

Chart 1 Question 1.1

Below, we show the respondents' attitude towards the degree they feel are daily exposed in metaphors in their daily life and within their work.

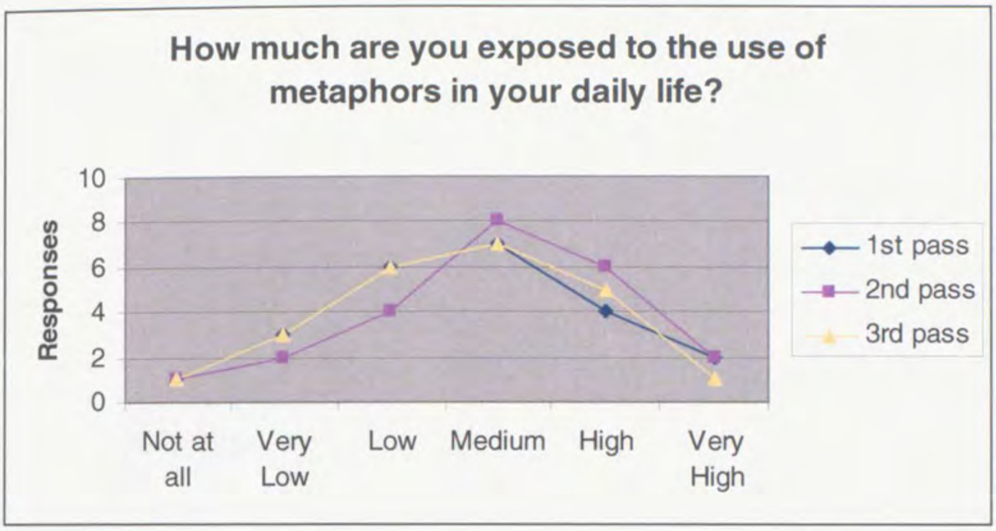

Chart 2 Question 1.2

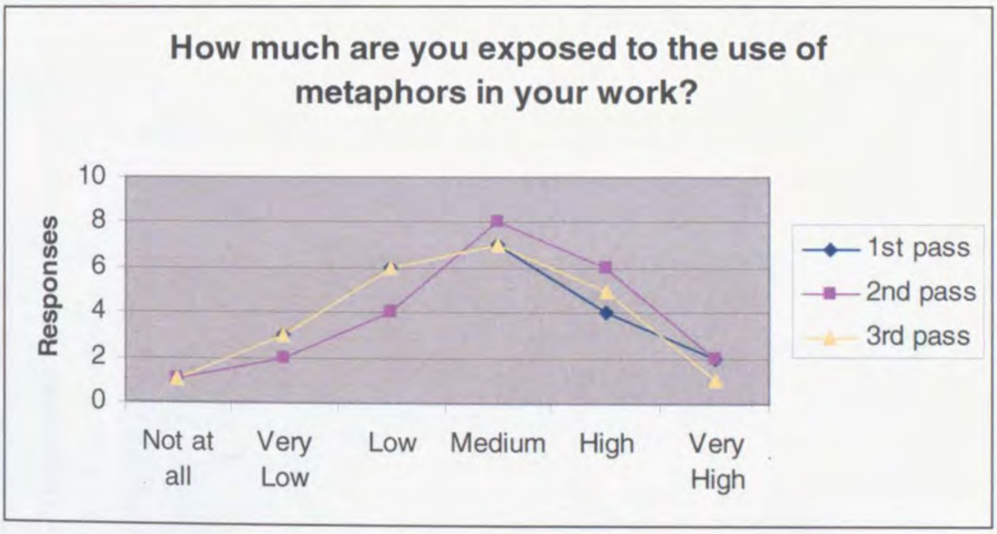

Chart 3 Question 1.3

As it is easy to see, it is the same trend that is followed in both cases, according to which people feel moderately exposed to the notion of metaphors in their professional and personal lifes.

However things change when we come to the valuation of the attitudes of regarding the role of metaphors in the daily work tasks of people and their overall assessed value they bring to the accomplishment of tasks. For both there is a definite shift in the attitudes of the respondents towards a more positive assessment after their exposure to the SRA concepts and especially after their involvement in the experimentation with the application scenarios.

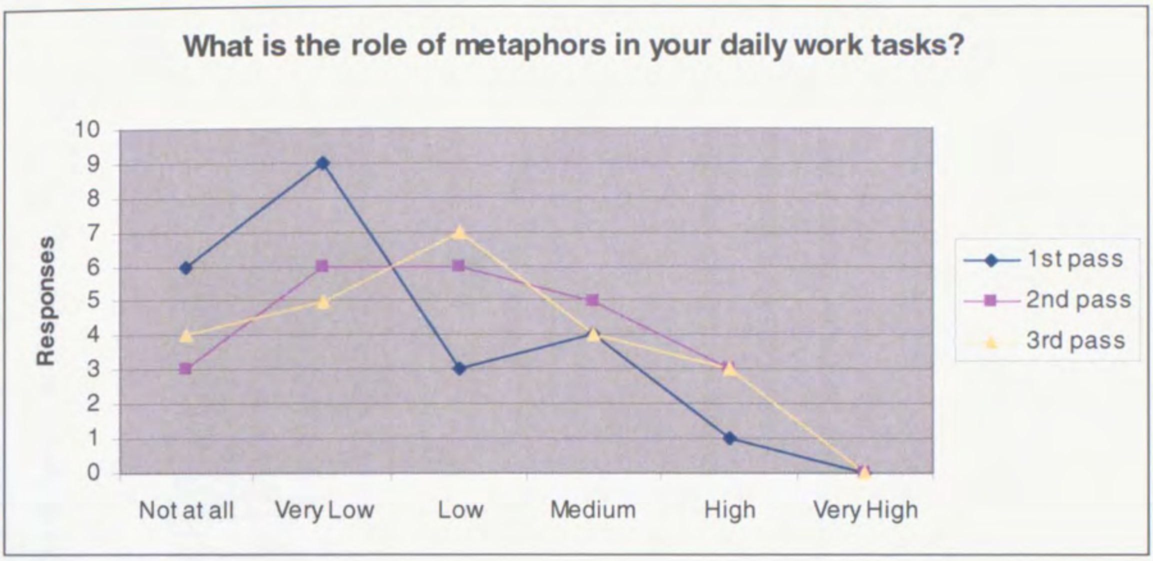

Chart 4 Question 1.4

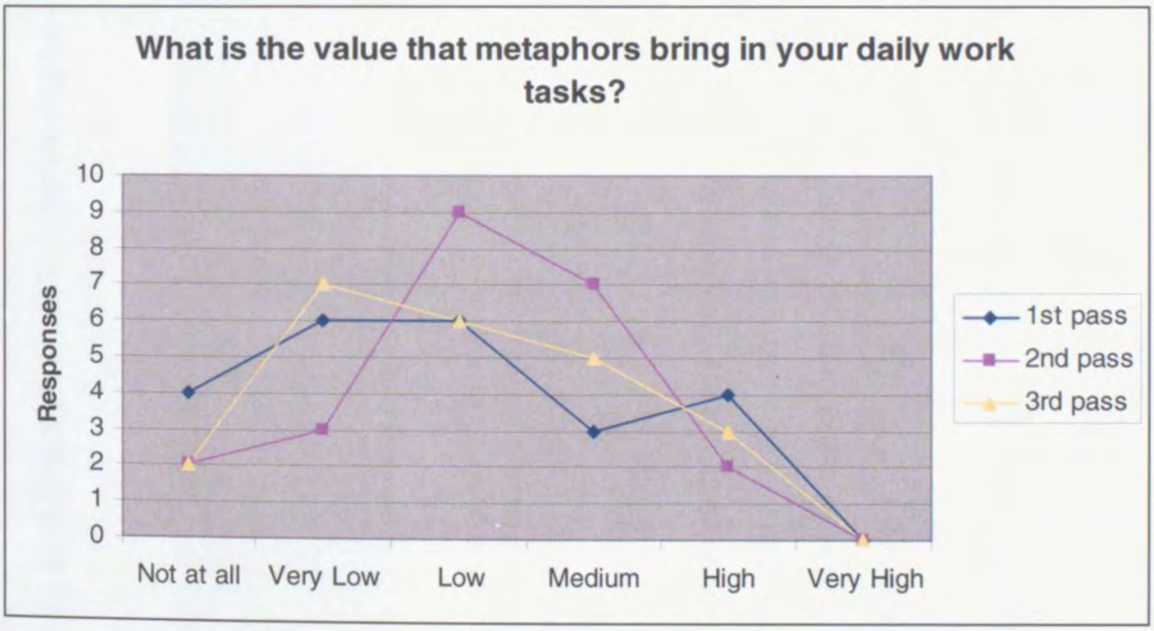

Chart 5 Question 1.5

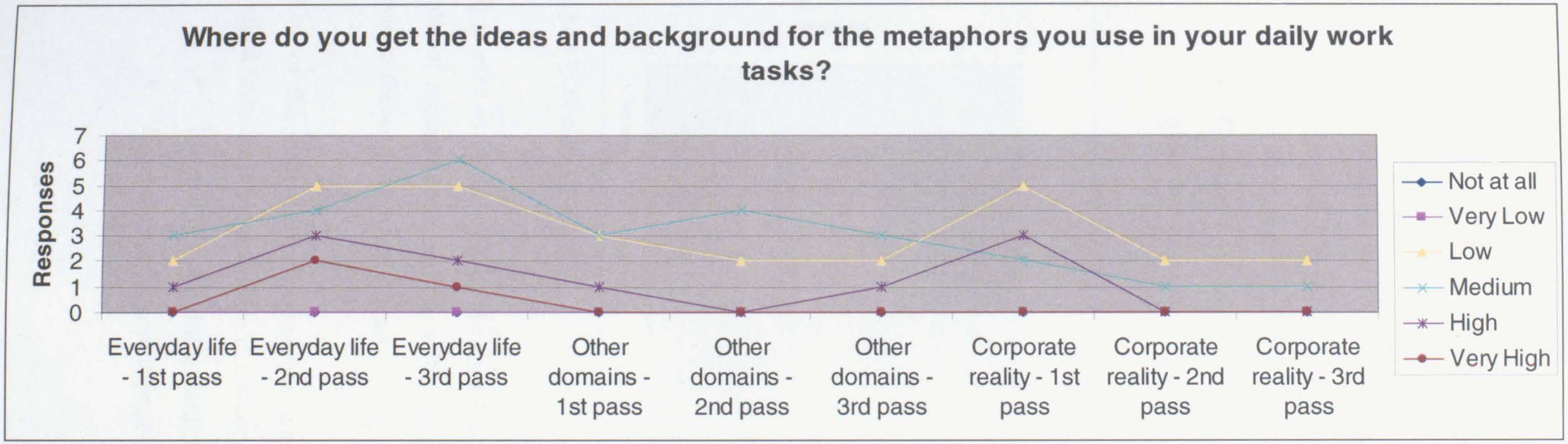

Chart 6 Question 1.6

Question 1.6 is different from the previous ones in terms that it asks the respondents not to only quantify an attitude towards a specific position, but also select amongst more than one that are available. In this case the respondents need to express the domains where they get their ideas for the metaphors they use in their work tasks; they have to select between every day life concepts, other domains (science, technology, etc.) and finally the reality of their company or the market they are operating.

One can identify that the role of corporate reality diminishes, while this of everyday life is relatively strengthened.

It is interesting to see the results of a cumulative chart we composed based on the results of four questions, namely:

- Question 1.7: Are metaphors affecting the style of your work?
- Question 1.8: Are metaphors affecting the culture of yourself, your colleagues and your working environment?
- Question 1.9: Do you see gains from the use of metaphors in the working environment?
- Question 1.10: Is the ratio of gains and benefits against costs and problems in the use of metaphors in the working environment well-balanced?

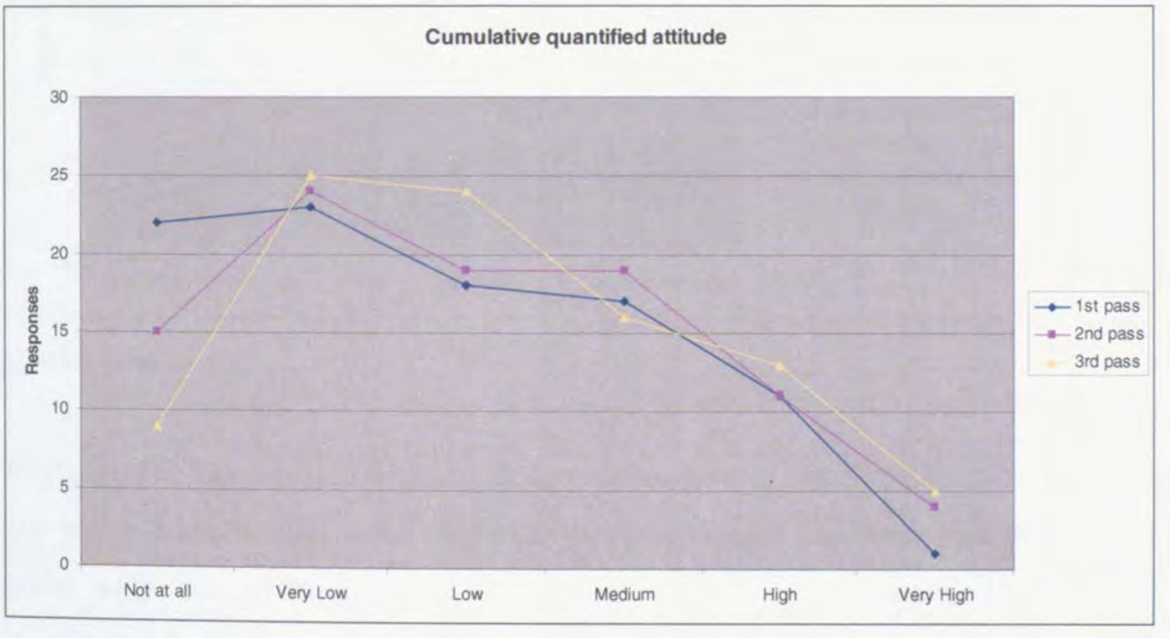

Chart 7 Questions 1.7 to 1.10

It is easy to identify again the shift towards a better positioning with respect to the role of metaphor use and the utility this can bring to the accomplishments of tasks within the working environment.

One of the most difficult questions was question 1.12. there we asked the people which tasks are easier for them to conceptualise, making a distinction between:

- 'Simple' or 'straightforward' tasks on the one hand, and
- 'More abstract', 'sophisticated' or 'complex' on the other hand.

Respondents were asked to select one of the two, thus biasing their input. This is scientifically not correct, as especially this issue is quite difficult if not even dangerous to approach with such an easiness, but the results are still useful for the scope of the research.

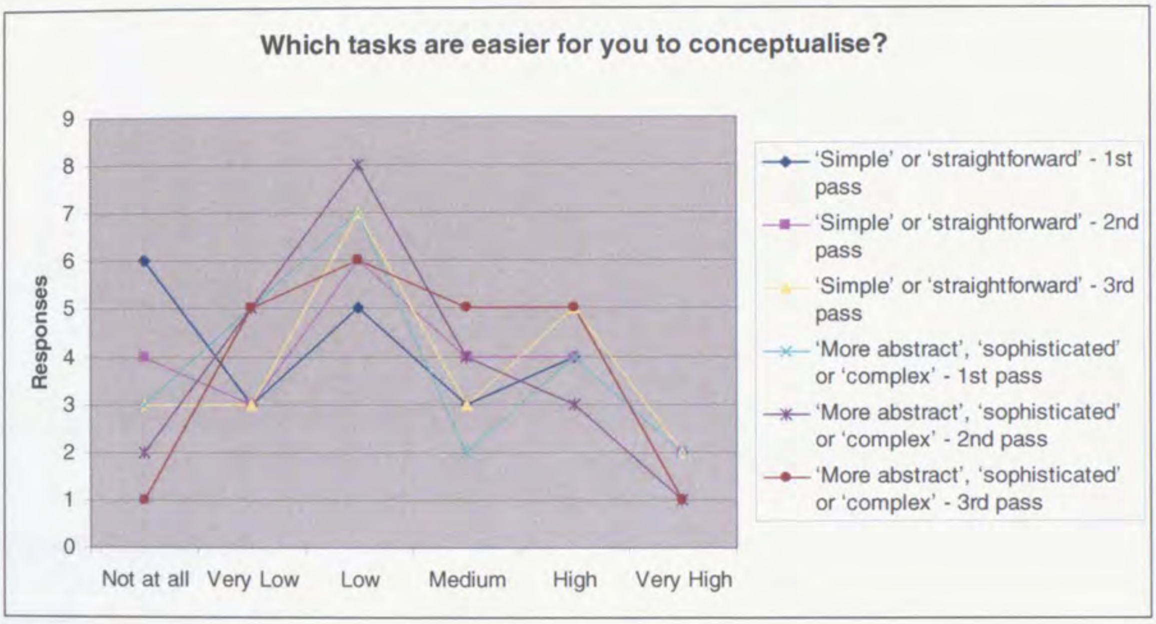

Chart 8 Question 1.12

As the reader can see from the chart, it seems that there are two communities: the ones that believe that simpler tasks are easier to conceptualise and those that think this is better only for more complex tasks, and given their exposure to the SRA experimentation, they have been only given the opportunity to reposition their attitudes by e.g. making their beliefs more solid. Though we have not been expecting this outcome[13], now that we look at this in retro, we see that it is quite normal.

Quite interesting are the results of the chart below; this time it is about the time people think are investing in thinking about the way they perform a task. Though there is a clear shift towards recognising that they all invest some time on thinking about how to perform a task, in general we see a consistency regarding the attitudes of the people – with other words there are deeply rooted attitudes and these cannot change easily or

[13] We were expecting that one of the two possible outcomes would have dominated – especially after the exposure of the people to the SRA experimentation. At the end, and quite *not* surprisingly, it seems that

quickly as it was the case of the SRA experimental sessions that were part of the conducted application scenarios.

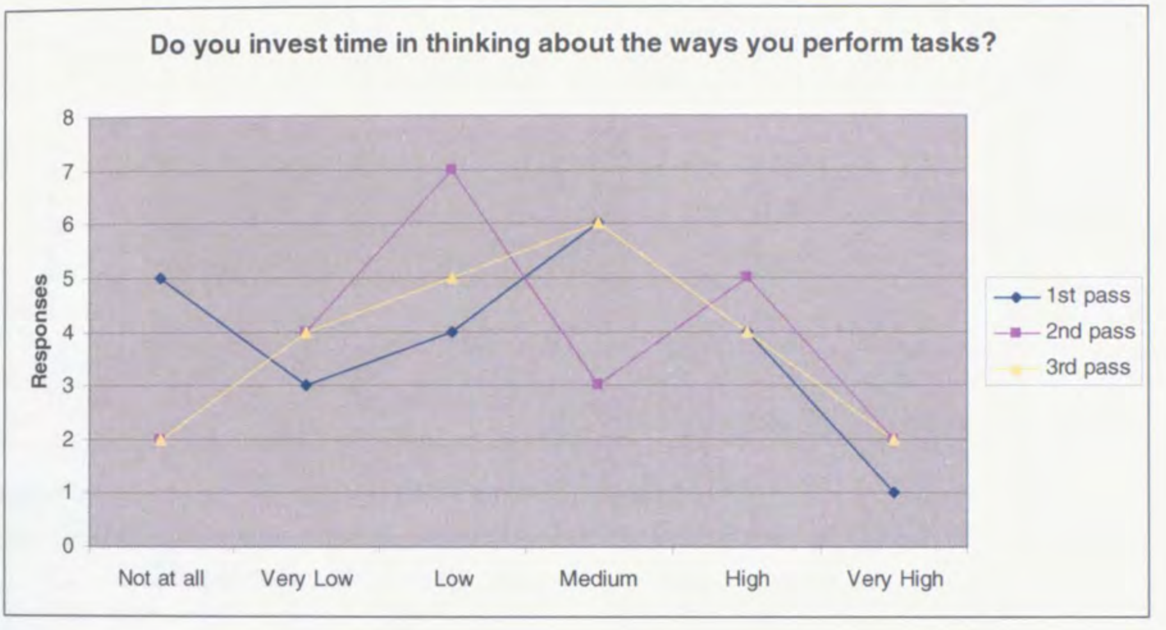

Chart 9 Question 1.13

Questions 14, 16 and 17 try to recognise who carries, according to the respondents' opinion, the responsibility for three respective issues:

- Culture in the work environment (question 14)
- improvements in the use of metaphors in the work (question 16) and finally
- the adoption of metaphor in the work (question 17).

For all three, the available options are:

- The respondent on his / her own self
- The team (s)he belongs into
- The company (s)he works for and its Management
- The market (s)he and his/her company are operating

We think of this distinction as sufficient to express both the terms of this first hypothesis as well as these of the other ones, therefore we use this also in further questions.

For all three questions we developed the same cumulative chart listed below which we show for each of the four options.

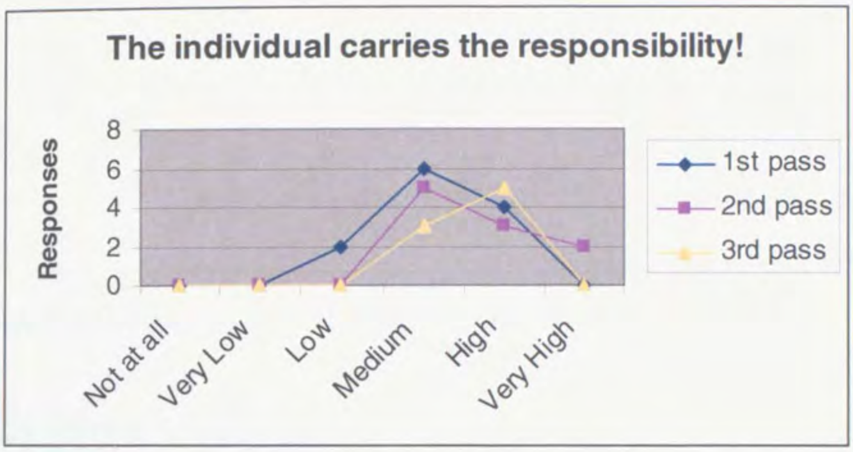

Chart 10 Questions 1.14, 1.16 and 1.17 – group 1: individual

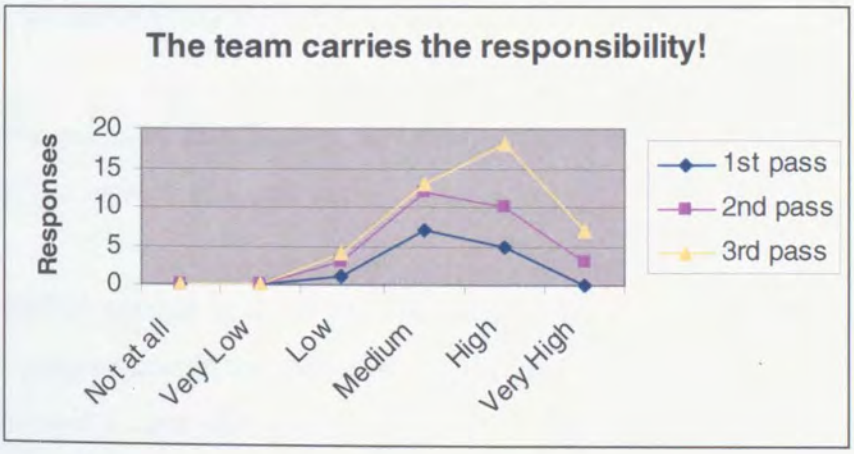

Chart 11 Questions 1.14, 1.16 and 1.17 – group 2: team

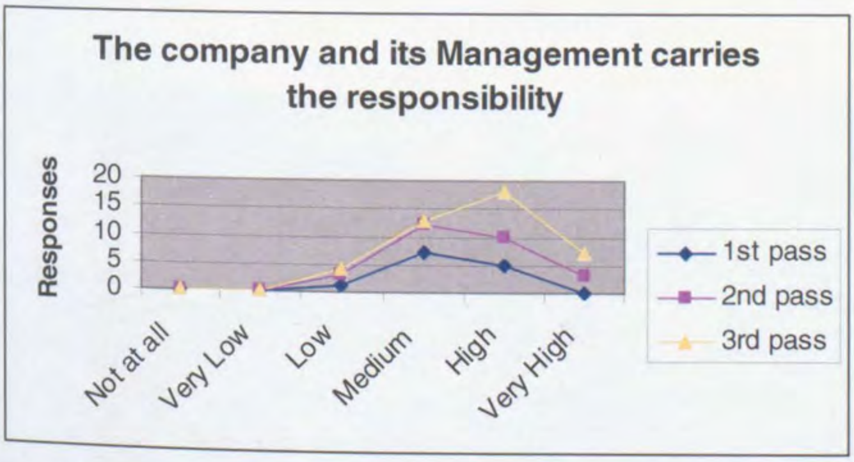

Chart 12 Questions 1.14, 1.16 and 1.17 – group 3: company

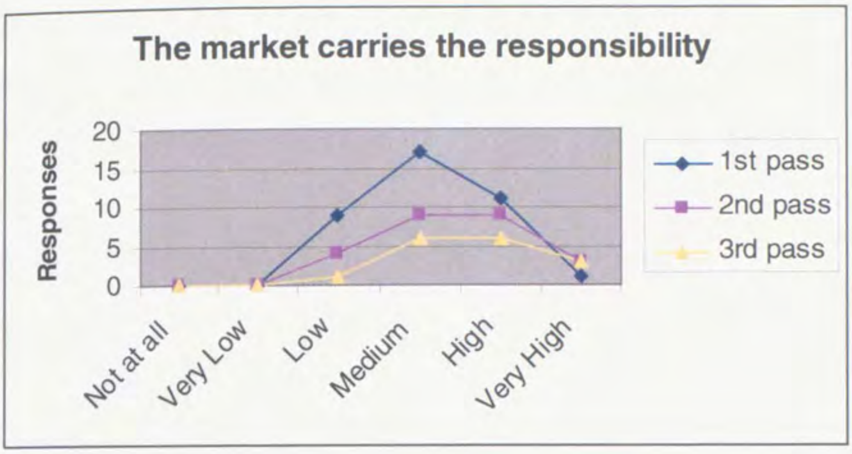

Chart 13 Questions 1.14, 1.16 and 1.17 – group 4: market

It is easy to recognize the diminishing trend for finding responsibility in the individual or the market, while respondents increasingly assign the responsibility either to the team they belong to or the company and its management body.

We consider this finding as highly relevant to the research as it demonstrates the power aspects of metaphors.

Similar support to the argument is provided by Question 1.15, related to the matter of improvements in the use of metaphors within the working environment. For this again there is a clear shift towards a positive attitude, i.e. respondents by the time of the 3rd pass agree that there is (more) space than they saw by the time of the 1st pass.

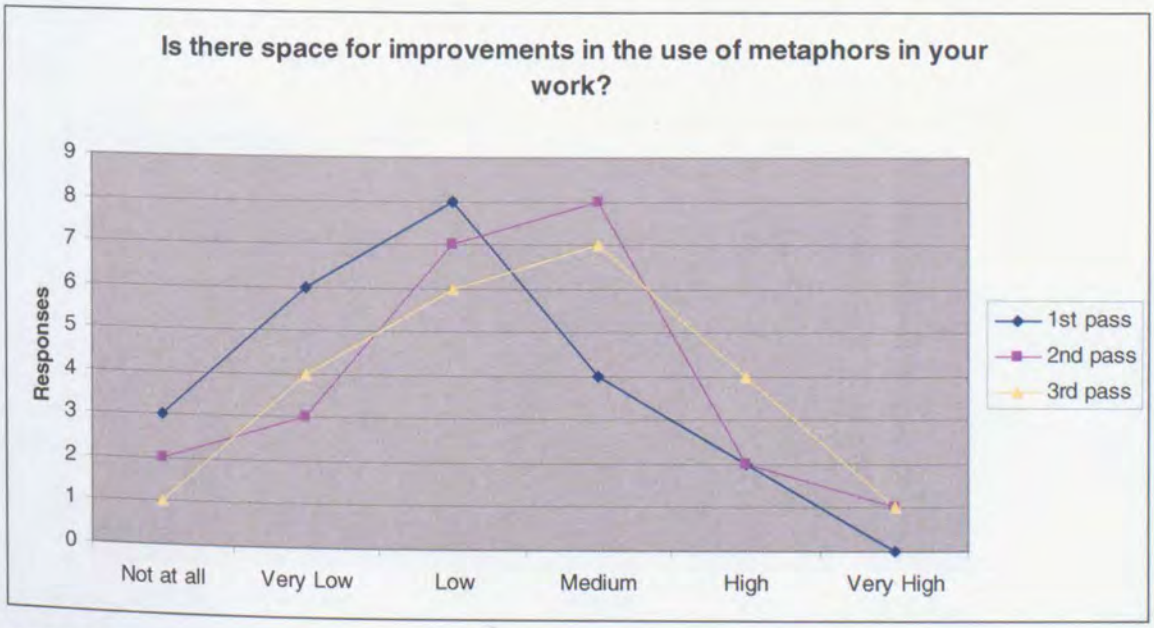

Chart 14 Questions 1.15

Except from the aforementioned 'general' questions related to the first hypothesis, we added to the questionnaire two more special sections related to the notion of SR and to product development matters.

Regarding the notion of SR, the questions were:

- What is the respondent's perception of a Situation Room?
- Whether (s)he understands the concept and the connotations it brings with? And finally
- How (s)he judges its appeal for use in the corporate environment?

The latter related to the linking of the respondent's attitude with one of five available options:

- Too difficult to use.
- Too much related with critical and emergency cases.
- Too much emotionally loaded with negative cases.
- Interesting for a new type of situation based collaboration and culture in the corporate environments.
- Will not change things at all. Not worth to introduce.

Below we list the results by means of the respective charts.

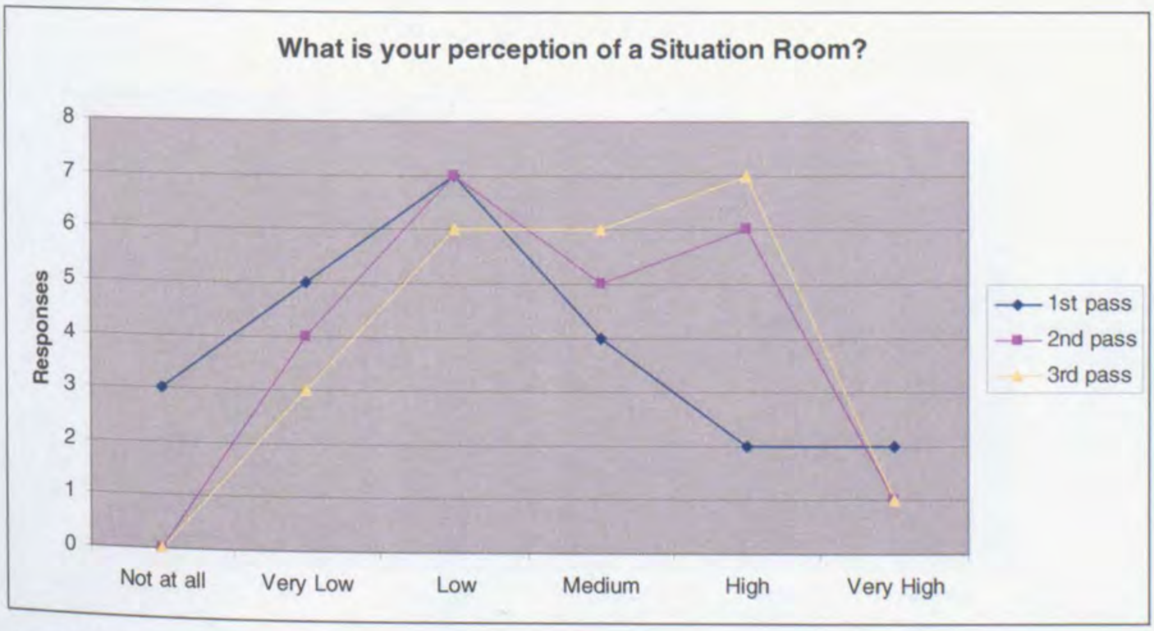

Chart 15 Question 1.18

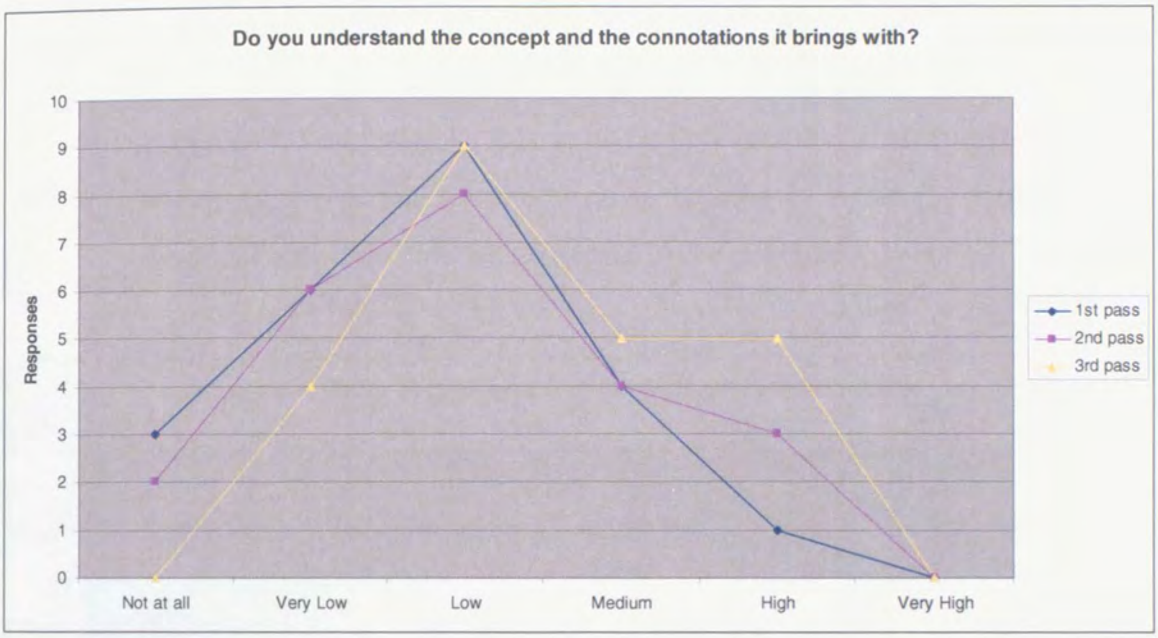

Chart 16 Question 1.19

Regarding question 1.20, below we list the separate attitudes.

Interpreting the (obvious and self-explanatory, as it seems from the charts below) results it seems that:

- Respondents did not see any special difficulty in operating (within) a Situation Room

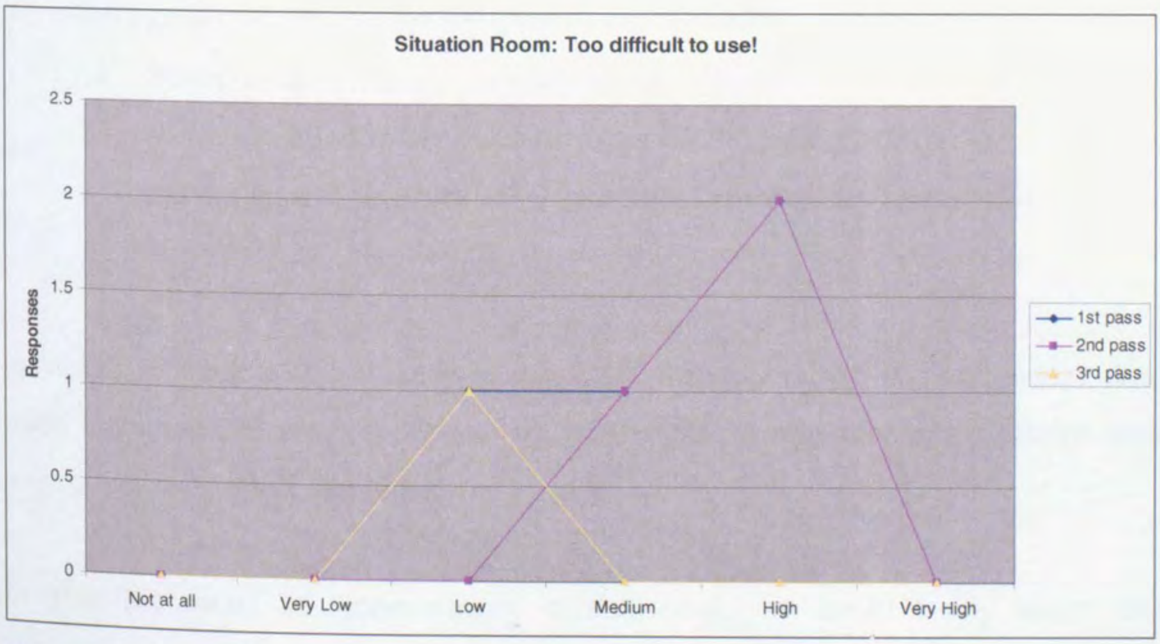

Chart 17 Question 1.20 – option 1

- Perceive it as much related with emergency and critical situations. It is extremely useful to see that in all three iterations no clear tendency was apparent for a change in this attitude. It seems that it is something deeply rooted in the people's mind. And something to seriously draw attention from our side – for this we comment in the conclusions section.

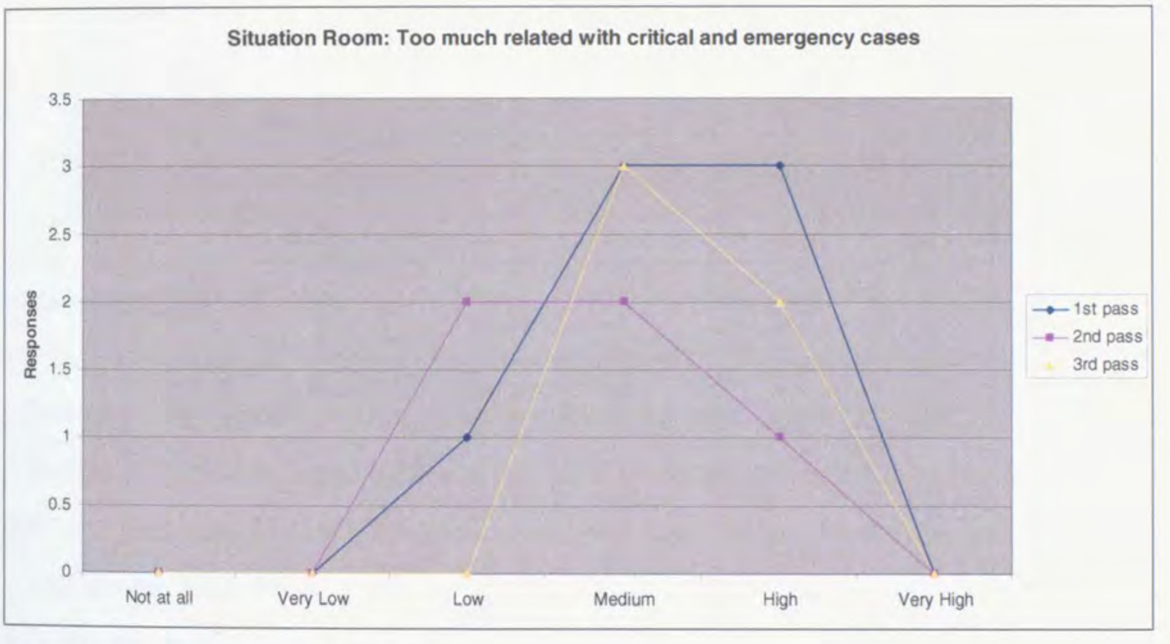

Chart 18 Question 1.20 – option 2

The above chart relates also with the next option: here the question was whether SR is too much emotionally loaded with negative events. According to the chart:

- There is a definite improvement of the attitude of the people that participated in the experiments as by the 3rd pass of the questionnaire they did not keep their initial view of a SR as emotionally loaded with negative events.

However, it is interesting to keep in mind that the respondents did not change their mind regarding the previous option i.e. of the SR as an entity much related with emergency and critical situations.

In case we faced an improvement to that front, we could easily claim that experimentation has helped in the change of people's attitude to both these criticisms.

Chart 19 Question 1.20 – option 3

Regarding the fourth option, i.e. a SR as a new type of vehicle to support collaboration, people's attitude was not as high as we expected it to be. Reasons for this are discussed in the later section and the conclusions. However, and as already stated above, both these separate sections of the questionnaire related to the SR notion and the product development process were not central to the validation of the first hypotheses, thus their role is (extremely) important (therefore we also present the results and take them highly into account) but not capable to turn down the hypotheses.

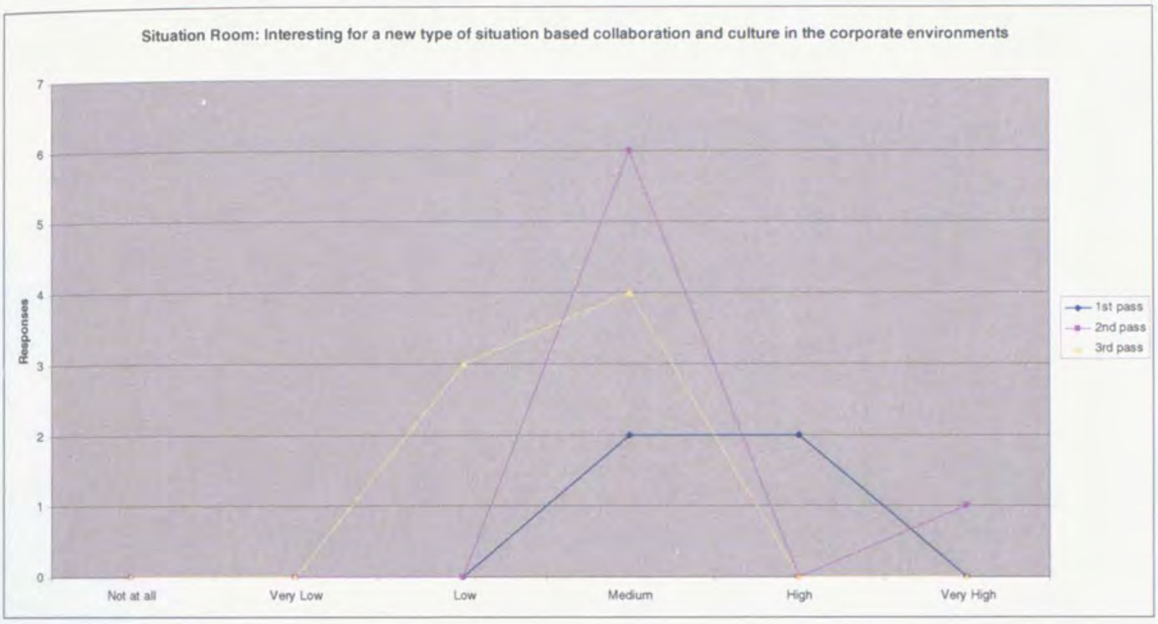

Chart 20 Question 1.20 – option 4

It is interesting to see that the exposure of the people in the experimental SRA sessions, strengthened their belief towards a moderate-to-low adoption of SR as a tool for collaboration. This, is a direct measure of the validity of the research approach as well.

The last option expressed a skepticism, stating that 'it is not worth to introduce SR as it shall not change anything at all'. Though there is a change in the attitude of the respondents, it is questionable to proceed to any further reasoning based only on this; however, if we read between the lines, it is easy to see that people feel that all (decision) power lies in the team and the corporate Management. Therefore, any interesting concept or tool cannot be introduced to change things in the corporate reality if it shall not be approved or supported by these two elements (if you remember from the previous charts, neither the individual nor the market in which a company operates have the power to change things in the daily work reality).

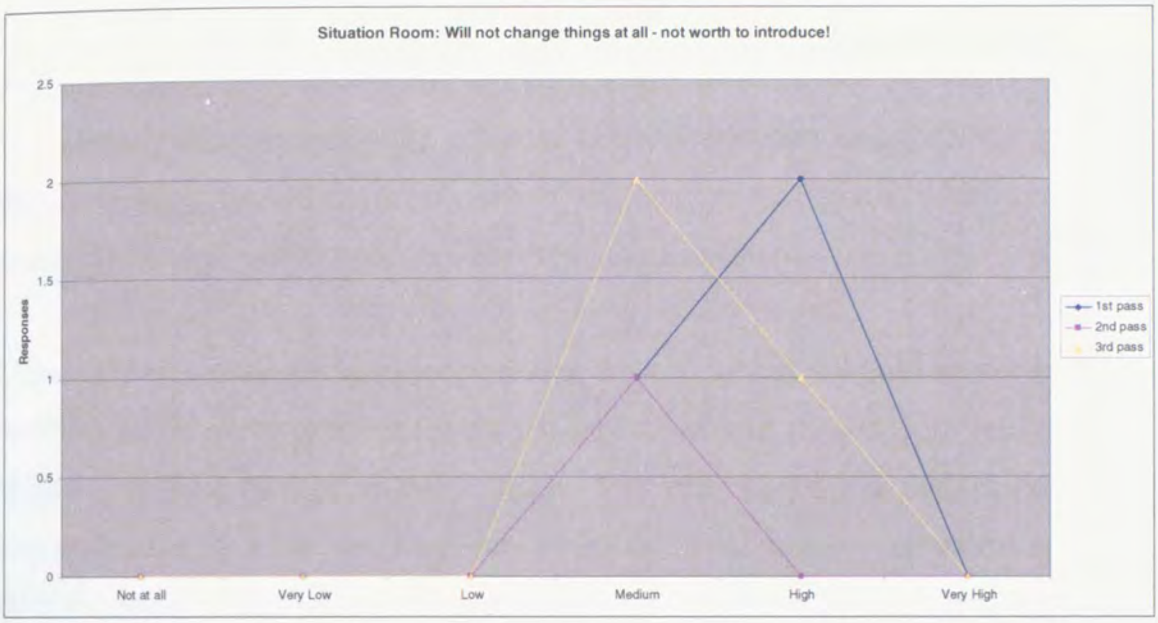

Chart 21 Question 1.20 – option 5

To the product development related section of the questionnaire, we have two questions, namely:

- How is product development regarded as a process in your company?
  - There are strict procedures to follow.
  - It is a process open to improvements and new styles.
  - It is a strongly collaborative process.
  - Many people are involved but collaboration follows strictly defined paths.

and:

- Are there any reasons for improving your product development process in your company?
  - Financial / economical (e.g. high costs)?
  - Organizational (e.g. too many people, not the right mix of people, no hierarchy, too much hierarchy, etc.) ?
  - Related to the technologies (out of date production plan, inability to address today's challenges, etc.)?

Below we present the results in the respective charts.

The existence of 'strict procedures' to follow when developing a new product is doubted: taking into account that all participants were having a good professional background, this change in the attitudes between the first and the third passes is demonstrating only one thing: people live with perceptions some of which prove to be useful while some others need reconsideration and revisions.

Especially regarding this question, we were expecting that it would be not needed to be filled out in every pass but for consistency reasons let this happen. And the result shows a definite change in the attitudes. The interpretation is that as people got exposed to the SRA process, they were given the opportunity to reconsider several of their experiences and match this experience they were facing with other experiences they were exposed to, *therefore* given the opportunity to reconsider the existence of what they initially tended to believe i.e. of some 'strict procedures'.

Chart 22 Question 1.21 – option 1

Similar to the previous option, people have gained on confidence regarding the improvements and the (change of) styles employed when considering the product development process. For this change, it is for certain that SRA has played a central role, as depicted in the results of the chart below.

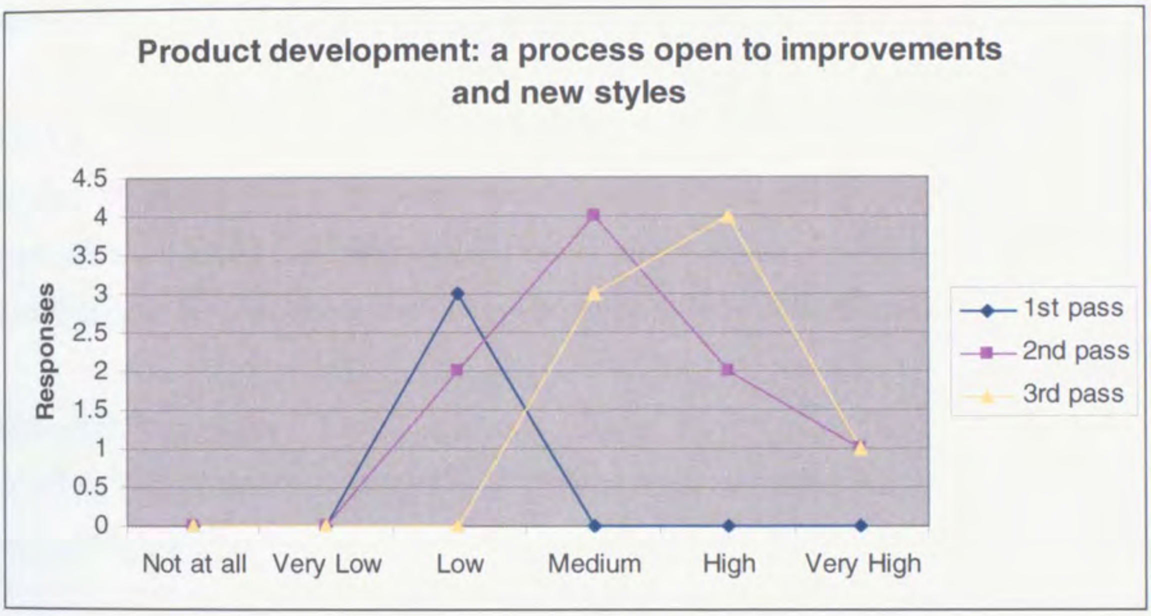

Chart 23 Question 1.21 – option 2

Again, there is a change in the attitude of the people that participated: after the final 3[rd] pass, participants did consider product development as a strongly collaborative process.

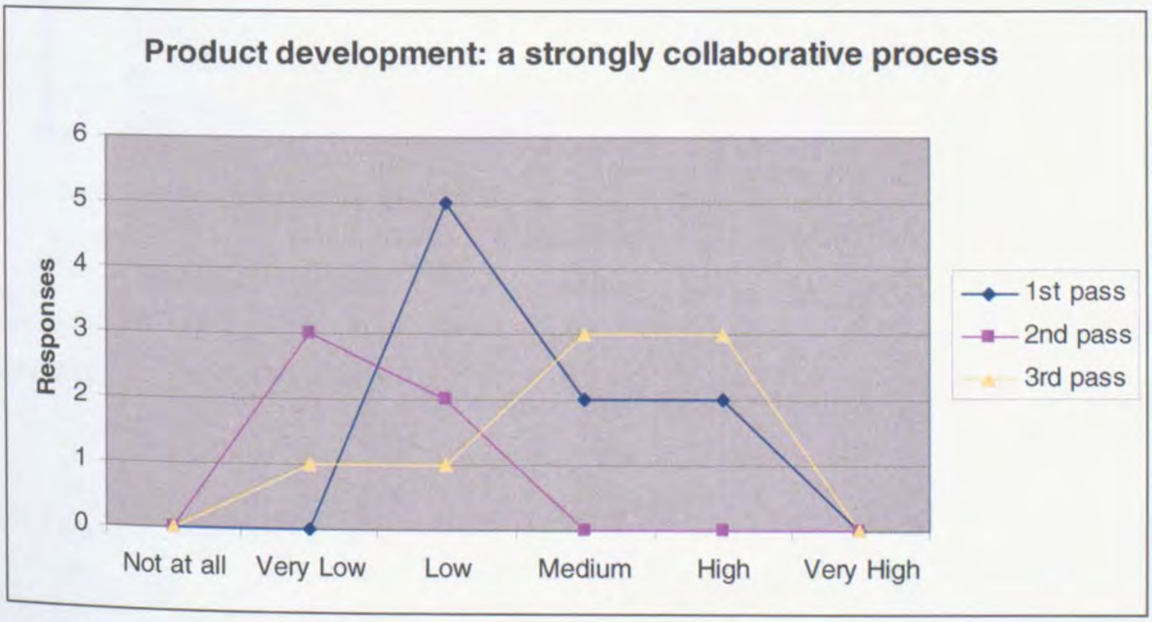

Chart 24 Question 1.21 – option 3

A rather difficult chart to understand its meaning is the one below. The question is the same as above, regarding the product development process and how people regard this. Perhaps the problem lies in the expression as we used an adversative sentence implying that *though* many people are involved in the product development process, their collaboration *does* follow strictly defined paths.

Having in mind the previous option, the present one is giving the respondents a feeling of insecurity, as if their confirmation for the utility that new styles and methods (like SRA) can bring to the product development process is punished by the fact that despite them, there will always be some strictly defined paths.

Therefore, one proper way to read this chart is to recognise the smoothing of the belief by the 2nd and especially the 3rd pass that characterised the initial response by the time of the 1st pass.

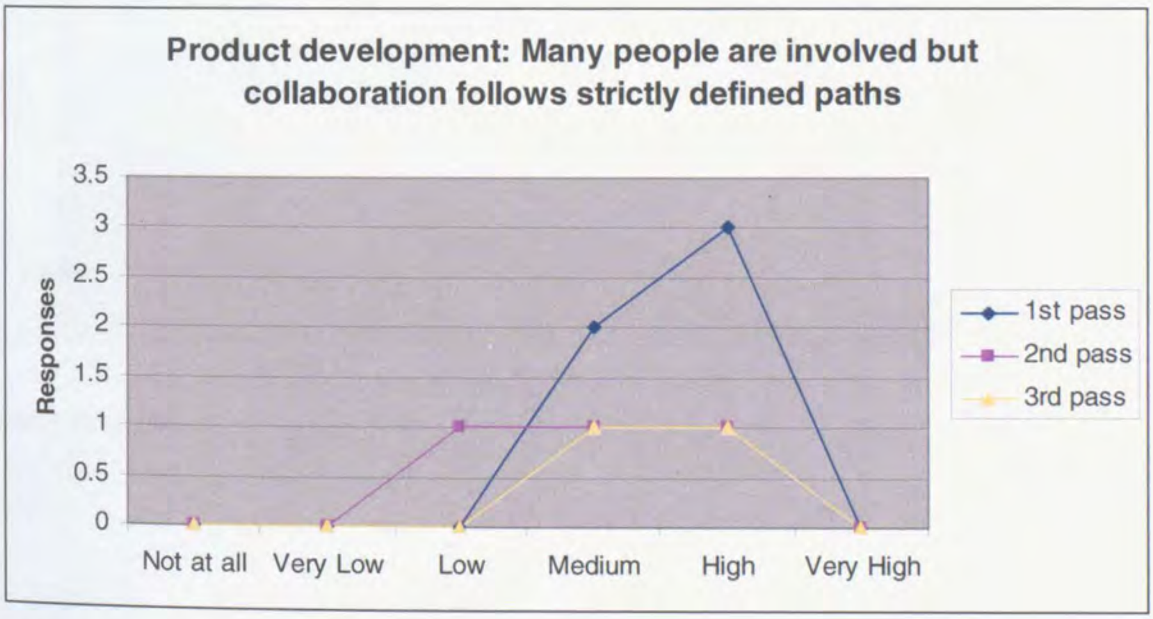

Chart 25 Question 1.21 – option 4

The last question of the second special section of the questionnaire related to the first hypothesis concerned the reasons that people feel companies need to change their product development processes.

Below we present the three different charts related to the three available options presented.

The first chart traces the financial or economical reasons – and if we read it correctly, it seems that after the 3rd pass less people believe that the reasons are mainly related with money and monetary resources in general.

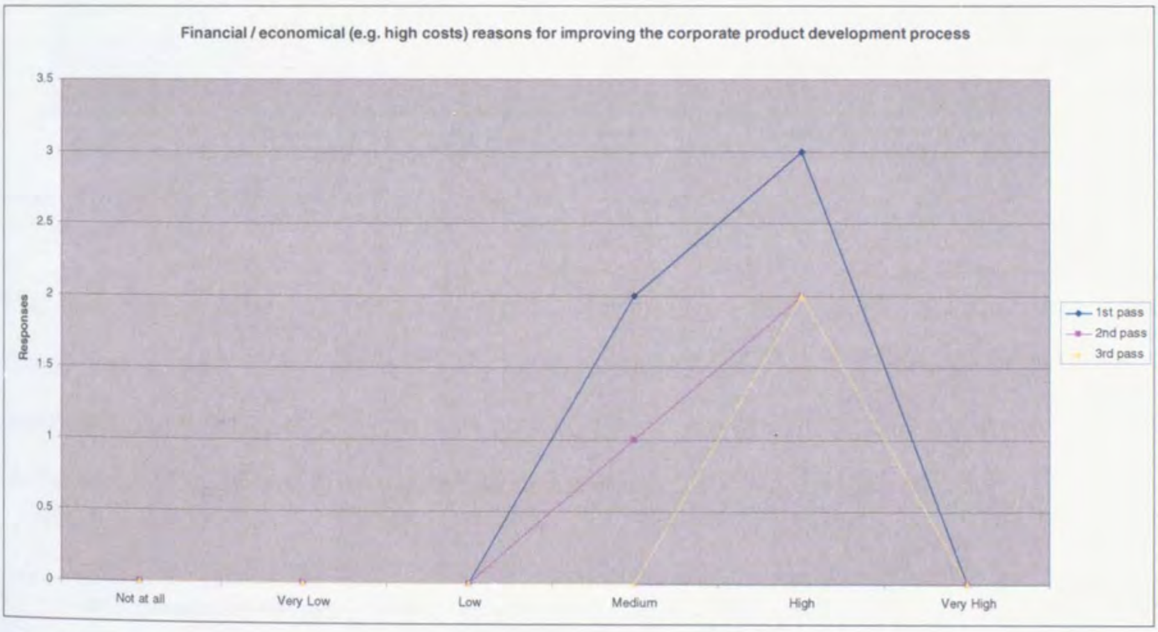

Chart 26 Question 1.22 – option 1

However, more people believe that this has to do with organisational aspects. But again, this chart does not give strong evidence for the underlying argument.

Chart 27 Question 1.22 – option 2

The last chance relies on the third chart, which shows that people see the risk or the threat not within the company, its organisational grid or its money supplies but (correctly, according to the opinion stated) to the environment and more specifically to the technologies and how these can affect the reality within they operate.

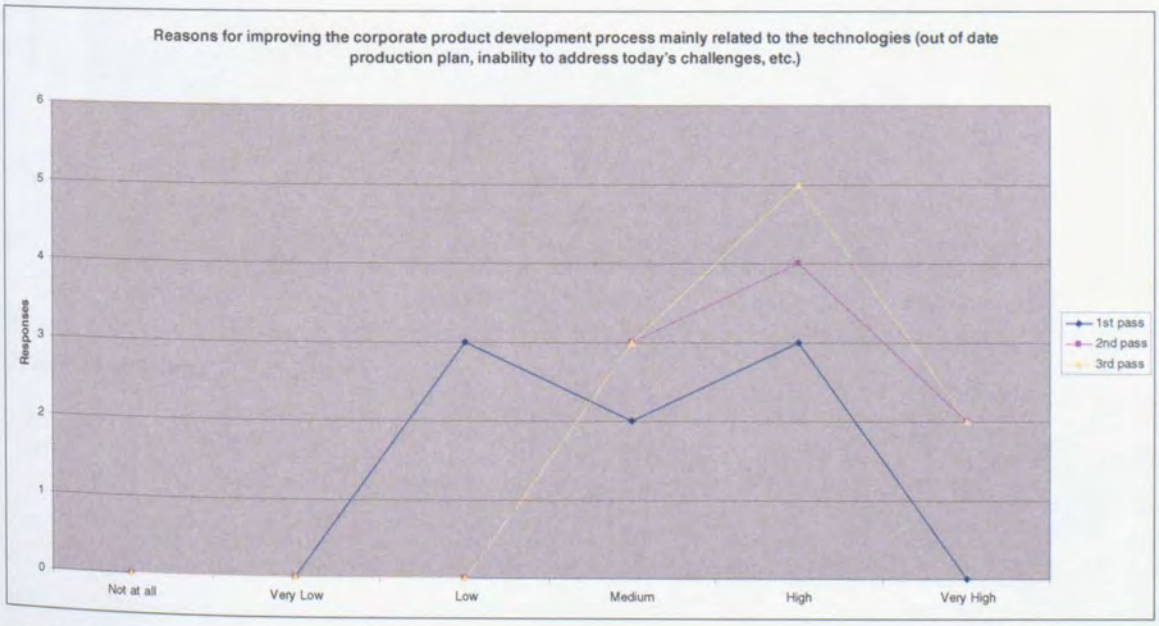

Chart 28 Question 1.22 – option 3

5.1.2. Second hypothesis

The first question in the section of the questionnaire dedicated to the second hypothesis concerns the appropriateness of a metaphor or a conceptualization for a particular work task. It uses six alternative options to guide the participants in their response. More specifically, people are asked whether the appropriateness of a metaphor is related with respect to:

- appeal to them
- overall success of its application
- efficiency it brings in the communication aspects of the particular work task they are about to perform
- acceptance from colleagues and other members of the team.
- acceptance from the company and its Management, and finally
- acceptance from the market they are operating.

Below we list the results in the respective charts.

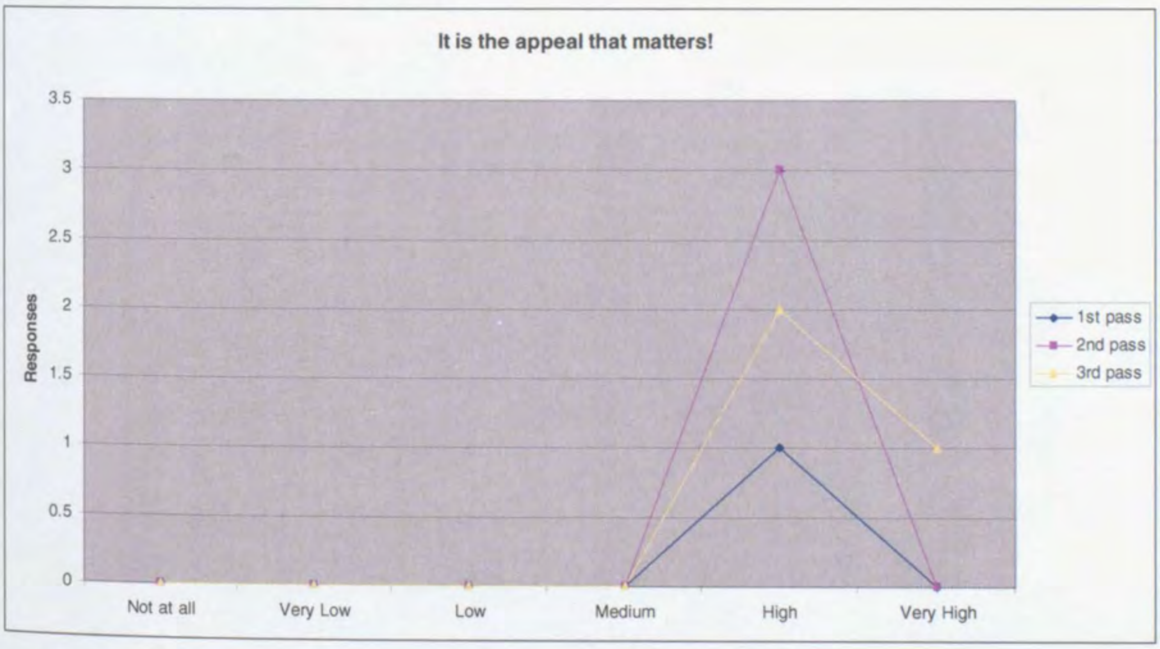

Chart 29 Question 2.1 – option 1

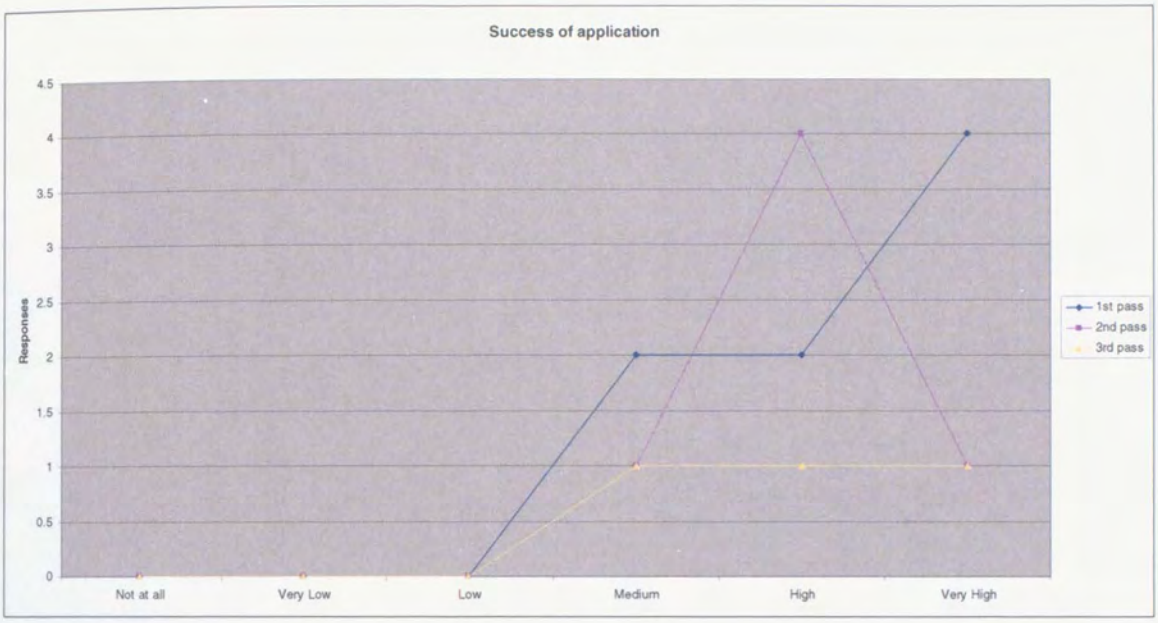

Chart 30 Question 2.1 – option 2

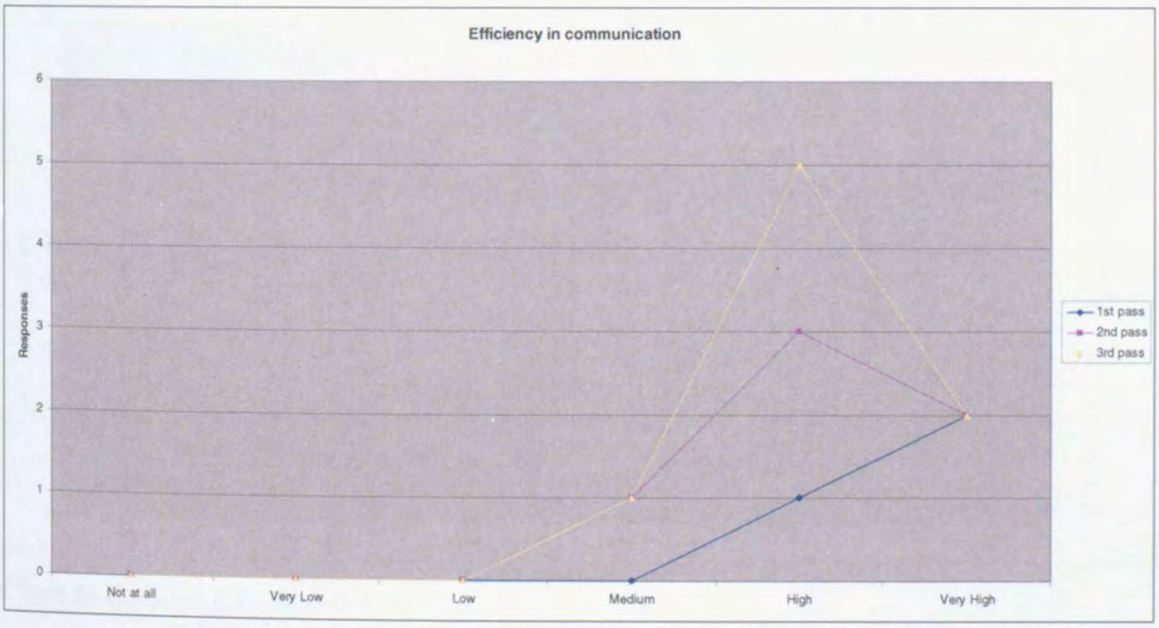

Chart 31 Question 2.1 – option 3

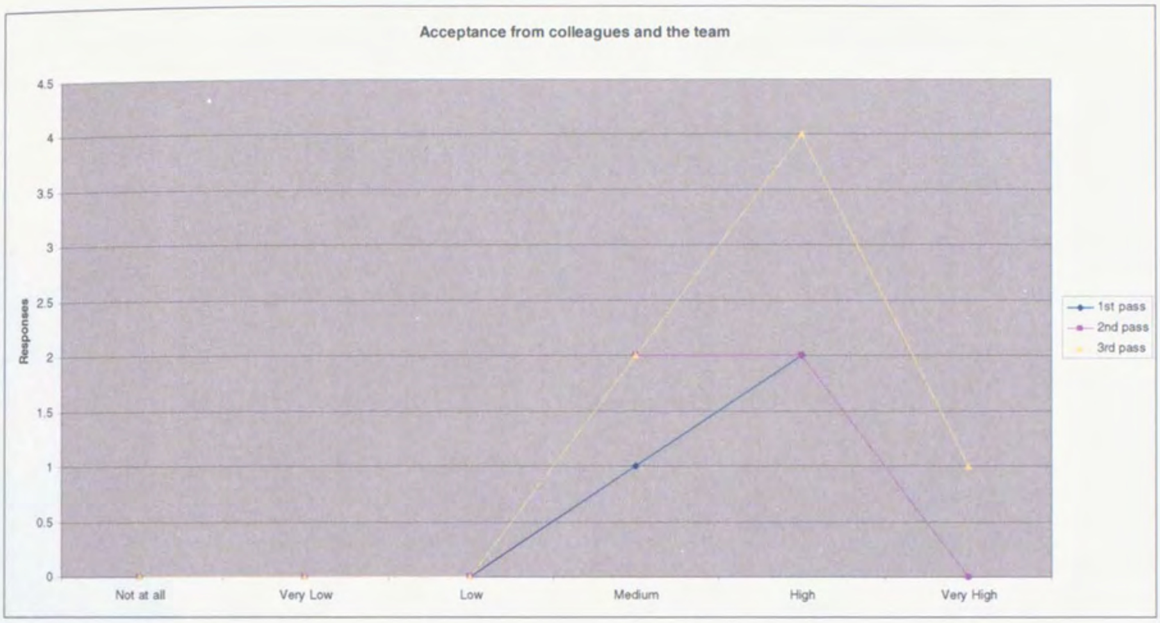

Chart 32 Question 2.1 – option 4

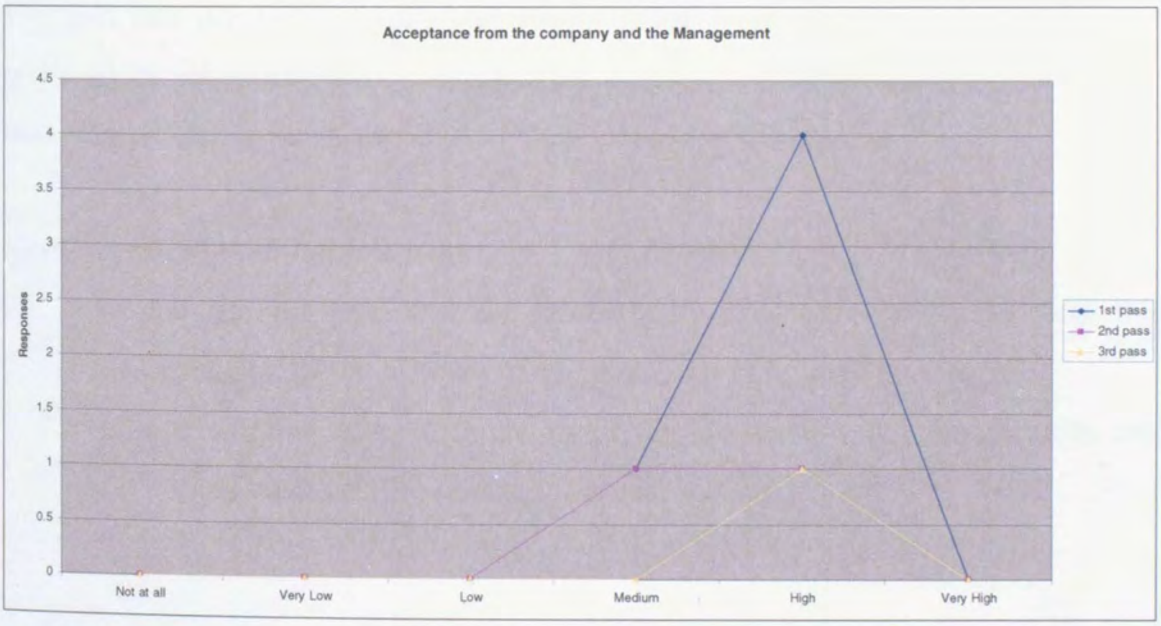

Chart 33 Question 2.1 – option 5

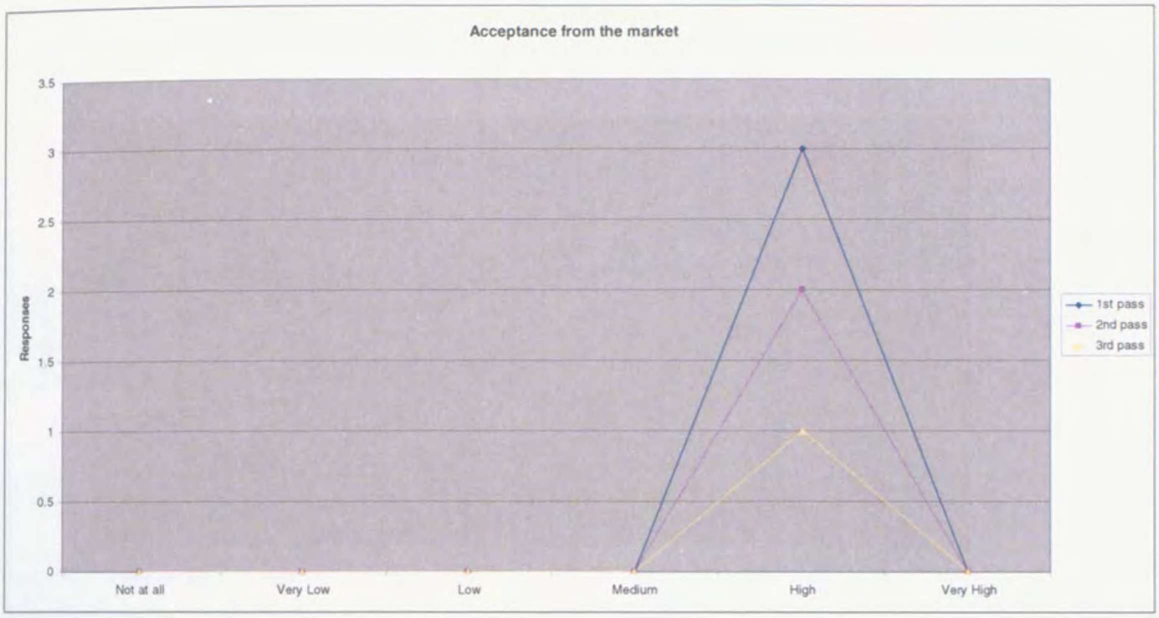

Chart 34 Question 2.1 – option 6

The next two questions aimed to find out the link between a working task that is optimally or suboptimally executed and the employment of an appropriate or wrong metaphor (cherchez the metaphor, as French people would say).

More specifically the concern was:

- For working tasks that are suboptimally executed - how much does this depend on the choice of a wrong metaphor or no metaphor at all?
- For working tasks that are optimally executed - how much does this depend on the choice of an appropriate metaphor?

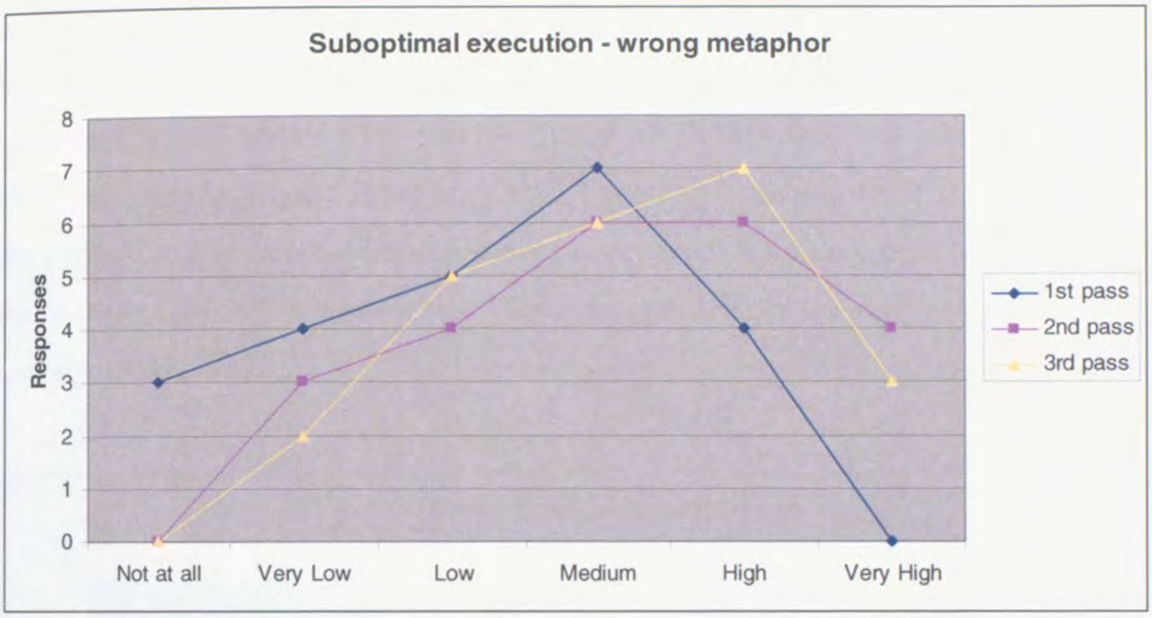

Chart 35 Question 2.2

Chart 36 Question 2.3

It is easy to recognize for both questions that the peak in the 3rd pass has moved towards the right side of the chart, i.e. that people were more convinced that the choice of a metaphor plays a critical role to the execution of a particular task.

The wording in the next question is not as satisfactory – but as it is now completed the interaction sessions it is late for any improvements. The concern here is on … improvement in the work and whether this is the core matter for the people when considering the case of employing a metaphor. We ought to have been more specific in terms of defining the term improvement and what people should understand that this term covers. Should it refer to quantitative aspects of their work? Or purely qualitative ones? And of what specific qualities? The issue is that what we get from their responses is a quite interesting shift towards slackening their attitude towards improvement: it seems that improvement (of any type) is not any more an end in itself. As if there are *other* matters that have an importance to use as criteria when considering the work.

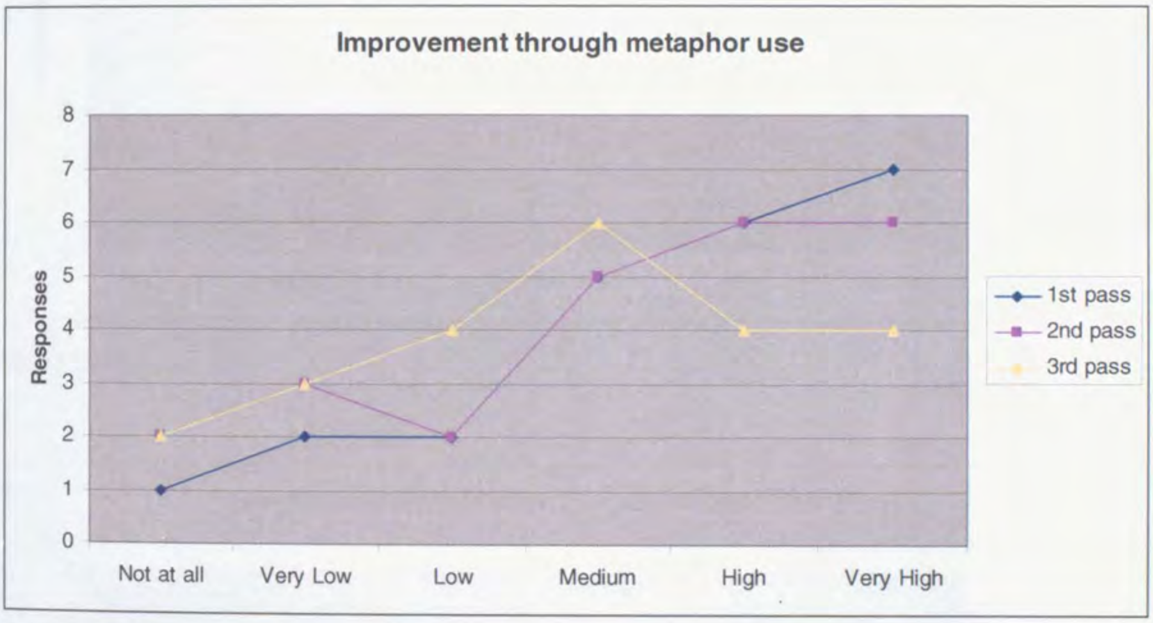

Chart 37 Question 2.4

The last two questions are forming again a pair – this time we ask whether metaphor use shall work better

- for simpler tasks than to complex ones, and
- for concrete tasks than to abstract ones.

Trying to read the charts, we only get as valid input that:

- either the respondents have an accurate idea of the use of metaphors and their relative role to (help) perform simple or complex tasks on the one hand, and more concrete or abstract tasks on the other hand,
- or there is some confusion from the side of the respondents that is apparent in their responses with some insecurity they exhibit in terms of not changing (much) of their attitudes.

It is our belief that the second is taking place, i.e. that the question was expressed in some way that did not help the comprehension of the respondents.

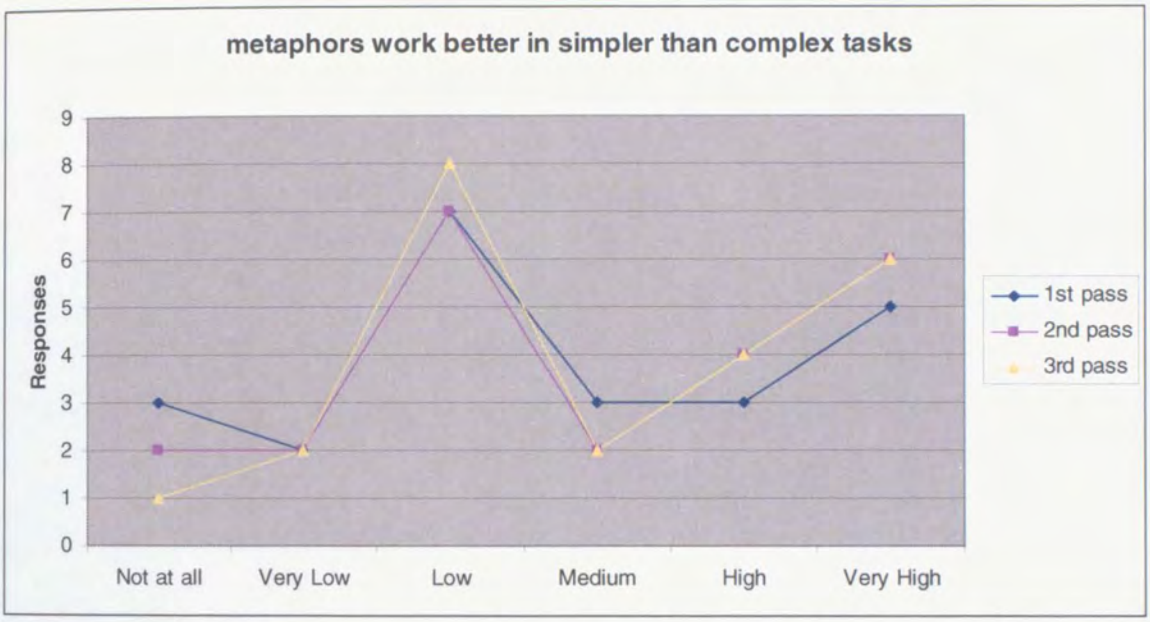

Chart 38 Question 2.5

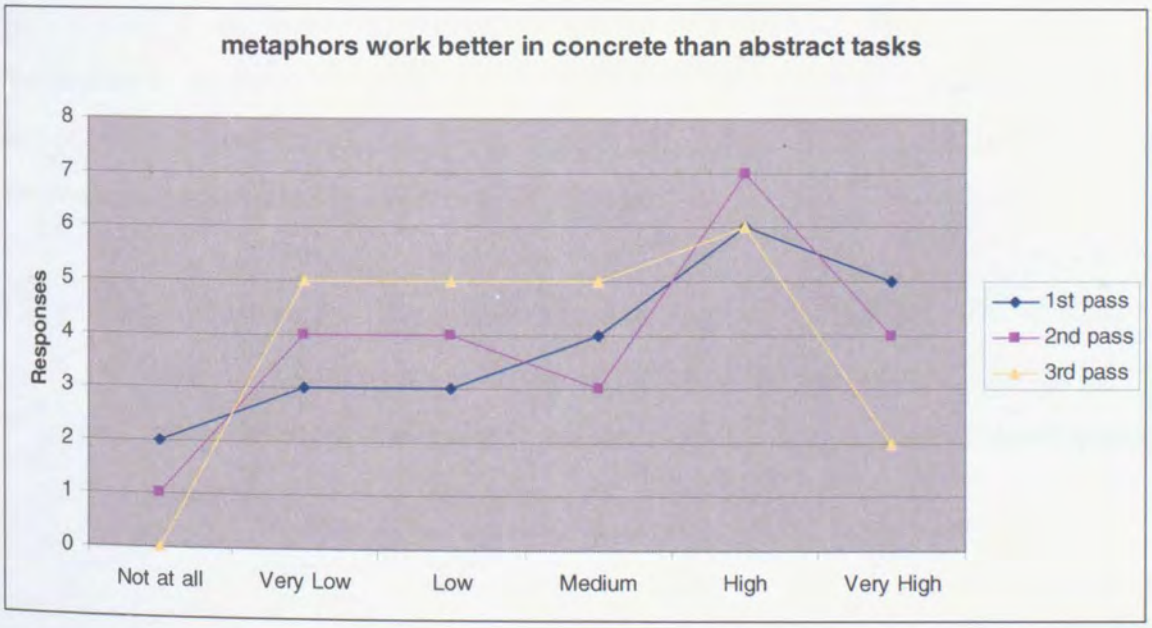

Chart 39 Question 2.6

5.1.3. Third hypothesis

The first question for validating the third hypothesis aimed to find out whether activities like the development of a product, the introduction of a new product, the watch of the competition for improving one's own products, or the launch of a product to the market are regarded as being (semantically) close to a 'war'.

The results are presented in the chart below.

Chart 40 Question 3.1

As it is easy to see, there is a change in the attitudes of the people that participated in the research, as there is a definite shift in the people's feeling and towards the acceptance of the war-like analogy – especially after the 3rd pass in which the respondents participated in their own SR sessions.

The next two questions though separate aimed to find out whether people:

- draw analogies with war or war-like notions in their work
- see gains from the use of war-like notions in the product development process

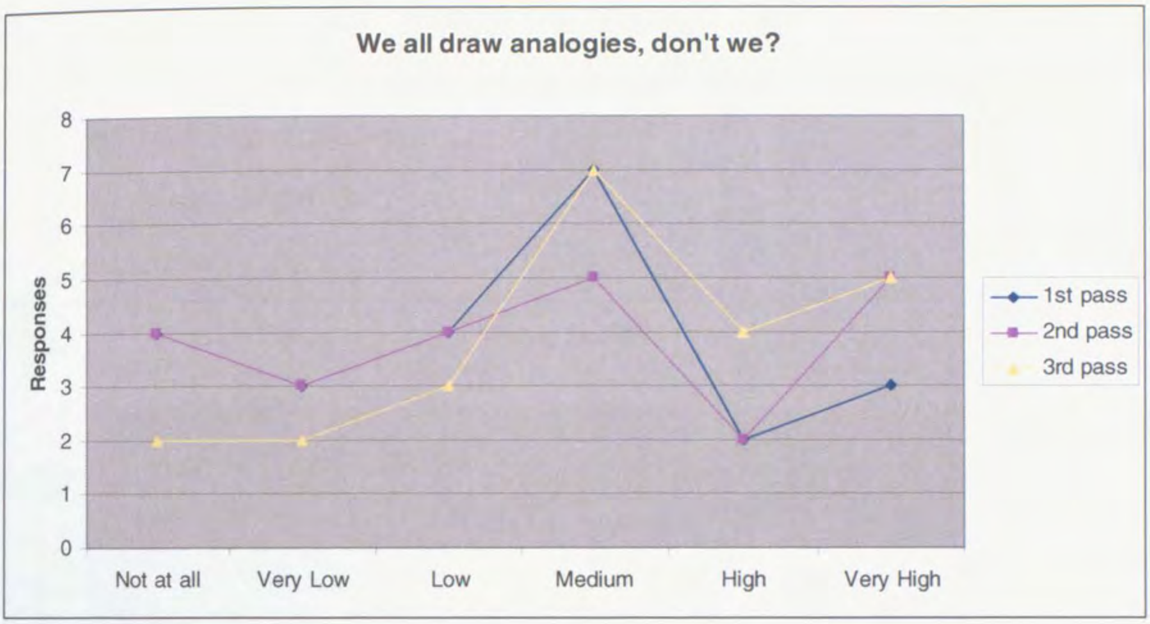

Chart 41 Question 3.2

Interestingly, the people's attitude to this question did not change – it only strengthened significantly after the 3rd pass, confirming the research hypothesis.

Chart 42 Question 3.3

The original scepticism to the use of war-like notions in the product development process gave its place to a moderate acceptance. It is also obvious from the chart that there is a stepwise improvement from the 1st to the 2nd and then to the 3rd pass.

The fourth question aimed to decode people's positioning with respect to the term of a Situation Room. We asked people whether they see any positive or negative aspects (emotional, conceptual, motivational, etc.) in the reference to a Situation Room and their answers were grouped under two categories:

- Mainly positive, and
- Mainly negative

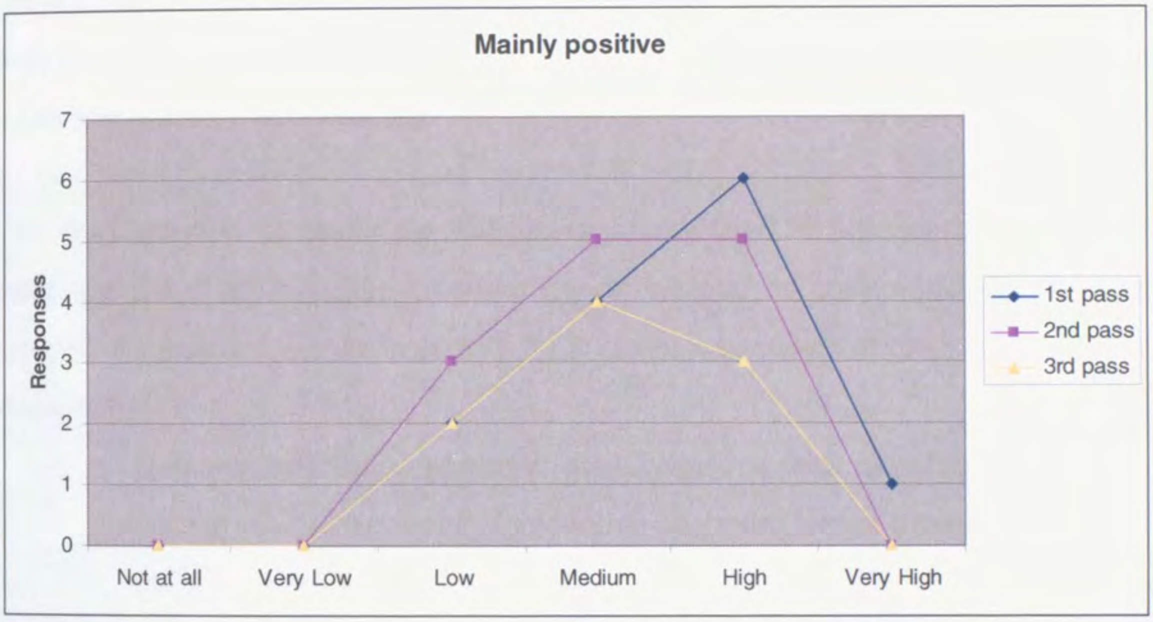

Chart 43 Question 3.4 – option 1

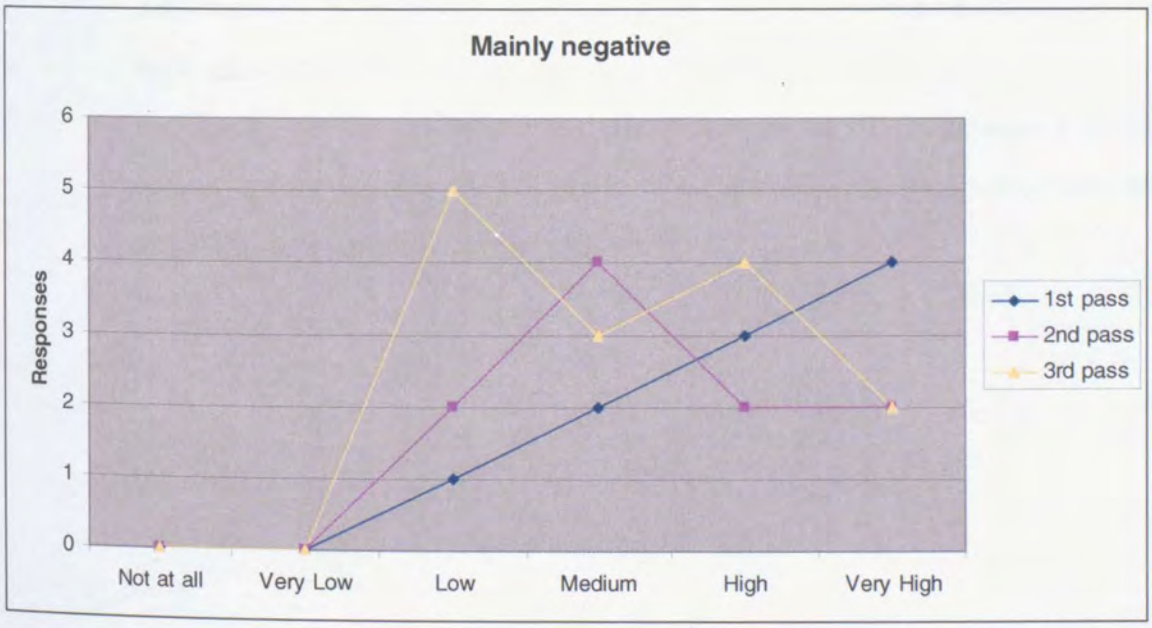

Chart 44 Question 3.4 – option 2

We take it as a positive development that respondents have smoothed their initial positive disposition towards the term Situation Room and its references, after their exposure to the SRA sessions. And we again take it as a positive development that their negativism has retreated.

What is extremely interesting though obviously outside the scope of the research is to read between the lines and see why someone selects to moderate a negative opinion than to choose an equally moderate but positive one.

For sure, there could have been improvements in several other questions wordings but especially for this we believe that we don't need an improvement in the wording but a better tool to assist our reasoning.

The final question to assist the validation of the third hypothesis concerned the disadvantages of applying the Situation Room metaphor in the product development process. We supplied respondents with three options, namely that the Situation Room metaphor:

- Either transforms a 'peaceful' activity in one with negative connotations (in war ethics are wounded and killed, there are lots of innocent casualties, etc.).
- Or provides difficulties with the time aspect – it is tiring to be in a 'war' continuously, as imposed when applying this to the product development case which companies need to face continuously.
- Or, finally, it does not show any disadvantages at all - it reflects exactly the conditions faced in the corporate world and how the companies need to organize their response to the environment.

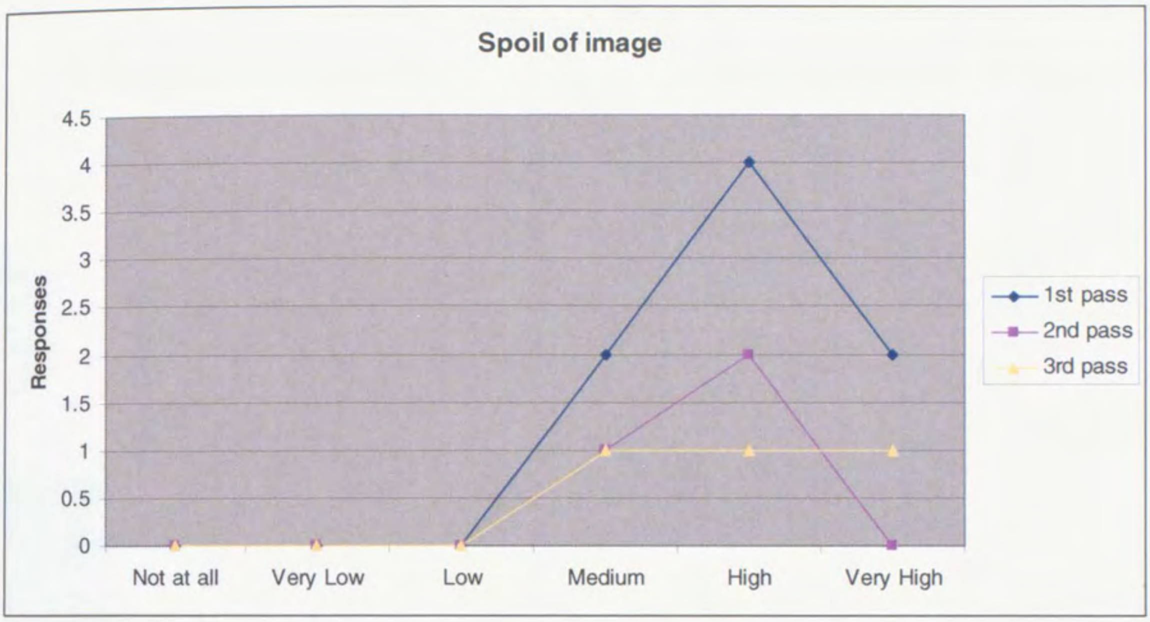

Chart 45 Question 3.5 – option 1

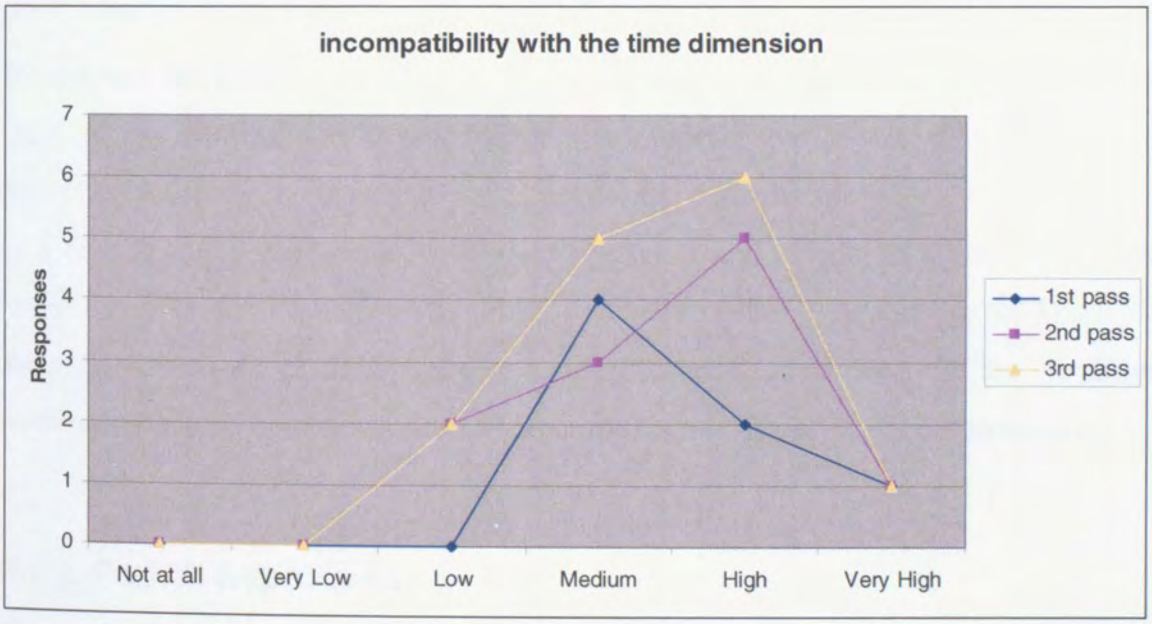

Chart 46 Question 3.5 – option 2

Chart 47 Question 3.5 – option 3

We see that the people rather ignored the possible problems related with the military 'past' of the SR term and its war-related connotations, and in a similar fashion they either concentrated on the time aspect, i.e. how to cope with the underlying continuity of a task that will continuously demand resources and efforts in a way that might prove tiring if not even overwhelming, or chose option 3 according to which no disadvantages at all as SRA 'reflects exactly the conditions faced in the corporate world and how the companies need to organize their response to the environment'.

5.1.4. Fourth hypothesis

We start the questions that shall help in the validation of the fourth hypothesis with a pair of questions related to the link between the Situation Room and how this facilitates learning:

- Firstly we concentrate on the *concept* of the Situation Room, and
- Secondly we focus at the *operation* of a Situation Room

The charts below show the results we received.

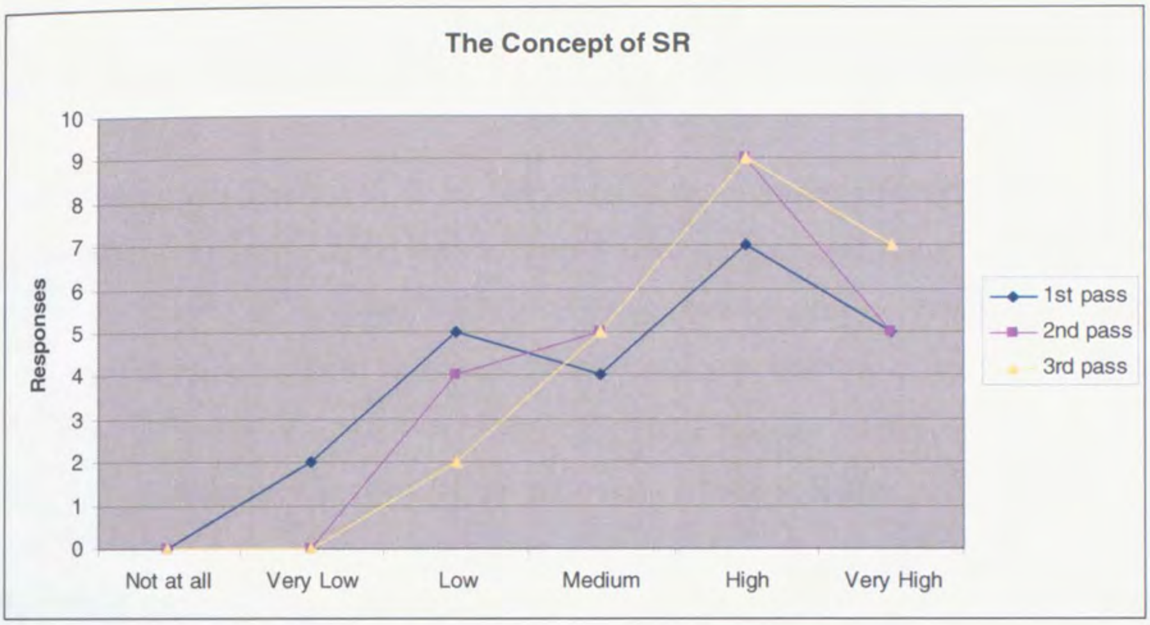

Chart 48 Question 4.1

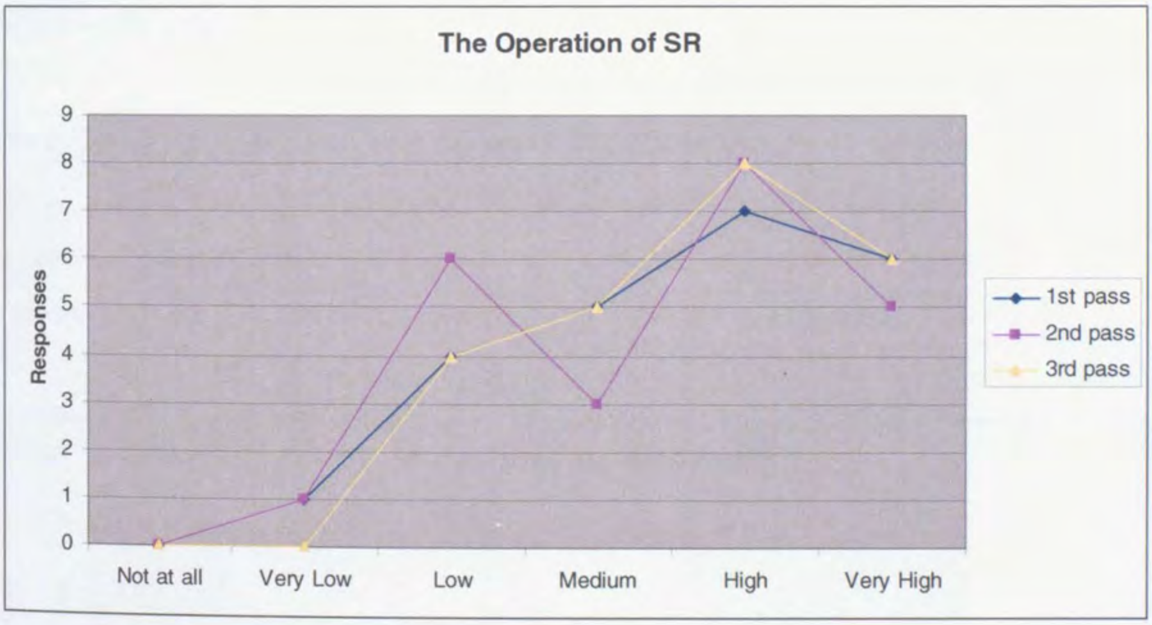

Chart 49 Question 4.2

Except from some relatively small and therefore not significant changes in the attitudes of the respondents, they exhibit an extremely reassuring consistency in regard to both these questions. Furthermore, comparing the two charts, one can easily juxtapose the curve of the 3rd pass in both of them, and find out an extremely matching similarity between them. This gives ground to the belief that people did not necessarily feel comfortable with the attempt to make a distinction between the concept of SR and the operation of an SR – though obviously these are two distinct matters, it is quite normal for them to mistake themselves – we should keep in mind that their responses came as the result of a limited time exposure session and not of a longer term living with and employment of SRA for daily work tasks.

The next question aimed to find out 'why the corporate learning process is facilitated by the concept of the Situation Room'. Two options are provided, namely:

- The 'war' analogy applies (better) when dealing with our own self-development and improvement. And secondly that
- Learning is a continuous process. The corporate intelligence exercise is therefore well served by the notion of a Situation Room.

To both of these options a process of convergence towards more refined positions has gradually taken place throughout the three passes of the questionnaire, and as shown below in the charts.

An extremely positive outcome relates to the strengthening of the second option by the 2nd and 3rd passes, which speaks for the fact that this continuity that we claim to be a central feature of SRA, is something that can only experientially approached, in the case through the conduct of the experimental application scenarios.

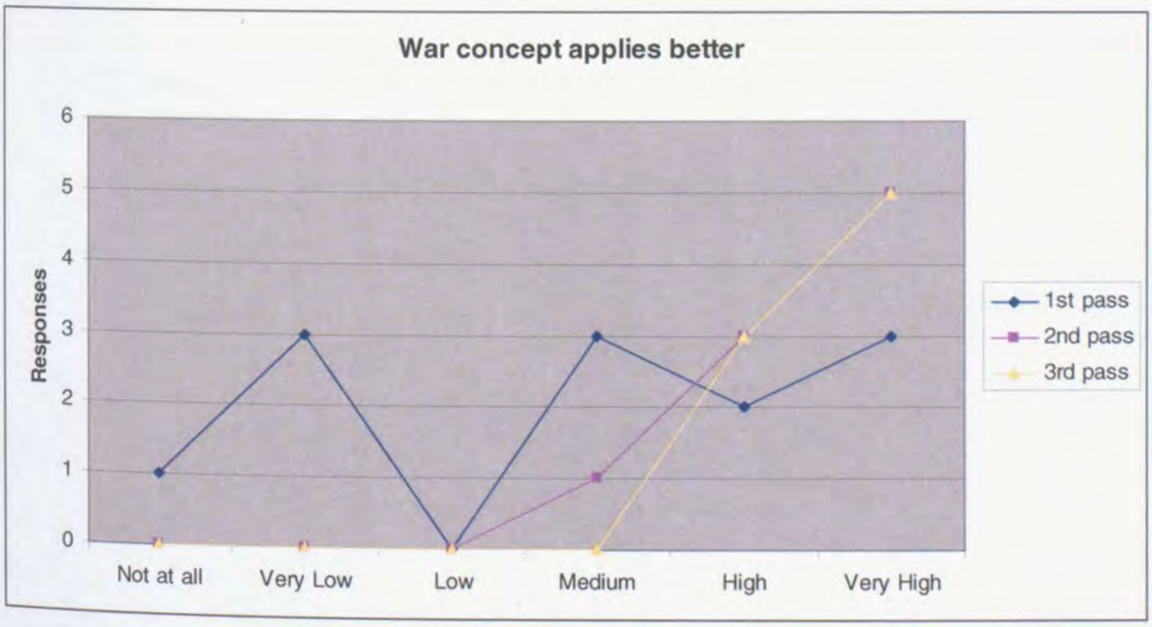

Chart 50 Question 4.3 – option 1

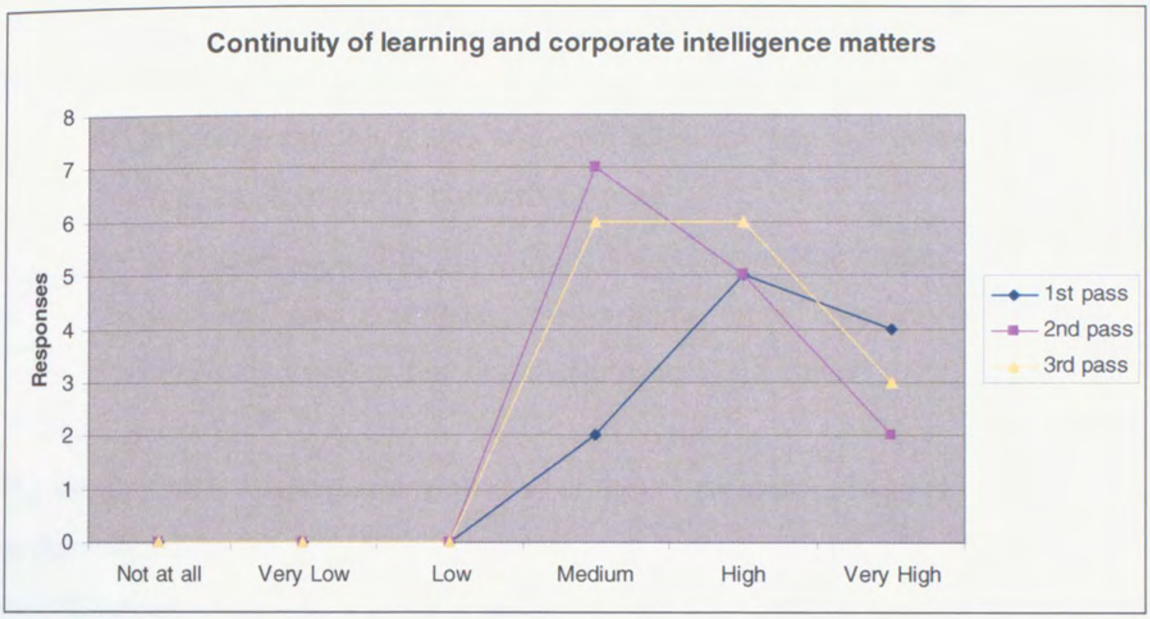

Chart 51 Question 4.3 – option 2

The last question in this section focuses on how the corporate learning process is facilitated by the concept of the Situation Room and provides, again two options:

- It is either that SR makes tasks and activities easy to organize, thus putting more emphasis to its expressive power
- Or it gives a feeling of comfort and facilitates the culture of sharing for processes and activities, thus putting more emphasis to emotional, semantic as well as functional affordances and aspects.

The results below speak on their own: after the 3rd pass, there is an obvious decrease in the respondents' belief that the catalyst is the organisational support, towards the second option which relates to more intangible and soft aspects.

For us, given the context and the scope of the exercise, this is provides sufficient evidence of a quality that is inherent to the design aspects of the research.

Chart 52 Question 4.4 – option 1

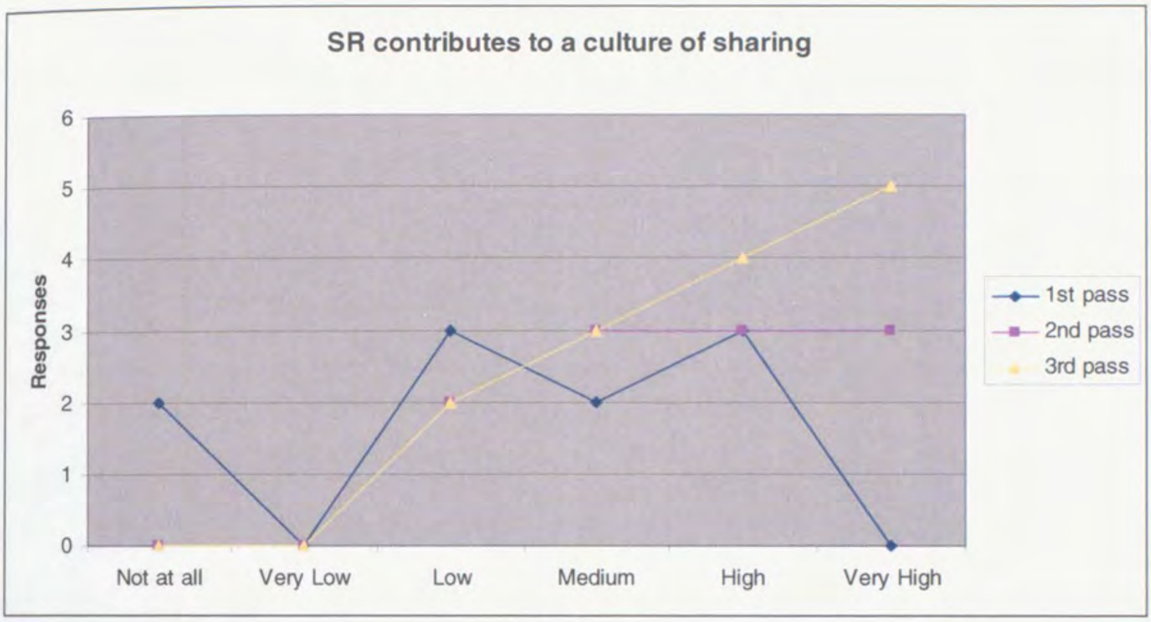

Chart 53 Question 4.4 – option 2

5.1.5. Fifth hypothesis

The validity of the fifth and final hypothesis has been demonstrated by five questions, the final of the questionnaire. We present them below together with the corresponding charts with the results.

The first question aimed to foresee whether companies should be 'equipped' with a Situation Room – at the end, does it make a difference in the valuation between two companies, one with and another without a Situation Room? Respondents were checked on the validity of the argument that the one with a Situation Room has an advantage.

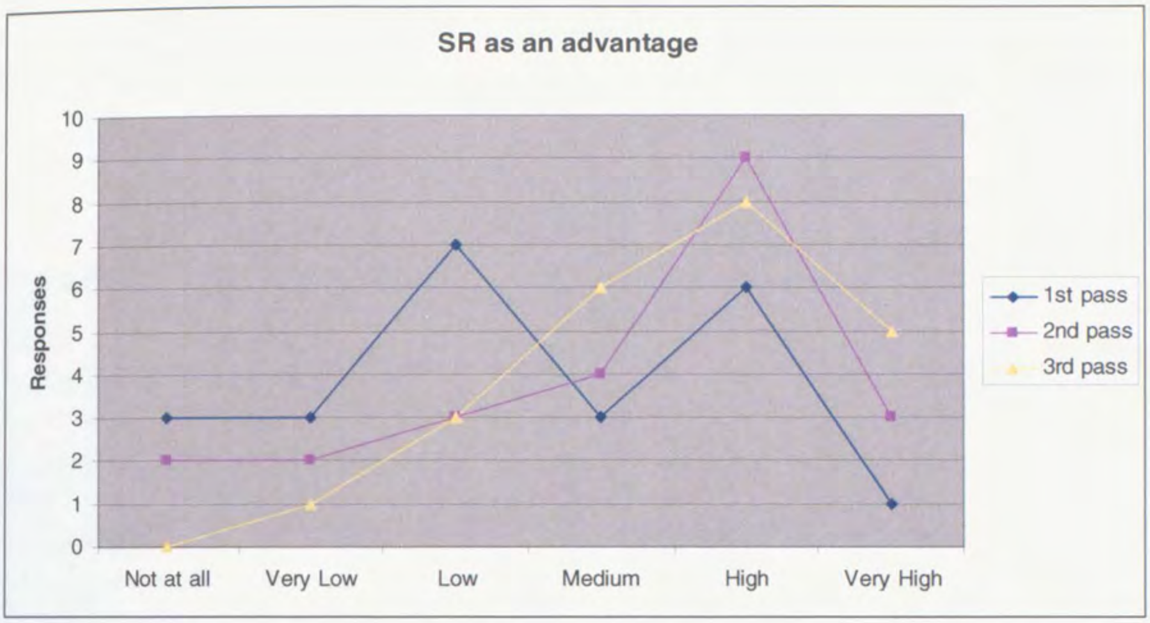

Chart 54 Question 5.1

The next two questions aimed to identify the means to recognize a potential increase of the corporate knowledge capital through the use of Situation Room Analysis. More specifically we ask firstly whether an increase of the corporate knowledge capital should be made

- Either *directly* on Situation Room related benchmarks such as frequency and intensiveness of operation, amount of tasks performed, etc.
- Or *indirectly* on Situation Room related benchmarks e.g. number of new products, increase in sales, improvement of product development cycles, etc.

Results are presented below in the respective charts.

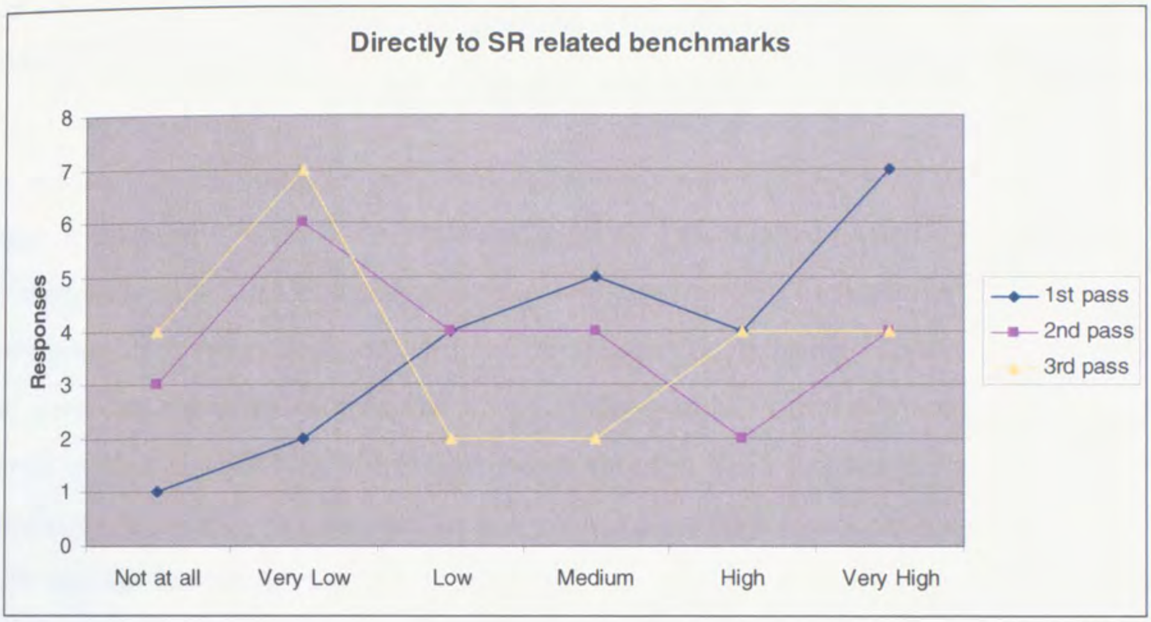

Chart 55 Question 5.2

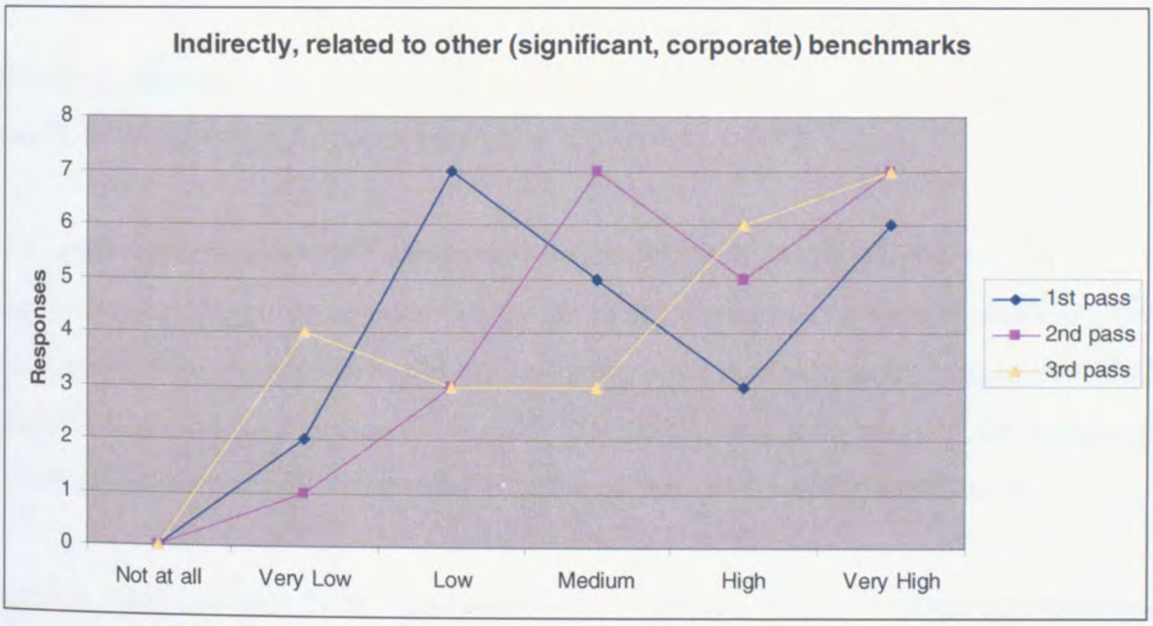

Chart 56 Question 5.3

Using the proximity in the presentation of the two charts, it is tempting to recognise an inversion in the attitudes between the 1st and the 3rd passes. More specifically:

- The curve describing the 1st pass of option 1 becomes similar to the one describing the 3rd pass of option 2.

Why is this happening and what does this mean to the hypothesis? Simply, it means that the *distribution of attitudes* that people showed by the time of the first pass regarding the fact that an increase of the corporate knowledge capital should be made *directly* on Situation Room related benchmarks has given its place to the distribution of attitudes by the time of the third pass but this time related this only *indirectly* on Situation Room related benchmarks.

It is an important change – and most importantly it is difficult to explain. It is quite normal for people to ask for a direct relationship. Let us consider an example scenario: a company invests an amount of money and resources in the establishment and the operation of a Situation Room. One of the reasons relate to the support and fostering of corporate learning. Nothing is wrong if the people from the Management Board wish to look in direct measures and assess through them the success or not of their initiative. This way, they would look at figures like: how many people populated the SR and for how long, how many decisions were made and how many actions have been planned. We are all used of this myopia that exhibits a last for figures and statistics – much of which is not necessarily meaningful or sense making.

However, the relation to indirect benchmarks that are not (necessarily) SR-related or –based, is an extremely important aspect as it provides to SRA a goal orientation.

We wish only things were same easy to understand as far as the next question concerning the valuation of a SR. Valuation is usually mixed up with evaluation – we have avoided this to happen as we explicitly provided guidance to the respondents that aimed to link the term valuation with the SR as an intangible asset of the company which increases its book value, similar to the capture of a fixed material asset.

For this what can only be recognized is that there are clearly two subgroups amongst the respondents, and that both of them used the three passes of the questionnaire to improve or refine their views.

This is a fair thing to happen – it actually supports the view that SRA can successfully apply to the corporate world and to different schools of thought, people with differing and opposed in certain cases views on issues related to learning and learning theories.

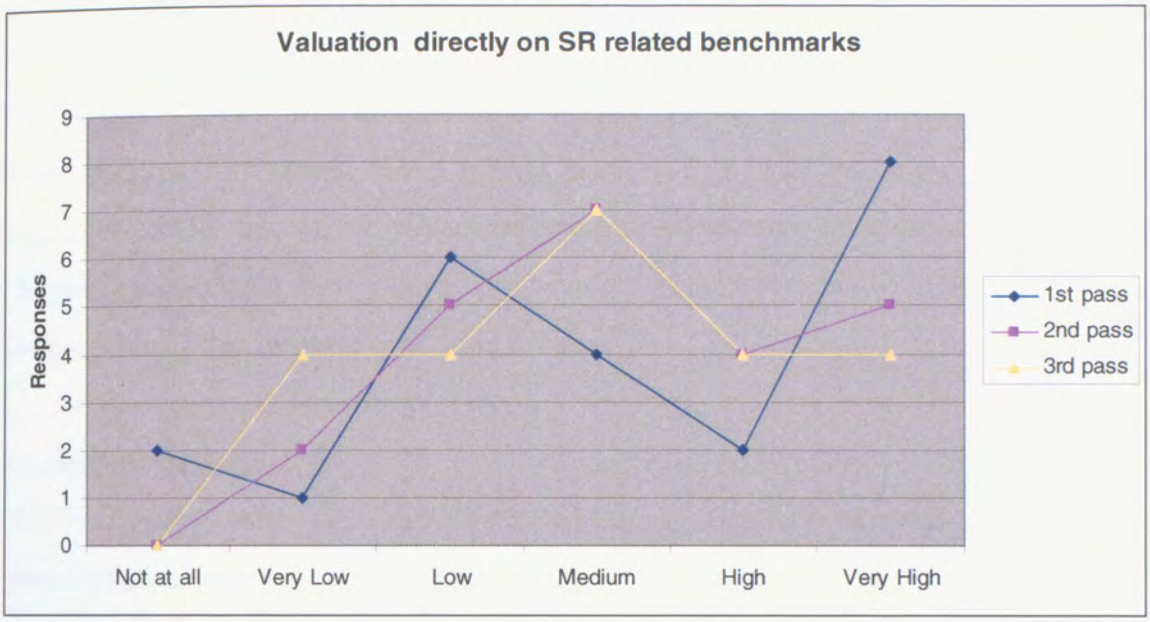

Chart 57 Question 5.4

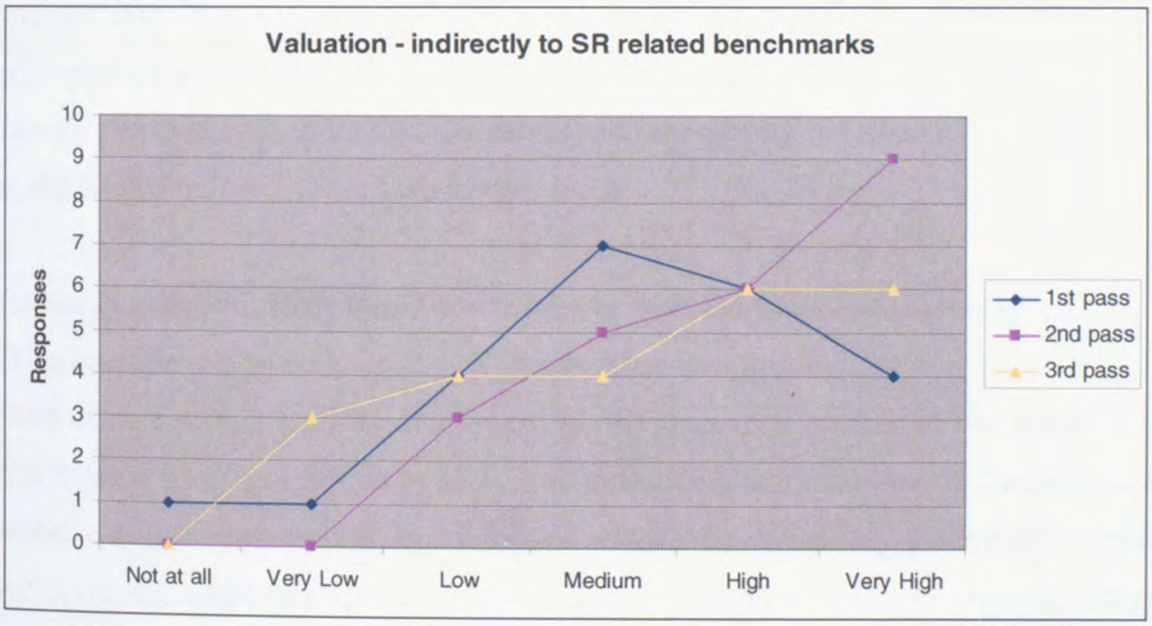

Chart 58 Question 5.5

5.2. Conclusions drawn from the application scenarios

This section contains the conclusions of the posed research hypotheses, as these have been validated throughout the previous section. For assisting comprehension and readability of the section, we are not referring to all research questions that have been addressed and which were extensively covered previously, while in some cases we have combined two or more questions in one.

Research Hypothesis 1:

The metaphors and the various types of conceptual schemas and mental representations that people – either as individuals or as members of a team – use for carrying out most types of product development tasks, spanning from relatively 'simple' and 'straightforward' ones to those we tend to regard as more abstract, sophisticated or complex, have an increased significance to the ways these tasks are carried out, to the practices that are developed for carrying out these tasks, as well as to the overall 'culture' that characterizes them.

Research question: How familiar are people with the notion of (a) metaphor?

(This question relates with Chart 1 of the previous Section.)

With respect to this first research question, the responses confirmed our belief that that there is no single or homogeneous understanding from the site of the corporate world and user communities regarding the notion of a metaphor, or alternatively the terms paradigm and conceptual schema. In the three different passes of the validation questionnaire, it was clearly marked that no convergence could be recognized towards an unequivocally positive or negative finding.

However, and although metaphors have been cited widely as a challenge in corporate knowledge management initiatives, as many studies have shown, some of which extremely recent as for instance (Leidner, 2006), only few have considered their implications to organizational culture and knowledge sharing, or address the influence of culture on the approach taken to knowledge management. According to (Leidner, 2006), "whereas in one organization, the KM effort became little more than an information repository, in the second organization, the KM effort evolved into a highly collaborative system fostering the formation of electronic communities".

In this respect, the results for this first question as grounded by the responses acquired provide an objective non-biased starting point that supports the use of SRA to a general audience of potential users consisting of all possible subcategories, spanning from those that are highly familiar to the notions of metaphors to those that are hardly aware of such abstraction mechanisms.

Research question: How much are they exposed in the use of metaphor?

(This question relates with Charts 2 and 3 of the previous Section.)

With high confidence the results for this research question were clearly showing that there is a normal distribution amongst the attitudes of the participants in the research for the exposure they experience in the use of metaphors in their daily working life, while only a very small amount of people declared that they are not exposed at all in the use of metaphors.

Again, this response provides sufficient evidence for the validity of our hypothesis regarding the existence of a correlation between the use of a metaphor and the significance that this has to the ways tasks are carried out, to the practices that are developed for carrying out these tasks, as well as to the overall 'culture' that characterizes them.

Research question: What is the role of metaphors in daily tasks?

(This question relates with Chart 4 of the previous Section.)

In all three passes of the validation questionnaires, there has been a definitely positive assessment of the role that metaphors have in daily tasks, both in terms of their role in regard to the sharing of an understanding and the provision of sense making qualities to a given task, and to their ability to support the exchange of information and other necessary elements of an interaction process.

This outcome is supported by Schein (1985) who defines organizational culture as a set of implicit assumptions held by members of a group that determines how the group behaves and responds to its environment. At its deepest level, culture consists of core values and beliefs that are embedded tacit preferences about what the organization should strive to attain and how it should do it (DeLong & Fahey, 2000).

These tacit values and beliefs determine the more observable organizational norms and practices that consist of rules, expectations, rituals and routines, stories and myths, symbols, power structures, organizational structures, and control systems (Bloor & Dawson, 1994; Johnson, 1992). In turn, these norms and practices drive subsequent behaviors by providing the social context through which people communicate and act (DeLong & Fahey, 2000). Putting this into the context of knowledge management, organizational culture determines the social context (consisting of norms and practices) that determines "who is expected to control what knowledge, as well as who must share it, and who can hoard it" (Delong & Fahey, 2000).

And, again, there is an easily recognizable symmetry between the responses acquired for this questions and those provided to the next one.

Research question: What is the value that metaphors can bring in daily tasks?

(This question relates with Chart 5 of the previous Section.)

As mentioned above, the participants in the research provide a similar final pattern in their responses to this question as in the previous one. However, it is interesting to recognize that the path towards the final version of their responses is not the same, as the main discrepancy lies in the second pass where the responses in regard to the *value* of metaphors show a clearly different pattern when compared to the responses related to the *role* of metaphors. As supported by other findings of the study related to the appropriateness of metaphors for particular work tasks, we see that a dominantly bureaucratic culture seems to create the expectation among corporate members that the Management needs to provide a vision of purpose for the particular metaphor use before the corporate users and the various levels of the organizational members should embark on activities related to the use of these metaphors. Thus value is something not necessarily subject to be proven in terms of utility taken or perceived, but also a matter of intra-corporate promotion and 'selling'.

Research question: Where does the background of metaphors come from?

(This question relates with Chart 6 of the previous Section.)

Perhaps one of the most interesting questions we asked the participants. From the available options for answering, the corporate reality and the everyday life attracted the majority of the responses.

The underlying objective of this research question was to improve information integration in knowledge-intensive business tasks taking place as part of the Situation Room sessions. Especially for big companies and organizations, where information integration has become a major issue during the last decade, the choice of the original application domain which shall constitute the background of the employed metaphors can have a major impact to the success or failure in the adoption of a new system, and relate with the following factors:

- The vast amount and the huge growth rate of all kinds of documents, ranging from e-mail to project descriptions and other reports.
- The significant variety and complexity of IT infrastructure in use in medium to large enterprises, ranging from legacy systems to modern web servers.
- The dissemination of corporate knowledge across structured formats, like in relational databases, and unstructured formats, like in text and office documents.
- Partly missing know-how or missing time of employees to scan results from these heterogeneous resources for content relevant to their work and to learn improved searching techniques (especially this…).
- The variety of work- and communication flows and corresponding different information needs for people in various job roles.
- The variety of conceptual structuring or the absence of such structuring in the corporate document bases.
- The variety of languages and terminologies in use (even for generally accepted and commonly used terms like competition or market, are we sure that all people understand *exactly* the same thing when mentioned?).

It is for these reasons that the limitation of the metaphors selection space to the corporate reality and the everyday life serves the efficiency and effectiveness in the adoption of new patterns of work and should be respected.

Research question: Are metaphors affecting the style and culture of the working environment? Are there more gains and benefits with respect to costs and problems in the use of metaphors?

(This question relates with Charts 7 to 14 of the previous Section.)

Again for this question the participants in the research showed a generally positive disposition, acknowledging the influence of metaphors in the working patterns and the daily reality of their work. However, their responses were not as emphatically confirming as we expected them to be. Trying to trace back to the reasons for this, we identified after discussions with the participants that their reservations in expressing a stronger attitude and position to this question related to their own perceptions of the organizational culture within their working environments. As a help to understand this can be used Earley's (1994) work on organizational culture which emphasized the individualistic and collectivistic aspects of culture. More specifically, companies encouraging individuals to pursue and maximize individuals' goals and rewarding performance based on individual achievement would be considered to have an individualistic culture, whereas organizations placing priority on collective goals and joint contributions and rewards for organizational accomplishments would be considered collectivist (Chatman & Barsade, 1995; Earley, 1994). This dimension of organizational culture emerged as critical in our examination of the influence of metaphors on the style and the overall culture of the working environment.

Research question: What is your perception of a Situation Room?

(This question relates with Charts 15 to 21 of the previous Section.)

The distribution of the participants responses is rather normal in terms of showing confidence and understanding to the possible implementations of a Situation Room with respect to their own working environment and in direct linkage with tasks and activities that they currently perform. For this, there exist discrepancies between the three passes of the validation questionnaire but in no case do they constitute a basis for inferring any significant change in the people's acceptability or ability to conceptualise the role and / or the utility of a corporate Situation Room. Though we had been originally expecting some type of change in the participants' responses, again it can be very well grounded why this has not happened. More specifically, this has to do with the role of the three passes in the validation procedure: while for some questions this gave the opportunity for identifying changes and shifts in the people's attitude and perceptions, for some others, there was no such change to take place. It is therefore that we accept this as a valid and correct part of the conducted research.

Research question: How is product development regarded in your company?
(This question relates with Charts 22 to 25 of the previous Section.)
This closed set question provided four options as answers to the research participants, namely that product development is to be regarded either as related to some strict procedures that need to be followed, or that it is a process open to improvements and new styles, or that it is a strongly collaborative process, or, finally, that despite the involvement of several people it remains a procedure that follows strictly defined paths.

Product development can be described as a knowledge-intensive activity (Meyer & Utterback, 1993). In a typical new product development project, managers, engineers and technicians apply the expertise that they have developed over time through being engaged in research, design and production, as well as the knowledge that they have gained from more formal education and training. At the same time, by being involved in a particular project, their skills and capabilities may potentially be enhanced as they interact with new people, and confront and solve new problems. The result of this activity is the development of a particular product. In the past, the collective learning gained from a product development project was not systematically reused in other potentially related projects. As a result, almost all new projects had to 'reinvent the wheel', in terms of the technical designs used and the procedures followed. Today, given the competitive pressures faced by organisations, this is no longer economically acceptable in many industries. Companies nowadays face new challenges in their attempts to improve the utilization of core capabilities and technological platforms in order to introduce as many products as possible from the same product family (Meyer & Utterback, 1993), reduce the time to develop a product family (Nobeoka, 1995), and better exploit the links between projects in a multiple-project environment (Clark & Wheelwright, 1993).

Initiatives that support these kinds of activities, supposedly through encouraging knowledge transfer and knowledge sharing (collectively referred to as knowledge management initiatives) have been proposed as solutions to the problem of improving product design and development (Clark & Fujimoto, 1991). Such activities that are aimed at exploiting the internal capabilities of firms (March, 1999) have dominated the product development scene. In the context of this research question and its subsequent one, our motivation was to explore the limitations in the use of Situation Room in the context of new product development.

The participants converged to the recognition that product development constitutes a process that is open to improvements and new styles, while supporting the argument of its collaborative nature. It is extremely encouraging the fact that the majority of the respondents did not go along with the position that there are strict procedures to follow.

Research question: Are there any reasons for improving product development process in your company?

(This question relates with Charts 26 to 28 of the previous Section.)

The peak in the participants responses concentrated to reasons related to the technologies. It is neither financial or economical reasons related to e.g. high costs, nor reasons related to the organizational dimension that were recognized as the driving force behind the need for improving product development processes in the corporate world. It is worth to mention here that in a post-validation exercise with a control group consisting of students in an MBA course, we asked them to separately order these three reasons according to their significance. They all set them in the reverse order from the one that actually resulted during the research i.e. they chose as priority the money, while technology was ranked as number three. The conclusion to be drawn is that though financial or organizational reasons may seem more important for outsiders, it is the technology that is the most important reason to drive changes in the product development process.

Our result goes well with a number of studies that have examined the practice of knowledge transfer and sharing in the context of product development. Meyer & Utterback (1993) discussed the transfer and sharing of specific technological components and platforms between projects as the source of core capabilities. The transfer of designs and knowledge between projects was also studied from a multi-project management perspective by Cusumano & Nobeoka (1998). Banker &

Kauffman (1991) focused on aspects related to designing software modules to be shared across products, and Markus (2001) provided an extensive review on knowledge reuse in product development environments, discussing the role of repositories in the capture and retrieval of information.

Research Hypothesis 2:

With the use of such appropriate metaphors, conceptual schemas and mental representations, which appertain to a particular task, being able to 'serve' it and sufficiently express its characteristics and idiosyncrasies, it is possible to improve substantially the way product development is executed.

Research question: How do you judge the appropriateness of a metaphor for a particular work task?

(This question relates with Charts 29 to 34 of the previous Section.)

Judgment of the appropriateness of a metaphor for a particular work task is, for easy to understand reasons, an important aspect of the success of its use and of the improvement issue that lies at the core of the second hypothesis.

For acquiring the participants' views, we had stratified the space of possible answers into six eventualities, namely:

- The appeal that a metaphor can have to a person;
- The successful application into the particular work tasks it has been employed for;
- The positive impact and overall efficiencies it can bring to communication aspects of the particular work it is used for, what one would be able to describe as expressive power of the metaphor;
- The acceptance from the people and the team that are exposed to its usage;
- The acceptance from the corporate Management; and finally
- The acceptance that is enjoyed by the market for the use of this particular metaphor.

Quite interestingly for this question there has been a lot of changes amongst the different options and several participants needed to change their initial attitude and converge to another option as result of their exposure to the hands-on application scenarios workshops. The results for this question showed the following:

Appeal does matter, as it also matters the successful application of a metaphor, but both of them do not count as much as it counts the communication potential of a particular metaphor and the efficiencies that a metaphor can bring to this particular corporate front. The same holds also for the acceptance factor by the people – as for the acceptance by the Management or the market, these seem to not form a serious concern for the participants at all, quite justly according to our opinion.

We look at the next two research questions together as they both aimed to shed light to the same aspect though from the opposite directions.

Research question: For a working task that is suboptimally executed, how much does depend on the choice of a non-appropriate metaphor?

Research question: For a working task that is optimally executed, how much does depend on the choice of an appropriate metaphor?

(These questions relate with Charts 35 to 37 of the previous Section.)

The answers we received for the two questions above confirmed the validity of the research approach and also the methodology we have chosen, as they provided the same results pattern. More specifically, the participants confirmed the direct correlation and reciprocity between the choice of a metaphor and its impact to a working task: you choose a wrong metaphor and you get an weakly- or even ill-served working task; you choose an appropriate metaphor and then you have an optimally performed task.

Of course, there is always space for examining the quantitative aspects of the above correlation; whether, for instance, a wrong metaphor provides equal 'amount' of suboptimalities (in whatever way one can define them, e.g. as user errors or mistakes in the performance of a task, or general lacks in the operation of a system, etc.) if applied to a working task, in comparison with the case of an appropriate metaphor and the savings that it brings to that same working task performance. But for the reasons of this study, this has been regarded as being out of the scope of the research.

However, it is extremely important, and to the best of our knowledge it is for the first time that such a correlation has been examined in the particular research context.

We again examine the next two questions together, as they both share highly related semantics: on the one hand we examine the diptych simple versus complex and on the other hand we examine the diptych abstract versus concrete.

Research question: Will metaphor use work better for simpler tasks than to complex ones?

Research question: Will metaphor use work better for concrete tasks than to abstract ones?

(These questions relate with Charts 38 and 39 of the previous Section.)

Our initial opinion after we completed the validation experiments with the participants in the research was that both these questions were expressed in some way that did not help the comprehension of the respondents, therefore the patterns in the answers were not enabling for some conclusions that are easy to recognize. What we now see, after having a complete overview of the participants' responses to the entire corpus of the validation exercise, is that the respondents did indeed get an accurate idea on the use of metaphors and their relative role to (help) perform simple or complex tasks on the one hand, and more concrete or abstract tasks on the other hand.

What the results for these two questions show are that it is highly depending on the task whether a metaphor will improve its performance or not. In other words, those who would be seeking for a rule of thumb like 'do use metaphors only for complex tasks' or 'metaphors perform better if applied in abstract tasks', this is simply not happening and it would be a mistake to support any arguments on such reasoning.

Even if we look at the findings related with the use of the Situation Room metaphor for specific product development tasks, this is something not grounded on the acquired research results.

Research Hypothesis 3:

The usage of concepts and metaphors used in the context of military applications, as it is the case with the proposed Situation Room, is likely to prove extremely useful and rewarding for application in the area of product development in the IT sector, as well as in the wider area of related business processes.

Research question: How much close to the concept of a war can be product development and its related activities?

(This question relates with Chart 40 of the previous Section.)

We were afraid that the war-like analogy would provide sufficient space to the research participants for misunderstandings. However, there are certain phenomena that were speaking for our hypothesis: every year the U.S.A. Department of Defense issues a list of the technologies essential to its national security. And every year these "critical technologies" include many of the same items: gallium arsenide chips, photonics, artificial intelligence — and simulation. Why simulation? Because the Pentagon understands that one way to improve its chances in battle is to practice fighting.

The business community is just coming to recognize what the military has known for at least 150 years: competitive simulation allows managers at all levels to practice converting informed choice into timely action. From such practice come faster decisions, higher quality execution, and better integration. The essence of learning is doing; the essence of doing is teamwork. A product development strategy, like warfare, is an interactive, dynamic process. Most executives understand that business is no longer a one-move game. A CEO who would say "The competition is gaining market share, let's cut price" is a dinosaur. Managers need to look several moves into the future and anticipate the feedback loops and time lags built into any competitive situation.

The results we received for this question were positive in terms that they showed an acceptance of the product development as a war-like process. Even some of the participants that showed some reservations to accept this, after being exposed to the experimental sessions of Situation Room Analysis, they were taking back their original skepticisms.

Research question: How do you rate the drawing of analogies with war or war-like notions for work-related tasks?

(This question relates with Chart 41 of the previous Section.)

People that participated in the research validation expressed their moderate acceptance for the drawing of analogies with war or war-like notions for work-related tasks.

More specifically, the results we received should not be read in quantitative terms but in qualitative terms: it is *not* a matter of how many people agree in the use of war or war-like notions for work-related tasks, *but* a matter of how much positively people rate the use of such analogies. Though the difference in the wording is small and quite easy to mix up, the difference in the meaning is big.

For the results we received, one should for sure conclude that there is a tendency to accept the adoption of analogies with war or war-like notions for work-related tasks, however in no case does this relate to the gains people see in their use – this formed the content of the next research question described next.

Research question: Are there any gains from the use of war-like notions in the product development process?

(This question relates with Chart 42 of the previous Section.)

Just as important to the previous questions, the conducted Situation Room Analysis exercise revealed a list of action items that a team needs to focus on after the experimentation, and the barriers that can keep those items from being accomplished. Both the list and the barriers need to be preserved: the list of action items can become the transition to action following the SRA session, but the barriers can become the more important list — they are the obstacles that need to be cleared for significant change to occur within the corporate environment.

Use of SRA as a support mechanism for organizing product development tasks within a company builds teamwork. Just as it practices strategic integration, it practices human integration. This is the final, most important connection between the art of waging war and the collaborative product development process.

The results we received from the validation were clearly speaking for this.

Research question: Are there mainly positive or mainly negative aspects (emotional, conceptual, motivational, etc.) in the reference to a Situation Room?

(This question relates with Charts 43 and 44 of the previous Section.)

Though we did not expect this to happen, we were surprised by the results acquired for this question. Despite the three consecutive passes that had taken place during the validation procedure, which aimed to the convergence towards better grounded and safer inferences, there was no clear shift to only the one or the other attitude; however, it is interesting to the processes that took place between the three passes:

- At first, there is an explicitly identifiable pattern in the 'mainly positive' faction, i.e. those that support that the use of Situation Room concept has to show mainly positive aspects.
- However, there is an interesting decrease both in the confidence and the amount of the supporters of this position. While
- Several participants were attracted for not agreeing with the position that the use of Situation Room concept has to show mainly negative aspects. This means that instead of winning more supporters of the 'mainly negative' camp, the validation process showed a tendency to attract people the doubters of the 'mainly negative' one.

When trying to read through this result, one can clearly see that for sure it forms an improvement in qualitative terms, as the aggregate of the people that are either positively or not negatively dispositioned with respect to Situation Room has grown throughout the three passes. However, it is still important to look more closely to the results.

In our first attempt to come to an analysis of this research question, we have written in Section 5.1 that 'though obviously outside the scope of the research [it] is [extremely interesting] to read between the lines and see why someone selects to moderate a negative opinion than to choose an equally moderate but positive one'. Especially if these people have been previously exposed to the use of the Situation Room metaphor as a method to organise their actions and plan their decisions, this result needs some closer examination.

In Section 2.5.2 regarding the examination of ways to bypass infinite regress, we mentioned that in the context of the study, there are (at least) three different types of problems to face:

1. First, we have to decide how to decide (and this may lead to an infinite regress). Assuming we have decided how to decide,
2. we have to find the optimal level of information and deliberation before the decision rule can be used. Once again, it is possible that this leads to an infinite regress.
3. Finally, we might ask about the optimal use of a given set of information.

Having now in mind that the validation of the research questions did not take place in some isolated laboratory environment but came as the result of the participants engagement in the use of SRA as a way to approach real world cases, the results come as a direct outcome of the inherent drawback of SRA that relates to infinite regress.

As already proposed in the aforementioned Section 2.5.2, one way to cope with this is the separation of the different decision-making activities into different groups as made by Radner (1996). However, and due to limitations in the resources of the participants, we were not able to validate the performance of the grouping as an improvement of the participants responses to this question (i.e. more participants to vote for 'mainly positive').

Research question: What are the main disadvantages of applying the Situation Room metaphor in the product development process?

(This question relates with Charts 45 to 47 of the previous Section.)

This question was hiding our biggest fear, i.e. that the participants would see as a handicap of the method to apply in product development tasks, the reference to a war-like metaphor, and this either because it might transform a 'peaceful' activity in one with negative connotations, or for some obvious practical reasons (it is tiring to be in a 'war' continuously, as imposed when applying war-like analogies to the product development front which companies need to face continuously). Finally, we provided the participants with the option to admit that the conditions faced in the corporate world and how the companies need to organize their response to the competitive environment is very much close to this of a war. Again the results were interesting in terms that they showed us that:

- The participants assessed very lowly the negative impact of any war or war-like connotations
- Many participants expressed their concern and skepticism with respect to the practical implications of adopting such a metaphor for a continuous process, while
- Relatively few(er) ones expressed their view that there are no disadvantages at all with the Situation Room concept.

For the second case that has attracted also the majority of the participants' attitudes, it is important to underline that it would be interesting to examine the relationship they see with respect to the previously mentioned diptychs concrete – abstract and complex – simple. Again, due to limitations in the availability of the participants, we were not able to validate any interaction between them.

Research Hypothesis 4:

An important element, which marks not only the usefulness and utility but also the value of this particular concept of the Situation Room for support of the product development process, is the facilitation of the corporate learning process.

Research question: Is the concept of the Situation Room facilitating learning?

Research question: Is the operation of a Situation Room by the company facilitating learning?

(These questions relate with Charts 48 and 49 of the previous Section.)

To both of the above questions, the participants took a positive disposition in terms of confirming the validity of the statements: either as an abstract concept or as a tangible infrastructure, Situation Room can facilitate learning processes within the corporate environment.

Our result confirms that cognitive knowledge on the level of understanding requires that the learner go through a reflection period. Reflection is even more important when the required learning encompasses a person's affective development. The theoretical approach for the learning processes we applied takes advantage of experiential learning combined with reflection.

The design and planned learning activities during the validation exercise were *very* context dependent, varying in form and content according to the type of learning expected with respect to e.g. the problems, the goals, and the results desired of a particular corporate environment, management aspects, internal organization, etc. in this respect, the primary condition on the selection of a situation to be included in the learning process is that it is derived from a relevant corporate work related problem for the participants in an area in which they and the company have interest in improving or changing.

Research question: Why is the corporate learning process facilitated by the concept of the Situation Room?

(This question relates with Charts 50 and 51 of the previous Section.)

The learning process, in the way that we have approached it in the research, is based on a model where there are three concurrently operating processes, namely:

- a number of participants actively working together as a group;
- the group which identifies a work related situation to serve as the focus for the SRA session; and
- a learning process which supports the development of group problem-solving and decision-making skills to be treated as the intangible assets of the corporate SR.

Using experiments as part of applying SRA as a learning method has several advantages:

- It is a conscious setting of the process in which the participants have to define objectives, methods, outcomes, etc.: it offers the possibility of gaining awareness of action.

- It is a method for creating innovative experiences - to provide the opportunity for setting the stage for creativity, new thinking, and innovation, and there is no need to support the significance of the latter with the field of new product development.
- It fits very well with the learning style amongst corporate practitioners, which has to be much more active than passive.

The SRA group and teamwork should, for the most part, be centred on exercises, games and simulations of real world situations, and be related to the participants' 'normal' work functions. In this respect the appreciation of the two options provided to this research question is not of an exclusive nature; quite the opposite is happening, as the participants specialise their acceptance to the Situation Room as a means for supporting corporate learning *either* in terms of accepting that the 'war' analogy applies (better) when dealing with our own self-development and improvement *or* by recognizing that as learning can be regarded as a continuous process, the corporate intelligence exercise is well served by the notion of a Situation Room.

Research question: How is the corporate learning process facilitated by the concept of the Situation Room?

(This question relates with Charts 52 and 53 of the previous Section.)

With this question the set of questions related to the fourth hypothesis is closed. Two different options were tested, i.e. whether SR makes tasks and activities easy to organize, thus putting more emphasis to its expressive power, or whether SR gives a feeling of comfort and facilitates the culture of sharing for processes and activities, thus putting more emphasis to emotional, semantic as well as functional affordances and aspects.

The results we have taken are self-explanatory in terms that they speak on their own: there are fewer participants that believe that catalyst for the learning process is the organisational support provided by the SR concept, while the majority of the participants recognises the positive contributions of SR to the creation of a culture of sharing for corporate processes and activities.

For the experimental sessions, the learning process was designed so that participants would learn to analyze their chosen situations, to designing alternate process structures, to generate and test solutions (: rather solution concepts, as they did not have the space of applying any of them into real life), and to evaluate tested solutions (again: solution concepts) in terms of negative and positive consequences before presenting their results to the corporate management. It was hard for the groups to start using SR time for reflection.

Another part of the learning process involved attempting to do something in another and better way. The participants did in fact have many ideas for tackling with their situations. The challenge was mainly to learn to test and argue why one idea was worth trying. They had to learn the different ways of formulating and testing ideas. To address this, SR was a great eye-opener for most of the participants. One participant stated: 'In the company I just had an idea and sometimes I also had the opportunity to try it out. Sometimes it functioned and sometimes it did not: it was simply a matter of trial and error. But now I am much more aware of which experimental instrument I am going to choose, and the importance of having a test exposure, so that I can convince other colleagues and the Management.'

By the time the training was concluded, all of the groups had formulated a well-analysed situation with solutions that had either been discussed or for which there was a plan for coping with them.

Focus of experimentation seems to give SR participants a better understanding of their own resources and expertise: they are more conscious about how they can proceed in a new SR session. Still, the approach raises new challenges for them as well as for the people responsible of the introduction of SRA in the corporate environment.

The first challenge is to convince the SR participants that understanding and using SRA as a systematic learning process is a way of understanding SRA as a systematic problem solving process. A second challenge is to start working with reflections. The word itself is difficult, so we have to overcome resistance towards the concept by using exercises during the training and introductory period of SRA. After a while (and if allowed by the corporate Management…), the SR participants can see that a fire fighting approach to problem solving wastes time in the long run.

Research Hypothesis 5:

Both the use of the concept of Situation Room and its accompanying framework for application in the corporate product development process grid and decision making activities, as well as the contribution they make to the increase of the corporate knowledge capital, can be regarded as essential intangible assets of a company (or an organization), and as such they can be assessed and valuated by means of quantitative and qualitative approaches.

Research question: Does the existence and the operation of a Situation Room make a difference in the valuation of two companies? Does the one with a Situation Room have an advantage?

(This question relates with Chart 54 of the previous Section.)

Participants have unequivocal accepted the validity of this statement; though there is a 'tail' of responses that are spanning from the denial of SR contribution to the advantages that SRA can bring to the valuation of a company, the results clearly show a peak in the acceptance of this statement.

Research question: Should an increase of the corporate knowledge capital be made directly on Situation Room related benchmarks e.g. frequency and intensiveness of operation, amount of tasks performed, etc., or indirectly only on benchmarks like the number of new products, increase in sales, improvement of product development cycles, etc.?

(This question relates with Charts 55 and 56 of the previous Section.)

From the time of the first pass to the time of the third and last pass of the validation questionnaire, there has been a change in the people's attitude towards this question:

In the beginning, participants were mainly thinking that an increase of the corporate knowledge capital should be linked with *direct* Situation Room related benchmarks.

In this respect, a high frequency or an increased intensiveness of SR operation, as well as an increasing number of tasks performed would be recognized as indicative of an increase in the corporate knowledge capital. Quite *not* surprisingly, after they were exposed to the experimental SR sessions, the participants changed their view and they now agreed that it is better to look at some indirect benchmarks like the number of new products, increase in sales, improvement of product development cycles, etc.

We see this result as entirely normal that goes well with the nature of SRA as an intellectual corporate asset.

Research question: Similar to the above, should the valuation of the Situation Room be made directly on Situation Room related benchmarks or on indirect benchmarks only?

(This question relates with Charts 57 and 58 of the previous Section.)

To this last question, the responses were divided: there were two subgroups amongst the respondents which used the three passes of the questionnaire to improve or refine their views. This is a fair thing to happen – it actually supports the view that SRA can successfully apply to the corporate world and to different schools of thought, people with differing and opposed in certain cases views on issues related to learning and learning theories.

There is no denying the importance of intangible assets. Since 1980, the average ratio of market capitalization to book value for U.S. companies has swelled from just over 1 to more than 5 - even after the relatively recent collapse in stock prices. In this respect, differences in market and book value are (rough) estimates of the value of intangibles. But, on average, intangible assets now represent about 80 percent of the market value of public companies. One possible explanation for the growth, of course, is that a whole lot of irrational exuberance has inflated corporate stock prices far beyond the value of the assets that the shares have claim to. The more likely explanation, however, is that financial statements prepared according to accounting practices fail to reflect the true value of a company's assets and operating performance.

In an increasingly competitive, knowledge-based economy, intangible assets, such as brand awareness, innovation, and employee productivity, have become the key determinants of corporate success. And given that the investments companies make to build those intangible assets - such things as advertising, employee training, and R&D - are flushed through the income statement, balance sheets are increasingly a poor reflection of the value of companies' businesses. And in contrast to the traditional accounting system that is focused on transactions and historical costs, to determine the future value of a company, one should not only look at past history, but need to employ new measures to project forward. Situation Room Analysis has been presented as such a measure that can successfully be employed to leverage the increase of the corporate knowledge capital and support the agility potential of companies in regard to new product development tasks.

5.3. The assessment exercise

In parallel to the validation of the research hypotheses, we developed an assessment questionnaire with the aim to assess the overall utility of SRA as a corporate value adding process. The questionnaire template is given in Appendix 4 and Appendix 5 provides the completed questionnaire with the workshop participants' responses. The approach was same to the one followed for the validation of the hypotheses: After the initial short introduction to the SRA framework and a presentation of its application in product development activities and decision-making, we asked the participants to fill out a questionnaire listed in Appendix 4. The answers to this first pass are listed in Column described as '1st pass' in Appendix 5.

As one can see from the questionnaire, especially questions 4 to 10, costs and resources needed for 'feeding' and maintaining the system is an all too important matter. This occurred when one member of the group identified that this (: classification of situations) would be a perfect system for them for the case of organising their product development strategies with respect to their competitors and the general industry trend, while she took for granted:

- The connectivity with their existing Information Systems and applications (ERPs, marketing databases, etc.)
- The format of data for 'composing' exemplary cases.

In this respect, we presented an analysis of the potential cost categories that are incurred after introducing the SR framework to their companies. Even if the basic framework is given for free, a company still has to invest substantial resources in:

- Training of the employees in learning to use the SR framework, related to the people exposed to it – which is actually a far bigger audience than those people that will actually use the system;
- Using the SR framework for accumulating knowledge 'chunks', related to the people using it each time.

We should not forget that these people will also spend some (scarce) productive time for using the SR framework and time might vary having a typical average of some X minutes on a per day basis. Throughout the initial introductory period, corporate users will invest more than they will use, and sooner (how soon?) or later (how late?) they will also start 'using' the system which means consuming / exploiting the accumulated knowledge.

A further side effect of the above issue comes from the still undefined for many companies cost (and respectively its linked opportunity cost) for learning something (and respectively for not learning something). Though quite important, companies tend to ignore it; they only face this when late, and as one of the participants mentioned, it is usually "after a learning crash when they recognise that they had severely undervalued the learning experience".

At this point, the participants were asked to fill out again the questionnaire, without having access to their previous answers. Due to the informal and friendly atmosphere, for which we adopted patterns reported in (Nemiro, 2003), people felt comfortable to revise the answers they gave for this second iteration. The results for this are presented in the Column described as '2nd pass'. Significant changes are apparent – in most cases affecting both the core aspect of each separate question and the overall picture participants had for the SR framework in total. We note that about 35% of the combined participants' responses had changed from pass 1 to pass 2, and this trend continued during the third and final iteration; we comment on this later in this Section.

What we also identified during the workshop is that companies do not feel 'framed' or constrained by labels such as 'K(nowledge)M(anagement)' or 'multi-party collaborative decision-making' (Karacapilidis, 2001), and in this respect they are open to using methods and adopting solutions that will really help them in their business. (How one calls these methods and tools is another matter). Whether a solution provided is facilitating better management of a business process or is helping them to carry out a business-value added process that does not have any implication to innovation other than it helps the company remain in a healthy financial position) are secondary level issues that should not concern anyone – at least at an early phase.

As a last step in our exercise, we asked participants to self-organise as groups and plan their actions for product development in each of the five case studies according to the principles of the SR framework so that they get exposed to the practical aspects of its usage. Results of this final iteration are reported in the last Column described as 'After trial'. Again it is easy to see the differences in the answers given. An analysis of the data from the assessment exercise indicates the volatility that is inherent to the answers given. From this we reason that the overall acceptability of a new method or approach faces different 'epochs' since the time we read about it in some book or journal to the time we face its application for ourselves in our company.

The change in participants' responses between 2nd pass and after the trial is at the level of 37,5%, and in total between the 1st pass and the post-trial at the total level of 46%. This change is not perceived as a shortcoming of the SRA framework nor of the approach we used, as the different options provided to the participants rather facilitate them by means of supplying them with the necessary redundancy that helps them to shed light in different aspects of their particular corporate decision-making process and their individual needs.

Efforts to identify the gaps and rationalise the (different types of) responses incurred are always useful if not a must; for instance, it is a totally different case this faced by a small enterprise that aims to bridge communication gaps and interfering zones of corporate decision power, than this of a large organisation that aims to employ the method for facilitating communications related to product development amongst middle level managers.

Apparently, the most important point that came out of the discussions and interactions we had with the corporate practitioners who participated in the case studies is that *though companies are not knowledgeable of the term situation room either as a term or as an experience-based practice, however they are using empirical forms of metaphors or analogy-like structures each day and for many different tasks at all levels.*

This is extremely critical to take into account when considering that there is a notable trend, certainly in the industry sector, for increased use of collaborative learning and for labour-intensive tasks in the corporate environment, as reported in (Beyerlein, 2002) for two disparate reasons. The first is the belief in its educational advantages including greater employee enjoyment and motivation as well as greater relevance to real-world modes of working. The second, as expected, has to do with monetary utility ('money'), and concerns the perceived cost savings compared to conventional individual-oriented and ad hoc practices.

5.4. Synopsis

We presented the content that was created as part of the experimentation sessions on the five application scenarios which were conducted in order to assist the validation of the research hypotheses, followed by an assessment exercise. Discussion of issues related to each of the findings we came across has taken place, and some general outcomes of the validation process have been presented and documented.

6. Situation Room model

This chapter presents the first contribution towards the development of the Situation Room Analysis framework. More specifically, it describes the component (sub)models for Situation Room semantics, Information Management, and Situation Analysis. Especially regarding the latter model, this consists of 4 building blocks which address the overall situation environment, the (corporate) organizational infrastructure, aspects related to goals and strategy, as well as a final component related to assessment issues and which they form the *the why* and *the what* parts of a traditional roadmap. It also includes two sections devoted to the description of the semantic indexing technique and the ontologies, which are considered as essential parts of the proposed SRA architecture.

6.1. Overall model specifics

We have to consider the main entities with which we will proceed in defining the basics of Situation Room Analysis. These are at first notions that are related with:

- the concept of the Situation Room per se,
- the managed information within the SR, and
- the main items of the conducted analysis which in our case focus on products and services in the IT market, as also has been given from the presented application scenarios.

In regard to all three of them we are proceeding in defining three corresponding models, namely:

- The Situation Room Model (SRM),
- The Information Management Model (IMM), and
- The Situation Analysis Model (SAM).

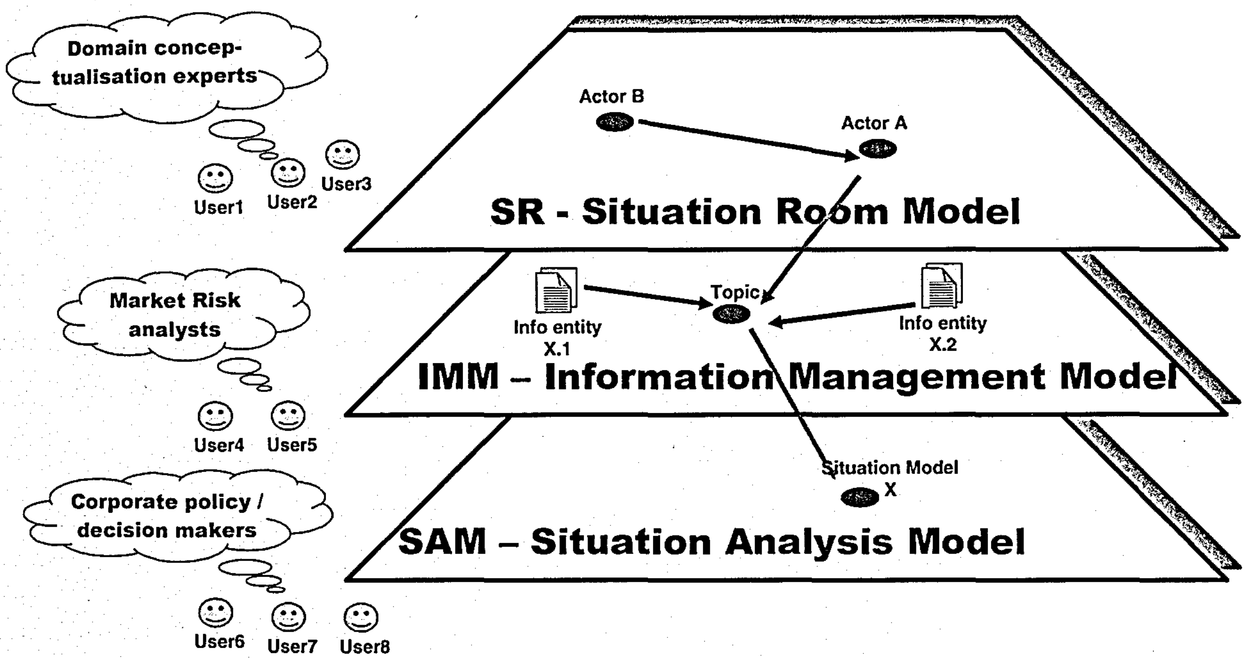

Figure 7 Representation of the three submodels in plane form.

They all concern descriptive conceptualisations of entities and activities annotated with the interactions and possible relationships amongst them, which results in a super-model namely this of the introduced Situation Room Analysis.

Figure 7 above gives an overview on how these three different submodels could be related with each other as if they constitute different planes that are defined in a common space. Entities that are defined in the one plane may interact with other entities residing either on the same plane or with entities of another one without any conflict. This is not in conflict also with the fact that different planes are subject of examination and care by different categories of users: while the population of SAM with situation data is mainly task of some corporate policy and decision makers, IMM is more possible to be subject of continuous processing and updates by market analysts, etc.

Information, as expected, is regarded as the key term for the model. As with the management of any other resources (human, organisational, technology, etc.), information needs to be treated within the SRM as an integrated business resource.

The particular setting to be established within the SR, reflected to its respective organisation needs to plan its future information needs and effectively use and manage existing information to support its activities.

For example, we consider the case of a corporate – interdepartmental – Situation Room; information is at the core of its business. The SR has as duty to treat the information it *collects* and *produces* as a valued resource; it must ensure that the information is secure, accurate and used appropriately. Improving access to a specific information resource adds value to the entire information infrastructure. The more a piece of information is used by the SR, the more cost-effective it becomes for it to store and distribute it. This supports the need to employ the classification of the decision-making activities as presented in Section 2.5.2 for layering functions and activities within the Situation Room in terms of different types of operations, thus making a clear distinction between the cost elements related to each of them.

Recent technological advances in the Semantic Web support the integration of information into open accessible networks. The introduction of these new technologies means that the authority 'running' an SR (be it a public entity or a private business) can utilise its information to better serve its core purposes, by sharing information efficiently among different persons and / or agencies. However, the lack of a clear whole-of (big picture) approach to information management would be limiting the accessibility, and therefore the value, of such an SR.

To draw an analogy with the area of Web, we would rather see a need for supplying the SR with a search-engine like infrastructure, in order to tackle with the case of information reaching that point where its quantity is starting to exceed our ability to search it.

Though search engines have been in existence for many years, it is only until relatively recently that there has been recognised the need for specialised tools for use by experts. And though the initial need may have been for tools designed to search *static, well-indexed, well-defined* data collections, today's tools have to cope with *rapidly changing, heterogeneous, insufficiently-(or even ill-)indexed and -defined* data collections that are orders of magnitude larger than ever before.

In regard to improve operations within the SR, there are three main items we demand from its supporting infrastructure:

- We want it to give the SR participants all of the relevant information available on the situation under consideration
- We want it to give the SR participants only information that is relevant to our situation[14]
- We want the information organised and ordered in some meaningful way, so that the SR participants see the most relevant results first.

The first of these criteria - getting all of the relevant information available – concerns the *recall* capacity of the SR. Without sufficient recall the SR has no guarantee that valid, interesting info shall not be left out of the result set. Therefore, we want the rate of *false negatives* - relevant results that we never see - to be as low as possible.

The second criterion - the proportion of information in the result set that is relevant to a situation under consideration - is called *precision*. With too little precision, useful results can get diluted by irrelevancies, and the SR participants are left with the task of sifting through a large set of information to find what they want. In accordance to the above, high precision means the lowest possible rate of *false positives*.

Finally, there is an inevitable trade-off between precision and recall: search results generally lie on a continuum of relevancy, so there is no distinct place where relevant results stop and extraneous ones begin; the wider we define the settings, the less precise the result set becomes. This is why a third criterion, namely *ranking*, is so needful. This has to do with whether the result set is ordered in a way that matches our intuitive understanding of what is more and what is less relevant. Of course the concept of 'relevance' depends heavily on the SR participants own immediate needs, the overall context of the situation, and in particular the context of their search.

[14] This can be regarded also with some slackness, as in many occasions we do prefer to get also information on related / similar or even totally dissimilar situations, for personal information completion reasons.

6.1.1 Comparison of SRA with the Living Labs modelling technique

A recent aim of the European Commission is to support the pan-European creation of Living Labs as new forms of cooperation between government, enterprises, citizens and academia for a successful transfer of e-Government, e-Democracy and e-Services as well as other state-of-the-art applications, solutions, know-how and best practices. Quoting the European Commission, *"Innovation takes place when knowing what the market wants is brought together with knowing how to do it, in a new context"* (CEC, 2005).

The Living Labs concept is about moving out of laboratories into real-life contexts. In the past years, a number of national experiences can be mentioned across Western Europe[15], and more recently, an integration effort has been set out in a trans-European perspective as part of the FP6-IST Project CORELABS, started in March 2006 under the "New Working Environments" Unit of DG Research (CORELABS, 2006).

Furthermore, on November 21st, 2006, the Finnish EU Presidency has launched a European Network of Living Labs for the "co-creation of innovation in public, private and civic partnership". This is the first step towards a new European Innovation System, entailing a major paradigm shift for the whole innovation process.

But let's look at what exactly is a Living Lab and why we compare it as a related technique to SRA.

A European Network of Living Labs is a collaboration of Public Private Partnerships where firms, public authorities and people work together in creating, prototyping, validating and testing new services, businesses, markets and technologies in real-life contexts, such as cities, city regions, rural areas and collaborative virtual networks between public and private players.

[15] This idea started at MIT Boston with William Mitchell, *MediaLab* and *School of Architecture and City Planning*, with experiments spanning from the US (http://architecture.mit.edu/house_n/placelab.html or http://www.sfu.ca/livinglab or http://www.calit2.net/research/labs) to Singapore (http://www.ida.gov.sg), from Finland (http://www.sparknet.fi or http://www.mobileforum.org or http://www.helsinkivirtualvillage.fi) to Norway (http://www.fremtidshuset.com), from Sweden (http://www.testplatsbotnia.com or http://www.livinglabs.se) to Germany (http://www.mobilecity.org or http://www.fokus.gmd.de/home), from the Netherlands (http://www.research.philips.com/technologies/misc/homelab or http://www.livingtomorrow.com) to Denmark (http://www.crossroadscopenhagen.com).

The real-life and everyday life contexts both stimulate and challenge research and development as public authorities and citizens do not only participate in, but also contribute to the whole innovation process.

From a market and industrial perspective, Living Labs offer a research and innovation platform over different social and cultural systems, cross-regionally and cross-nationally. This is a natural move for ICT, life sciences and any innovation domain that deals with human and social problem solving and people's every day lives. However, this new approach to research for innovation is a huge challenge for research methodologies, innovation process management, public-private partnership models, IPRs, open source practices, development of new leadership, governance and financial instruments.

This complexity increases remarkably with the international nature of a European Network of Living Labs, implying a set of large-scale experimentation platforms for new services, business and technology, market and industry creation within ICT environment.

The essential feature of a Living Lab is the consideration of *users feedback* and *experience* as an integral part of the testbed itself. European research has known the operational value of Living Labs methodology in 3 main areas so far:

1. Bringing laboratory based technology testbeds into real-life, user focused validation environments;
2. Developing mobility services for citizens in a real-world early adapter community with existing and close to market technologies;
3. Studying the collaborative working environments of the future from a pan-European perspective.

In all cases, the main focus has been on a user centred, context sensitive, multi-site and multi-stakeholder co-design or co-creation process, supported by mutual trust and implying the joint consideration of policy, market, societal and technological aspect with equal weight, as shown in the following Figure 8:

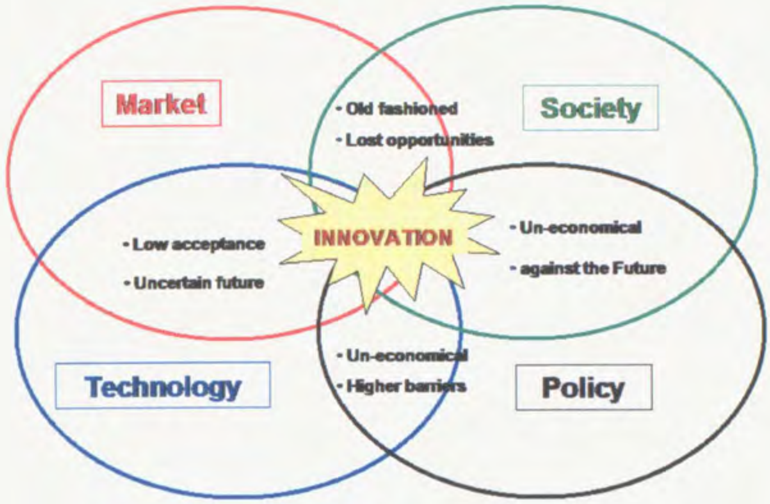

Figure 8 Human Centric Systemic Innovation Approach (from Eriksson et al, 2005)

Following, we identify five different phases of a Living Lab configuration process (Pierson and Lievens, 2005):

a) **contextualisation**, meaning a prior exploration of the technological and social challenges implied by the technology or service under investigation. Applicable methods are, consequently:
   - a **technological scan**, giving an overview of current and future technologies but also to map the specific functionalities and characteristics related to them;
   - a **(state-of-the-art) study** in order to determine the socio-economic implications of the research focus (framework as well as topic).

b) **selection**, meaning the identification of potential users or user groups, by means of non probabilistic or purposeful sampling. Useful criteria are, for instance:
   - the **maximum variation** of underlying phenomenon (e.g. education or age);
   - the search for a **significant variation** of observations (aka selective or criterion sampling);
   - the **theoretical variation** of relevant concepts (according to some preexisting study).

c) **concretisation**, meaning a thorough description of the current characteristics, everyday behaviour and perceptions of the selected test users regarding the research focus. In this initial **measurement** we look at specific user characteristics (socio-demographic and economic) as well their relation towards the introduced technology or service. The methodology used depends on the size of the test panel: for instance, a quantitative **survey** can be integrated, depending on the sample scale, by qualitative **interviews**. The initial measurement of the sample is made before a technology or service is introduced or before the test panel becomes active in the Living Lab; it then enables to perform a second measurement and a full evaluation at the end of the project.

d) **implementation** is actually the behavioural validation and operationally running test phase of the Living Lab. From a user-oriented and ethnographic viewpoint. We distinguish two major research methods:
   - **direct analysis**, using remote data collection techniques and strategies (like technological monitoring) and software logging tools (if applicable) on the device level (e.g. pda, mobile phone or digital television) as well as on the platform/network level;
   - **indirect analysis**, based on (thematically organised) focus groups, in-depth interviews and self-reporting techniques like diaries, all being applied to investigate the meaning and motivation for behaviour.

e) and **feedback**, consisting of two research steps:
   - an **ex post measurement** based on the same techniques of the initial measurement, to check if there is any evolution in the users perception and attitude towards the introduced technology or service, to assess changes over time in everyday life in relation to technology use and to detect transitions of usage over time.
   - a set of **technological recommendations** from the analysis of data, gathered during the previous implementation phase. This outcome of the feedback phase can be used as the starting point for a new research cycle within the Living Lab; in this way the iterative feature of our research cycle can be made operational.

In the tables below we try to compare the two modelling techniques with respect to their characteristics (Table 10) and in regard to the different processes employed during their application (Table 11).

Endogenous characteristics	*Living Labs*	*SRA*
user centred	✓	✓
context sensitive	✓	✓
multi-site	✓	✗
multi-stakeholder	✓	✓
co-design or co-creation process	✓	✓
supported by mutual trust	✓	✓
implying the joint consideration of policy, market, societal and technological aspects	✓	✓

Table 10 Comparison of the two approaches with respect to various endogenous characteristics

Though there is only one basic difference between the two techniques, this is quite important: Living Labs are conceived as a means to support long-term activities in the areas of innovation and e-participation over a widely distributed set of participating actors. This is not the case of the Situation Room concept; the latter though it mobilises different organisational actors within and outside the company (e.g. customers, suppliers or other value chain members), it uses as its fundamental cohesive element the notion of *situation*. In the Living Labs we don't organise the daily life around situations – like any living entity, e.g. the cell, a Living Lab faces different events or situations and its life is defined by them. This is on contrast to the Situation Room metaphor that aims to organise principles of (organisational, business or other participants') behaviour around the concept of the situation.

From an aesthetics point of view, it should be openly accepted that the Living Labs are a very modern concept. However, this can not succeed if the actors that are organising their work as member of a Living Lab are not having the appropriate tools to organise their routine in some language that can be shared and understood with the other members. And it is at this point that Situation Room Analysis may support the closing of this gap. On the other hand, Living Labs can be regarded as a very welcome add-on to the means provided by Situation Room Analysis, in terms of enabling the connectivity and networking of various Situation Rooms to formulate a new meta-entity.

Endogenous characteristics	*Living Labs*	*SRA*
contextualisation	Usually takes place through a technological scan or (state-of-the-art) study	Builds on a needs analysis or market needs; driver is empirical evidence
selection	Uses criteria like the maximum variation of underlying phenomenon (e.g. education or age), the search for a significant variation of observations (aka selective or criterion sampling) or the theoretical variation of relevant concepts (according to some pre-existing study)	Accommodates all sources of factors related to the application field, based on the participants experiences and familiarity with field practices. Encourages the use of cross-disciplinary problem solving paradigms and *ad-hoc* methods
concretisation	Methodology depends and may span from a quantitative survey to qualitative interviews	Methodology builds on the population of the three SRA models with field data and experimentation amongst the participants with various situations
implementation	They both take place either by means of *direct analysis* using remote data collection techniques and strategies (like technological monitoring) and software tools or of *indirect analysis*, based on (thematically organised) focus groups, in-depth interviews and self-reporting techniques like diaries, all being applied to investigate the meaning and motivation for behaviour	
feedback	Combining an ex post measurement and a set of technological recommendations from the analysis of data, gathered during the previous implementation phase	Reflected in the increase or decrease of utility acquired by the SRA, the differences in the usage patterns and the usage types, the culture that shall follow the adoption and the returns on investment

Table 11 Comparison of the two approaches with respect to the application process

We close the analysis in this section with an indication as to how the model can be implemented and validated.

Having in mind that some of the most essential problems that users, administrators, developers and vendors of information supply services, as well as in every application and service field, face today may be viewed under the common denominator of "interoperability" problems, the presented approach illustrates possible ways to address these problems when referring to the case of SRA implementation. A design goal of the research was to provide a cohesive technological infrastructure independent of any specific implementation pathway and to contain features that are effective and easy to use in a broad range of representative networked service environments which may be subject to variable configurations. For this reason we recognize the following types and broad categories of users:

1. SRA platform and service vendors (may concern IT companies, content providers)
2. Professional SRA service providers (as a specialization of the content provider category)
3. SRA Service developers (as a specialization of the content provider category)
4. SRA Service administrators (as a specialization of the content provider category)
5. SRA Service End users (i.e. enterprises – either public or private owned ones)
6. SRA IT managers (as a specialization of the previous End user category)

These users participate in one or more of the following four stages in the development and usage of the SRA-based service infrastructures that can be separately validated with respect to performance or cost-per-benefit-related criteria:

- *Establishment:* Implementing and deploying the presented SRA service approach across the enterprise information "supply chain" (be it in the context of an enterprise-wide case or a case limited within a specific business unit or division of the company or the organization).
- *Build:* Exercising the SRA service elements to define a baseline service flow configuration (establishing the exchange paths between known service sources and targets as well as the various filtering mechanisms involved. For this the exploitation of previous experiences from an earlier experimentation phase can only be beneficial.).
- *Operation:* Operating the SRA service flow infrastructures in close relationship with other enterprise processes and procedures.
- *Maintenance:* Exercising the introduced SRA concepts to define changes in the distributed service configuration (e.g. to cover changes as "small" as the addition of new SRA service elements in the overall service configuration and as "large" as merger with or replacement by another configuration such as in the case of replacing a service flow with a group of supplying service flows loosely linked and using a new distributed management scheme). This is a quite complex issue for which description may be regarded as outside the scope of the research. It

concerns the "reverse" engineering of an SRA service into a set of constituent services. In the following Table 12 we present some usage scenarios that illustrate activities in the *Build* and *Maintenance* steps that clearly demonstrate the value addedness of the approach.

		Foreseen Added Value to the Users when implemented		
User category	**Stage**	**Problem or need**	**Tools and repositories**	**How the system can be validated**
SRA Platform and Service vendors	Build	Must subscribe to standards for inter-vendor interconnect	– Web Service infrastructure – Common Repository (Ontology) Facility – Tools for modeling, development, deployment and service management	– SRA system provides a common "backplane" for pluggable subsystems. – It may be exploited as a globally usable notation for meta-service exchange protocols which enables flexible distribution of distributed services over a heterogeneous collection of information systems (e.g. as in the case of different units that use their own ERPs to ground information within SRA, not needing to disclose their source information to other units).
SRA Professional Service Providers	Build	Must accumulate and reuse SRA elements	Third party and in-house tools that apply meta-services to concrete SRA service-base catalogues and vice versa	Reusable, editable, and extensible meta-service should provide a first-level "asset base" that builds (new) value. This base of reusable elements starts a self-reinforcing feedback loop with continually increasing returns improved by engagement productivity for the SRA users.
SRA Professional Service Providers	Maintenance	Must modify Service process configuration: knowing what and where to modify; knowing dependency closure	Third party or in-house tools to manage reconfiguration editing of a service flow	SRA system exposes the information required to modify a service flow model. SRA context definition and self-describing features for the service flows are used to isolate dependency relationships.
SRA Professional Service Providers, SRA Service Administrators	Maintenance	Must integrate existing tools and data which adhere to standards other than service flow model into a distributed service configuration environment.	Tools based on ability to incorporate metamodels of services and alternate service definition practices and standards.	SRA system does or can subsume non-service representations. For example, may be elaborated in the future to contain any Web-based service model with a focus to domain-specific characteristics.
SRA Service Administrators	Build	Must establish and manage expressions, relationships, and lineage over multiple servicebase schemata.	Tools that use built-in facilities to define schema content, relationships, and lineage.	SRA system design is based on need to manage such information at multiple levels. The basic Web Services will have to be designed to allow navigation of meta-services correlated to schemata.
SRA Service Administrators	Maintenance	Must add, subtract, re-partition, reallocate, or merge	Service management tools.	SRA system consists of models of meta-services that assist in making such changes and allow impact of these changes to be assessed.

		service resources in deployment configuration.		

Table 12 Different roles in the SRA adoption phases

As a last remark, it should be noted that an important element of future research is the ownership of the content created within the Situation Room. On the one hand, there is a need to support the interests of the company that owns and operates the Situation Room as an intangible asset with relatively high costs of operation and maintenance, while there are many reasons to want to support the interests of the individual participants, employees and workers; the latter are sharing within the Situation Room their most important asset namely their intellectual capacities used for recognising, analysing and assessing the various situations, while also their particular contributions to the decision-making processes and the creation of a culture within the organisation.

Though this has been outside the scope of the research, we feel that it shall concentrate the future interest of many researchers in the field.

6.2. The Situation Room Model (SRM)

We define the following entities:

SR_X	a specific Situation Room *X*
SR^a_X	a specific ('discrete' approximation aiming to capture a) snapshot of Situation Room *X* at some moment *a*
CIO_{SRX}	The leading Corporate Intelligence Officer of Situation Room *X*
$CIS_{[1...N]SRX}$	The participating 1 to N members (Corporate Intelligence Specialists) of Situation Room *X*
I^a_{IN}	Discrete information incoming to Situation Room *X* at some moment *a*
$I^{[a,..]}_{IN}$	(Continuous) information stream incoming to Situation Room *X* since some moment a
$I_{co\ SRX\ I}$	Information collected at Situation Room *X*[16]
$I_{stor\ SRX}$	Information stored in Situation Room *X*
$I_{acc\ SRX}$	Information accessed in Situation Room *X*
$I_{use\ SRX}$	Information used in Situation Room *X*
$I_{disp\ SRX}$	Information disposed in Situation Room *X*

In the following we go through each one of the identified SR information lifecycle activities

SR activity	**Collection**
Definition	*Creation, acquisition or capture of information needed to support SR processes.*
Description	Different organizations collect information by a number of different means: records are **created** as part of normal business processes; libraries **acquire** publications to add to their collections; data is **captured** and **input** into databases; articles are **submitted** for publication.

[16] Further indicators may refer to temporal aspects of the event, actors involved, the particular type of information, etc.

	The SR supporting agency can reduce collection effort by e.g. accessing information collected by other departments [17]. Once collected, some information holdings may need to be **maintained** by the on-going collection of changes or improvements to the information, depending on the requirements of the SR processes it supports. Records can be **altered**; databases **updated** and publications **revised**.

SR activity	**Storage**
Definition	*Retention of information holdings, to support SR processes.*
Description	Once information is collected, it needs to be stored in a manner that can best support SR processes. These storehouses can include records management systems, libraries and computer databases. Information needs to be **classified** so that it can be stored in a consistent manner to enable more effective support of SR processes. Records are **appraised** to facilitate retrieval and disposal; publications are **catalogued** to facilitate their location, and data is **coded** to facilitate its use access and use within a database structure. Effective classification of information improves its flexibility. Information stored in electronic form can be **formatted** to suit the particular storage medium, and should be **backed up** so that it can be **recovered**. Non-electronic information, particularly information of enduring value, needs to be **preserved**.

SR activity	**Access**

[17] Of course this has its risks: though it seems having (far) lower costs, it makes the SR directly dependent to other departments' organization specifics. Which means that qualitative elements such as information granularity are not anymore possible to be regarded from a unique prism (for instance, it is a totally different "thing" what the Sales dept understands under the term *market* or *competition* with what the Marketing dept does).

Definition	*Locating and gaining entry to information holdings to support SR processes.*
Description	Once information is stored, it must be accessed so that it can be used to support SR processes. Access involves three sequential activities: • **searching** and **locating** the appropriate holding (internal or external), • **retrieving** or **querying** the required information and • **delivery** of the required information (or a copy) to the user's location. In cases where the information supplier initiates access, the information is **disseminated** or **distributed** to users. Electronic information can be **transmitted** using networks or **transferred** using physical electronic media. The **sharing** and **exchange** of information between entities of the SR requires facilities for easier access to information.

SR activity	**Use**
Definition	*Exploitation of information holdings by SR processes*
Description	Once relevant information is accessed, it can then be used to support SR processes. Information is used in a variety of different ways ranging from making a routine decision based on the content of the information, to intensive **processing** and **analysis** of information for specialised SR purposes. Electronic information can be **manipulated** to produce new or value-added information. This activity may involve the **integration** of information from different sources through processes such as data **matching**.

SR activity	**Disposal**
Definition	*Removing information holdings that are no longer required to support SR processes.*
Description	Once information is no longer used by SR processes, or its level of usage no longer warrants ready access, it needs to be disposed of in an appropriate manner. The method of disposal of an information holding requires consideration of its storage medium, value, users demand and other requirements. Business records are **destroyed**; databases are **deleted;** library publications are **culled**. Alternatively, information may need to be **archived** to support particular requirements. Each particular organization needs to develop policies and standards for the archiving of all forms of information. In an environment of increased information sharing and exchange, the agency responsible for the SR operation needs to ensure that the information requirements of other organisational entities are considered in disposing of information.

6.3. *The Information Management Model (IMM)*

The supported actions on a given information entity as this is defined in SRM are given in Table 13 below:

Nr	*Identifier*	*Action type*	*Description*
1	RM	Remove it	It is destroyed as if it never came to our consideration within a set structure under use in the Situation Room. This is not a usual or recommended practice, but may simplify procedures in several situations. A more recommended practice is to justify reasons for its irrelevance and ignore it (see below). However, and as long as logging of events is taking place, tracing back to this state is possible.
2	IGN	Ignore it	It exists but is not used for any current inferences made within a set structure under use in the Situation Room. This is the case of trying to simplify a problem by letting (temporarily or permanently) out a set of information regarding specific aspects of the subject under consideration.
3	LN	Link it	With some other piece of information within a set structure under use in the Situation Room. How? By means of choosing one of the enabled link types:
3a	LN_TO		Link as **related to** with a unidirectional link ***to*** the other information entity
3b	LN_FROM		Link as **related to** with a unidirectional link ***from*** the other information entity
3c	LN_BOTH		Link as **related to** with a unidirectional link ***for both*** information entities
3d	LN_ONL		Link 'only' to the other information entity without any further pre-defined relationship between them
3e	CUST_LN		This type enables user defined link types to be created by means of enabling users of the system to develop their

			own link categories, which may be domain- or user-specific and which may vary amongst each of the users or usage types[18].
3f	LN_LN		This forms an important type of linkage as it provides the means to link one link with another link.[19]
4	ADD	Add it	It concerns the insertion of a particular information entity to a set structure under use in the Situation Room.

Table 13 Actions supported on an information entity.

As seen from the above, the central notion for an information entity within the IMM is this of linking it to other entities.

Furthermore, important are also the *placeholders* in which a specific entity will be input. These may either be predefined if we expect specific entities to populate them, or *ad hoc* realised.

The latter case is rather not rare in actual business environments where SRA is to be employed. Because ad hoc creation of a placeholder takes place under time and resource pressure, its results are usually suboptimal. For this reason it is essential that placeholders are reconsidered on a periodic schedule and - if needed - adapted, renamed or consolidated with others.

[18] Before concluding to this decision, during the course of the study, we have considered the case of only supporting a "Link under condition(s)". Though this seems more formal and with more expressive power, it actually results to the following:

- we either support a predefined set of specific (types) conditions, which we could substitute with the corresponding set of link types as already done for certain types of linkage relationships,
- or we support an open set of conditional statements, which results in the very same set of customised / customisable links, which is exactly what we support in our approach. *QED*

In this way, we economise on redundancies which keep the implementation costs low and also minimise any ambiguities that might affect the implementation.

[19] One possible difficulty in the implementation, which may result in consistency and constraint satisfaction problems is this of the space of **Link** type relationships: in our description we define this to be between two entities. It is easy to see for instance that especially for 3d, 3f and 3e it is quite essential to support linkage with more than one information entities. For implementation reasons, we prpose that the system design might proceed in the definition of a **Group** action which enables groupings. However, such an action is included in the design but aims to facilitate aggregation operations for information entities. Thus, the approach we would promote is this of implementing a generic type of link that support for tuples which may be tuples of 2, 3 or N information entities. Having in mind existing development environments and programming languages, this is trivial to support, while before 10 years it would necessitate the development of a mechanism to handle this as a separate stream of actions.

In regard to the placeholders the same actions are holding as for the information entity - except from one, namely this of the creation of a new placeholder (it is easy to see the reason for this: while a piece of information has arrived to us or we recognise its existence, a placeholder is an artificial artifact as we are solely responsible for its construction[20].

5	CRT	Create	Creation of a new placeholder

Of course, it is expected that certain actions will be invoked by the user who should be supported to (be able to) take the liberty to invoke those ones that are only needed for escaping the need to exhaustively declare actions that are prerequisites to the latter one. This increases the user friendliness of the system though it may occasionally increase error proneness.

[20] A brief note on this: it has been considered as out of the scope of our research to further investigate this aspect. However, it is not always this the case: we have – very frequently – the case of information creation, based on synthesis of other (previously existing) information or even "out of nothing". The latter is also the case of making some hypothesis because we simply want to make it or need to make it.

6.4. *The Situation Analysis Model (SAM)*

This third model is critical for the market application of SRA; while the two former are generic and support for the application of SRA in many different contexts, the Situation Analysis Model[21] is providing the expressive power and means for applying in the given market context.

It builds on four building blocks, which directly relate with the wider notion and semantic attributes of a product. More specifically, these are:

6.4.1. Building block 1: Situation environment

The aim of this first building block of the Situation Analysis Model concerns environmental (external) analysis. This aims to facilitate transparency about the specific chances and risks of a particular product's market or any other context that is the subject of a particular Situation Room session.

However, environment as such implies also further aspects related e.g. to science, technology and society as well as the relative positioning of the particular company to each of these. This implies also the need for identification, analysis, and assessment of relevant parameters. Such an analysis can be reactive (e.g. after a product has been launched in the market, after a product prototype has been handed to the Marketing people, after ...) or proactive (before a product has been launched in the market, before a product prototype has been handed to the Marketing people, before ...).

Forecasting of future developments regarding a particular product and its environment may only be based on historical data and is generally regarded as risky because of dynamics in the environment. Trends and their analysis must therefore form an integral part of the environmental analysis. Based on the results of the analysis, scenarios for future development can be developed. The results of the environmental analysis are used for the strategic product lifecycle management process.

[21] For the sake of information, we should mention that at some earlier stage, during the course of the study, it was called Product Analysis Model (PAM), under the light that it actually aimed to provide an elaborated descriptive model for the market(s) in which product(s) are launched. The starting point and the main idea was to focus on a product – therefore also the "gathering" within the Situation Room. But as it could be easily extended to cover any situation, from a pricing policy issue to any other "event" type, we changed its name and become more self-descriptive to SAM.

The methodology to be devised has to describe the procedure of how to carry out an environmental analysis according to the specific scope and needs of a particular company and product combination[22].

In the next Table 14 we provide in tabular form some more items that would be useful to form the basis of the space of semantics for this first building block of SAM.

[22] We should stick to this: neither with respect to the product only nor to the company only. The reason is rather straightforward: it is different to have FIAT bringing a smart-like vehicle in the market than Daimler Chrysler (that actually did). For the former, it is a move compatible with their corporate history and tradition, which if realised should also be accompanied by an related pricing strategy (cheaper than the adjacent model). To not do so should be justified to themselves and then to the market. This interactive game forms also part, as it is easy to understand, of an SRA live experiment.

Items and parameters	Market • suppliers (number, USPs, costs, price, turnover, stability, etc.) • products and services (USPs, price, etc.) • customers (number, groups, importance, demands, etc.) • competitors (number, market share, target markets, strategy, etc.) • markets (segments, strengths, etc.) • technology (innovation steps, functionalities, costs, etc.) • etc. Politics • current and planned international (e.g. European Union), national (country) and regional (federals state) legislations • regulatory framework (product sector tariffing or protection aspects, etc.) • etc. Culture • national cultural specifics • individual histories • market ethics, practices and customs (if possible with a quantification and linkage of them to the product under consideration) • etc. Extended Enterprise partners and Value Chain member • profiles • assessment of positive intakes and spillover effects • etc.

Analysis methods and instruments	• segmentation, clustering, portfolios • benchmarking • chance/risk, SWOT, potential, trend, scenario • road mapping (technology, products) • etc.
Approach	• top-down: processing of existing and new qualitative and quantitative data for product analysis and planning purposes • bottom-up: processing of existing mainly quantitative data for product analysis purposes
Critical points and risks	• information needed for strategic decisions is mostly not available in internal operative systems • environmental dynamics and resulting unpredictability • bad modelling, which relates either to selection of an inappropriate modelling framework (i.e. one that does not fit to the purposes of a particular case) or population of an overall appropriate modelling framework with inappropriate or inconsistent information entities

Table 14 Requirement summary for the analysis of environmental aspects of a particular situation.

6.4.2. Building block 2: Organisational infrastructure

The aim of the organisation analysis is to achieve transparency about the company specific strengths and weaknesses as such this can have a direct impact to the particular situation under consideration.

Similarly to the environmental analysis, there is first of all the identification, analysis, and assessment of relevant parameters. The scope depends from the overall objective. The analysis again can be retrospective based on historical data or perspective. The forecasting of future developments is risky because of dynamics in the environment. Trends and their analysis must be an integrated part of the organisational analysis too.

Based on the results of the organisational analysis, scenarios for future development can be developed. The results of the organisational analysis are to be used for the strategic product lifecycle management process in combination with the results of the environmental analysis. The organisation analysis provides a performance evaluation for the company so that they can better assess their potential with respect to the situation under consideration.

To provide an analogy, if the environmental analysis provides an overview of the market in which a product is going to penetrate, the organisational analysis is focused to those intra-enterprise aspects (most of them of infrastructural nature) which will interactively affect the future of this specific action. A further analogy from the war domain is that while the environmental analysis provides data and information on the territory where a battle is going to take place, the other actors to be involved and possibly affect the operation, the organisational analysis is putting emphasis to aspects related to the type of men our army is having, the type of skills and competencies with respect to those of the opponent, the knowledge they have or that which they have to acquire, etc.

What the application scenarios we have examined in the context of this study aim to highlight is that before applying SRA by companies as a tool for practical employment, these companies have to create transparency about the business goals, the organisational and technological starting point, and capacity for assessing (many different aspects of) the environment they are operating at.

In this process, the following questions must be answered by them:

- Do the company's processes and information add sufficient value to differentiate it from the competitors?
- In which value activity/ies, value to the company's information and/or processes can be added? How to support this with e-business?
- What is the appropriate e-business support for each value activity interaction, bearing in mind the organisational and technological capability of suppliers and customers and the likely direction of the own value chain in the future?
- Can the company add sufficient value to processes/information on its own, or should it consider taking part in an Extended Enterprise?

- What is the company's most appropriate role in the Extended Enterprise?
- Which distinctive competencies does the company need to strengthen its position in the Extended Enterprise?
- What level of e-business does the company need to sustain its participation in an Extended Enterprise?

The organisation analysis finally has to identify the potentials of using SRA as a leverage by targeting the audience to populate the Situation Room of the company. For instance, while for company A decisions regarding a specific issue for a product need to be addressed by a team consisting of the Commercial Director and a set of Regional Directors, which will decide on a policy and demand or command its implementation to the Technical Dept or the Product Manager, for some other company (with a different – and rather much better… - culture and value system) they would ask for Technical Dept and / or the Product Manager to drive the discussion or at least have a leading role therein, while also representatives from the Marketing Dept might participate.

Conclusively, we say that the results of the organisational analysis is critical because it helps us to solve the problem by better defining it. (For many corporate failure stories, the main reason comes back to an erroneous or inconsiderate definition of "what is the problem".

The methodology will describe the procedure of how to carry out an organisation analysis according to the specific scope and needs of a company.

Items and parameters	Human resources • staff number • qualification • (core) competencies • etc. Structure • hierarchy • allocation to products and services (also related with financial figures as variants, costs, turnover, profit, etc.) • etc. Processes • in-/outputs, activities, resources, constraints, objectives, interfaces • etc. Control aspects • process key figures • etc. Technology • production facilities (automation degree in development, etc.) • employed know-how • ICT infrastructure • etc.

Analysis methods and instruments	• Efficiency, pay-off • ABC/XYZ, process cost, failure possibility and impact • Core competences • Technology portfolio • Quality Function Deployment (QFD) • chance/risk, PEST[23], SWOT, sensitivity, potential, benchmarking • trends, scenarios • road mapping (products) • etc.
Approach	• top-down: processing of existing and new qualitative and quantitative data for organisational analysis and planning purposes • bottom-up: processing of existing mainly quantitative data for organisational analysis purposes
Critical points and risks	• information needed for strategic decisions is mostly not available in operative systems • interactions with building block 1 for environmental impact

Table 15 Requirement summary for the analysis of organisational items.

6.4.3. Building block 3: Goals and strategy

Strategy[24] is based on market requirements on the one hand and a company's abilities on the other hand. Strategy is a complex and multi-layered matter. The market

[23] A scan of the external macro-environment in which the firm operates can be expressed in terms of the following factors:

- Political
- Economic
- Social
- Technological

The acronym PEST (or sometimes rearranged as "STEP") is used to describe a framework for the analysis of these macro-environmental factors. A PEST analysis fits into an overall environmental scan. The PEST factors combined with external microenvironmental factors can be classified as opportunities and threats in a SWOT analysis. However, and despite the fact that the concept of the PEST analysis is to look at external factors which influence the business, just as in the SWOT analysis, the focus that a PEST analysis produces is that it shows which external factors are influencing the business; therefore, there is often confusion between a SWOT analysis which looks at internal to business and external to business within the same market factors.

requirements might change rapidly and the own abilities have to be developed and adapted in goal-oriented way. A strategy has to close the gap between market demands and company abilities. Strategy has to provide the mid- and long-term orientation for a company and forms the basis for definition of operative short-term goals.

Goals should be regarded as the result of the combination of strengths and weaknesses with respect to opportunities and threats. There are quantitative and qualitative goals. In order to use goals as guidelines that drive decision-making within the Situation Room, dependencies between individual goals must be made transparent and have to be put into a goal hierarchy. A potential analysis needs to also assess the plausibility of goals.

Another aspect that is of importance here is that the particular organisational structure interacts with the strategy. More specifically, the structure of the Information Supply Chain – independently of whether it concerns the internal corporate environment i.e. within departments, or the interfacing with external ones, is representative of the overall strategy that a particular company follows in its business activities, its positioning with respect to competitors, suppliers and customers, etc.

Thus, interactions between structure and strategy on the one hand concern adaptations at the structure level to better serve a devised strategy (i.e. the top down approach), while on the other hand bottom-up modifications to a previously defined strategy may be needed to facilitate good or optimal practices within a specific structure.

Of particular interest is the employment of the concept of a Situation Room for revisiting the notion of strategy; instead of keeping the strategy as a distant high level ("strategic") issue, we can reconsider it as a tightly coupled entity to that of a practical tool namely this of the SRA.

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[24] We are using the term strategy at this level rather with the notion of company policy, i.e. for axiomatically validating the inclusion of some activity to those that can be regarded as valid for the company. Their implementation, of course, forms part of the tactical and operational levels.

What is obvious and will become more apparent is that in addition to the strategy (associated to a great extent with the corresponding structure), the actual implementation of the particular structure also plays a significant role.

From our experiences in the software business, a specific strategy mapped to a specific scheme, may be considered as under-performing, being based not on strategy-specific criteria but mainly on implementation-related ones.

For example, in the case of forming the info chain structure for communication with clients, the scheme to which a company might have converged represents at a great extent the philosophy and the overall approach of the particular company with its clients.

For instance, we consider two specific cases:

- Case A, representing a strategy for keeping low communications overheads with clients.
- Case B, representing a strategy for serving the client according to "the client is king" principle and by embodying the latter within the company's grid of operations.

According to Case A, we consider the following structure as depicted in the Figure 9 below.

Here, we have the client communicating with only a single contact point in the company, who may be a sales person, a secretary, a help desk worker, etc. Of course it does make a difference who that single contact person is, as:

- in case he is considered as an "intelligent human agent", he will be able to develop a good idea of the client's request and thus be able to draft a plan which he will subsequently communicate to the other people in the company. Or alternatively, he will be able to delegate the task to the appropriate person or department. Furthermore, he may be the one who will communicate with the client for informing him about the satisfaction of his request, e.g. in terms of providing him with the sought solution / result.

* in case he is not considered as an "intelligent human agent" (e.g. in the case of a blond secretary), he will have to either "post" the request to a department that seems to him as more appropriate, and without filtering in or out anything from the original request.

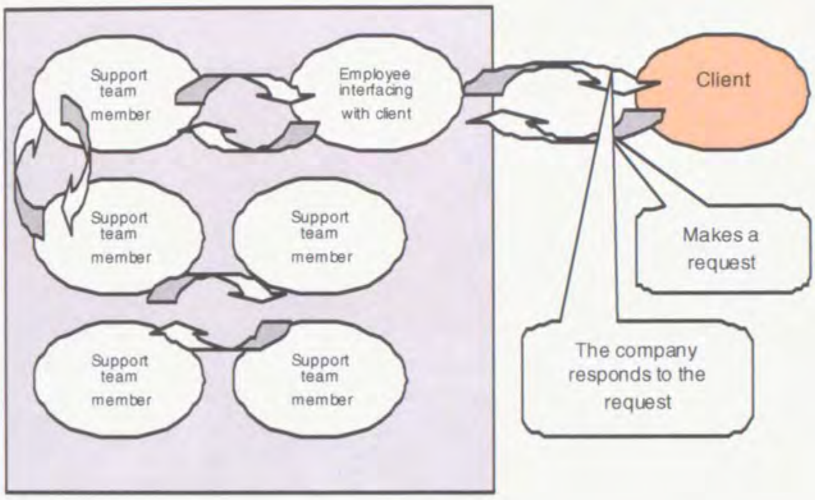

Figure 9 Case A: the client is kept "outside" the company Value Chain.

Companies that are positioned in the service sector, as well as administration departments that are interfacing with clients or suppliers, have accumulated experiences and the majority of them has somehow converged to schemes and structures that are considered as well-balanced with respect to the costs and benefits related to their operation.

What is relatively easy to see from the above, and will become more apparent from the description of the second Case, is that except from the strategy (that is recognisable at a great extent to the corresponding structure), it is also the implementation of the particular structure that does play a significant role.

From experiences that we have from the software business sector, it follows that a specific strategy that has been mapped to a specific scheme, may be considered as under-performing, based not on strategy-specific criteria but mainly on implementation-related ones[25].

[25] This again relates to the fact that in many cases criticism for a strategy should be rather addressed to its implementation. However, because decision making is treated as a practice, no distinction between

According to Case B that is depicted in Figure 10 below, the client is not kept "outside" the company value chain; he is rather embodied in the people's network, being (perhaps) able to monitor (parts of) the ongoing interactions, and thus may add (his personal) value by means of experiences and expertise, in the service provision process.

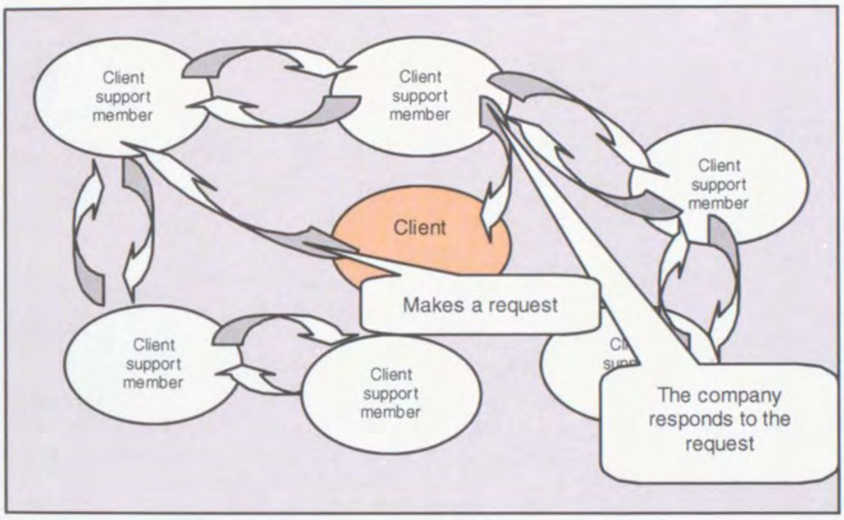

Figure 10 Case B: the client is part of the company Value Chain.

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the laboratory-based decision design and its real-world implementation has been made. It is therefore that there exists a need for SR and SRA.

Items and activities	Strategy • Formulation • Review • Update • etc. Goals • Definition • Consistency check • Ranking (goal system) • Calculus (synthesis and decomposition) • Communication • Adaptation • etc.
Approach	• top-down: strategy definition • bottom-up: goal agreements
Critical points and risks	• incompatibility of goals and strategies amongst the participating entities of the Situation Room

Table 16 Requirement summary for the definition of goals and strategy

6.4.4. Building block 4: Assessment

The strategy assessment determines the benefit of a particular business decision options by quantitative and qualitative assessments. In literature there are well-established scenario techniques which allow the impact analysis of different assumptions with regard to (any particular) value adding benefits. A result of this is the creation of preferential roadmaps. This part of the model has to describe the procedure of how to develop different scenarios and carry out an environmental analysis according to the specific scope and needs of a company.

What is to be taken for sure is that working in and with networks together with the mastery of key processes enables change in enterprises through evolutionary processes of which an instance is this of the Situation Room Analysis.

Items and activities	Strategy assessment • qualitative and quantitative scoring • risk and sensitivity analysis • etc. Strategy road mapping • agreement • visualisation • etc. Strategy selection • communication • translation into / from operative goals • etc.
Approach	• top-down: by the management (centralised / centrally coordinated) • bottom-up: by the individual workers or groups of them (decentralised / anarchic)
Critical points and risks	• data quality • availability of qualitative and quantitative assessment criteria • environmental dynamics

Table 17 Requirement summary for the strategy assessment.

6.5. Synopsis

In this chapter we presented the Situation Room model by means of describing its component (sub)models for Situation Room semantics, Information Management, and Situation Analysis. The latter consists of 4 building blocks which address the overall situation environment, the (corporate) organizational infrastructure, aspects related to goals and strategy, as well as a final component related to assessment issues.

In the case of corporate Information Systems (IS), practices that are developed by the users of the systems constitute a precious source to establish the various model and submodel ontologies of such IS, and open up new perspectives for improved value creation within the corporate working environment. The future preoccupation is to continue the improvement of such models and the development of specific tools to support the use of the created models as part of the institutional IS engineering. For the latter we propose an architecture that is described in Chapter 7 of the present document.

7. The Situation Room Conceptual Architecture

7.1. Overall approach

In organizations a conglomerate of software systems is used for decision-making and decision-support purposes. Development and maintenance of such systems are challenging, as special focus is required on integration and interoperability with other systems and - most importantly – with the corporate process grid.

To handle this challenge, it is essential that the developers and other personnel responsible for the development, maintenance and administration get a good understanding of the system's architecture, its interfaces to the environment, and the context in which the system will be used.

For the central concepts of architecture and architectural description we use the following definitions from (IEEE, 2000)[26], and for interoperability the definition from (USDOD, 1996):

- *Architecture:* The fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution.
- *Architectural Description:* A collection of products to document an architecture.
- *Interoperability:* a) The ability of systems, units, or forces to provide services to and accept services from other systems, units or forces and to use the services so exchanged to enable them to operate effectively together. b) The condition achieved among communications- IT systems or items of communications when information or services can be exchanged directly and satisfactorily between them and / or their users.

Furthermore, the work is informed by a number of related architectural frameworks that are commonly in use today. RM-ODP (Reference Model of Open Distributed Processing) (ITU, 1995) is a framework that provides the developers a standard for

[26] Compared to IEEE 1471, our aim is to give some overall normative guidelines, including the use of UML notation, as a set of predefined viewpoints and a reference architecture.

creation of systems that support distributed information processing services to be realized in heterogeneous environments. The method uses five different viewpoints to describe the system. The framework is neutral in the selection of tools for describing the architecture.

TOGAF (The Open Group Architecture Framework) (TOGAF, 2005) is an enterprise architecture framework that consists of a subset of architectures: business, data, application, and technology respectively. TOGAF consists of a set of tools and methods for developing different architectures. The goal of TOGAF is to become an industry standard method that is neutral to both selection of tools and technologies.

ATAM (The Architecture Tradeoff Analysis Method) (Clements, 2001) is an analysis method used to understand the various tradeoffs that have to be made when creating architecture for software intensive systems. NATO has started a Multilateral Interoperability Program (NATO, 2005) that focuses on interoperability between member nations' command and control systems.

In the scope of the research we refer to information integration as an interoperability mechanism since the same requirements and architectural decisions apply to both.

Unfortunately, architectural descriptions for business information systems vary in structure and content – if they exist at all. They seldom include important information like the stakeholders the system was originally built for, which corporate practices affected the system, which standards that were applied, and which other systems it was built to collaborate with.

From the end users' perspective, successful implementation of a business system is dependent on the developer's ability to understand the working processes the target system must support. From a high-level viewpoint, a major concern is that the new system must not interfere with other existing systems.

Non-existing architectural descriptions, problems adapting the system to the working processes, and a need for information integration and interoperability was the motivation to develop an architectural description framework for Situation Room Analysis.

Collaborative design is encouraged and supported by the framework, to ensure that the systems are built based on real understanding of the needs of the end users and the requirements from environment system interfaces. The framework assures a common structure and content of architectural descriptions for an organization's systems. At the same time, it provides the flexibility to focus on the concerns defined by the particular organization.

This will assist developers in maintenance and evolution as well as development and description of new systems (actually: new implementations of the system and the underlying SRA framework).

We present the experience from explorative investigations where the SRA framework was used to develop architectural descriptions of the respective information system infrastructure with a special concern for functionality, reliability and interoperability.

The SRA framework assists the architect by:

- Supporting cooperative design through the definition of a set of views and selection of notation that allow end user involvement in important parts of the work.
- Supporting development and description of the architecture of new systems, as well as documentation of the architecture of existing (legacy) systems.
- Providing guidelines for practices applicable to corporate environments that need to integrate information from several heterogeneous systems
- Providing a structure that ensures that documentation of different systems developed using the framework will have a uniform structure and content.
- Presenting a list of quality related concerns that the architect should consider when creating the architecture, and instructing how to include description of the concerns of particular importance.

An architectural description created using SRA is structured around a set of views, each of which describes the system from a certain viewpoint. Views are useful for illustrating different aspects of the same target system. Concerns that are of special importance to the target system such as for interoperability must be identified and described.

A set of system assets, e.g. procedures and practices, that is useful for describing and understanding the architecture is also included. The reference architecture can be refined for a specific target system, or for a set of related systems depending e.g. on the user's needs and capabilities as well as on the context of operation (is it a big organization? Will they be using SRA only for one process? Do they wish SRA to be operated by special staff or by all? etc.).

It should be emphasized that the main purpose of the architectural description is to give the user an understanding of the fundamental aspects of the system and its context and without any need to elaborate on full user requirements, complete business process models, or more detailed design information.

In the following subsections, each part is described in more detail.

7.2. *Architecture concerns*

The SRA architecture framework defines how to describe *concerns* of special importance to the system. These concerns will need special attention within all or most of the *views* described later.

A concern may require special models or other formal descriptions to be created to ensure that the architecture description is correct and complete. Functional aspects that are considered to be of such importance that they should be treated separately and be specifically visible in the documentation should be identified and treated as a concern.

In a business environment, security should always be treated as a special concern due to corporate confidentiality issues. Confidentiality, availability and integrity are all key characteristics of information security. Security should be addressed in a dedicated model in each view of the architectural description. However, this is out of the scope of the research.

For the business environment, *interoperability* is a special concern. The SRA framework must operate in a context where many other critical systems both provide and rely on information from the system being architected. The security concern has a major impact on the interoperability.

Single sign-on mechanisms and shared role based access control are requirements that should to be handled by the interoperability concern as well. The focus on interoperability will require the architects to carefully design the information and operation interfaces to the environment, as well as the distribution and realization of the system components.

7.2.1. SRA system assets

System assets are sources of information that can be used when developing an architectural description. System assets can be considered as implicit requirements, which are not necessary to include in the requirement view, however assets may be included in component, deployment and realization views. Short descriptions of the most common assets for architectural description of an SRA implementation are:

- **Dictionary**: A dictionary is a reference list of concepts important to a particular SRA model aspect or concern along with discussion and/or definition of their meanings and applications.
- **Standards:** A standard is a formalized model or example developed by a state authority or institution reflecting laws and regulation and established by general consent. When implementing SRA in the corporate environment, a set of standards will probably be used, and these must be referenced or documented.
- **Practices and procedures:** For an SRA implementation, corporate practices and procedures regulations will affect how the system can be used, and how it has to be built. The architectural description should include references to the exact practices and procedures that have been considered, including comments on how these apply to the target system.
- **Patterns:** A pattern is a description of a recurring, well-known problem and a suggested solution. Patterns are identified and can be used on many system levels. The SRA framework includes guidelines for when to apply well-known patterns in the architecture. Summary descriptions of recommended patterns are included, along with references to sources such as (Gamma, 1995; Buschmann, 1996; Schmidt, 2000), where the full pattern description can be found. The framework suggests a number of patterns related to interoperability and information integration. The selected patterns are referenced in the architectural description of the target system, and specialized in the view(s) where they are applied.

Figure 11 below shows the four basic SRA assets. All four of them comprise the operation space for conducting SRA. Though any of the assets may not exist in a typically organized form (e.g. the dictionary), others like the practices and procedures are well-established in the minds of the practitioners who use SRA-like techniques in their every day life within their working environments.

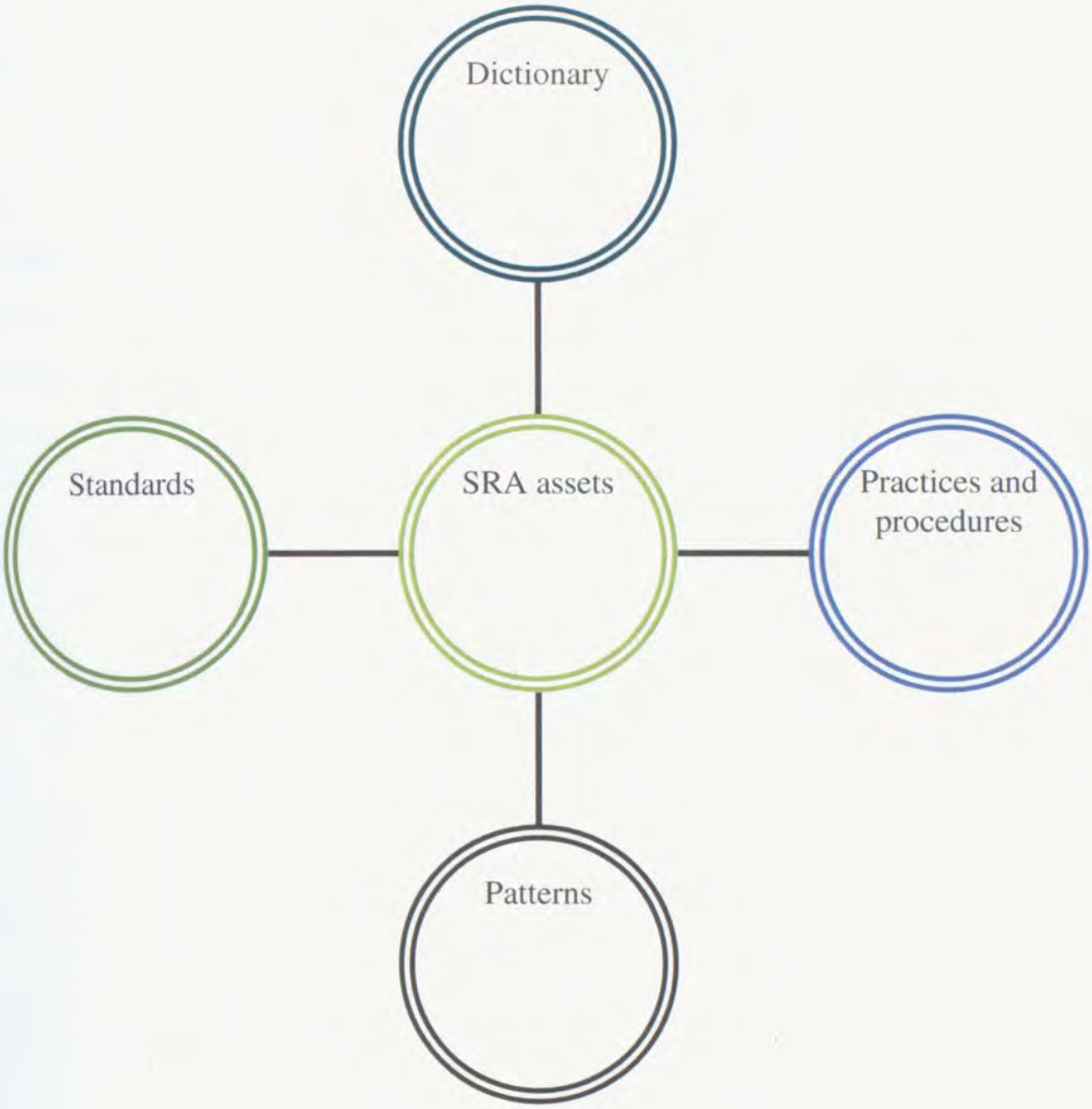

Figure 11 The four basic SRA related Assets.

The use of dictionaries and standards are important for information interoperability between different systems. If two systems should be allowed to interoperate across departmental or enterprise organizational boundaries, they should be in accordance with the same practices and procedures. Correspondingly, the use of architectural patterns will facilitate interoperability between systems and sub-systems.

7.2.2. Reference Architecture

SRA defines an overall reference architecture for information integration systems. This is a high-level, generic architecture which is used as a basis for development of target system architectures, and to compare architectures of existing systems. The SRA reference architecture defines four logical tiers, and the interface to the environment. The tiers are frequently referred to in the descriptions in the different views.

7.2.3. Views and Viewpoints

A central part of SRA is its definition of a set of viewpoints. Each viewpoint defines how a specific view of the target system shall be described, and prescribes a set of models that the view shall include. The notation to use for each model is also defined – normally a set of UML diagrams with accompanying textual description is used. Architectural descriptions created within the SRA frameowrk contain the following views:

- **Context view**: The context view describes the business-related aspects and stakeholders of the target system and its environment. Environment systems that will be involved in or influence the operation of the target system are identified, and their interfaces and collaborations with the target system are described. The context view should be created in collaboration between end users or domain experts, and software architects. The description in this view is important during the initial development of the architecture, but may be even more valuable during maintenance and integration with other systems, as it provides background motivation for the architecture that may otherwise be forgotten and hard to reconstruct.
- **Requirement view**: The requirement view describes functional and quality requirements that can affect the architecture of the target system. This does not include complete user requirements, but instead generalized versions of each type of user requirement that are of importance to the architecture. The models in this view are based on use case diagrams and tables of prioritized requirements, and are best constructed in collaboration between software architects and end users. Interoperability requirements are derived from the interfacing systems described in the context view, and the framework also provides a set of requirement choices guiding the process of eliciting integration requirements.
- **Component view**: The component view describes the decomposition of the system into components, including their interfaces, interaction, and the information that is handled. The security model is an important part of this view, and describes security mechanisms and how these are integrated with the rest of the system. The models of this view are kept at a logical

and platform independent level, and do not include realization details. For this view, the framework presents a set of architectural design issues for information integration systems, and proposes patterns and other solutions that can be suitable when the issue has specific characteristics.

- **Distribution view**: This view describes the logical distribution of components and roles. It describes which components that must be together on a node, which components that must be distributed to different nodes, and which components that may optionally be distributed. The framework includes recommendations for distribution choices based on parameters such as system size, resources distribution, and communication capacity. The distribution choices can be limited by the current deployment of components in environment systems, as well as their security infrastructure.
- **Realization view**: This view describes how to implement the system described in the other views on a selected target platform. It includes mapping of the architecture to the selected technology platform (e.g. Java or .Net), and also describes the actual deployment of the system on the selected nodes. Both technology platform and deployment choices can be limited by the requirements for integration and interoperability with the environment systems. An important aspect of deploying a new system into an existing information infrastructure includes interoperability testing. The realization view includes a "System Integration Test Model" that describes a set of test scenarios to be conducted during system deployment.

7.2.4. Iterative development process

The SRA framework recommends an iterative development process. An iteration of the architectural description work usually starts with describing the context view, and ends with the realization view. The work does not proceed in a strict sequence, but frequently returns to previous views when new insight is acquired. Each iteration results in a version of the architectural description that is reviewed. More than one iteration may however be necessary to complete the architectural description.

7.3. The Situation Room Engine

In its practical application, SRA addresses the needs for a solid technological basis for online recommendations and for corporate value creation through recommendations by an application orientation that will provide:

(i) the transfer of technology and expertise based on a lightweight web mining infrastructure for recommendations and

(ii) the establishment of the corresponding recommendation services that go beyond the conventional model of exploiting the preferences of corporate users.

The solution builds upon the following:

- **Combination of click-stream [27] data and conventional ERP/CRM information:** Recommendations provided by the SRA Engine should be based on both the behaviors of the corporate users involved in an SRA session and on the prior knowledge of the system about all other users, thereby identifying similarities and differences between the former and the latter. This extends the basis upon which recommendations are drawn and allows for a more differentiated treatment of seasonal or irregular activities and long-term behaviors.
- **Temporal profiles, behaviors and behavioral patterns:** Recommendations should take volatility into account. Situations change with time, while interpretations and particular access to documentation (re)sources may significantly influence their attractiveness for different corporate user groups. Moreover, the same corporate user may exhibit different behavior at different times, having some short-term or seasonal needs and some long-term characteristics and profile. Beyond time-dependent pattern management algorithms for analysis, reinforcement learning methods should be used as central framework to control the self-learning process of the SRA recommendation engine.

[27] A *clickstream* is considered as a virtual trail that a user leaves behind while surfing the Internet. In our SRA context, *clickstream* is a record of a user's activity during an SRA session, including every Web site or document and every page of every Web site or document that the SRA user accesses, how long the user was on a page, a document or a site, in what order the pages or documents were accessed, any functions that the user performed in terms of communication and sharing with other SRA users of the corporate resources and even the e-mail addresses of mail that the user sends and receives.

- **An advanced model of impact evaluation:** Recommendations should be observed as the basis of a long-term relationship between the corporate employee and the company itself. Thus, the impact of recommendations should be modeled and evaluated towards the establishment of a loyal, satisfactory and profitable relationship rather than the short-term maximisation of corporate success in responding to external events. This forms a main differentiation point between the case of regarding SRA as an intangible asset that characterizes the collective corporate intelligence, and the case of viewing it as an infrastructure that enables short term maximization of profits / benefits and resource utilization.
- **A lightweight multi-tier architecture for recommender services, data-mining services, database services and stream gathering services:** Recommendations should be realised in a lightweight, flexible way. Most large companies and organizations have state-of-the-art infrastructure in their domain of expertise but their infrastructure and background on IT is conventional. Hence, recommendation engines must be built upon conventional database technology, allowing for a gradual upgrading with modules for web data processing, mining and recommending.

The overall architecture of the proposed Situation Room Engine is shown in the picture below, which should be read as follows:

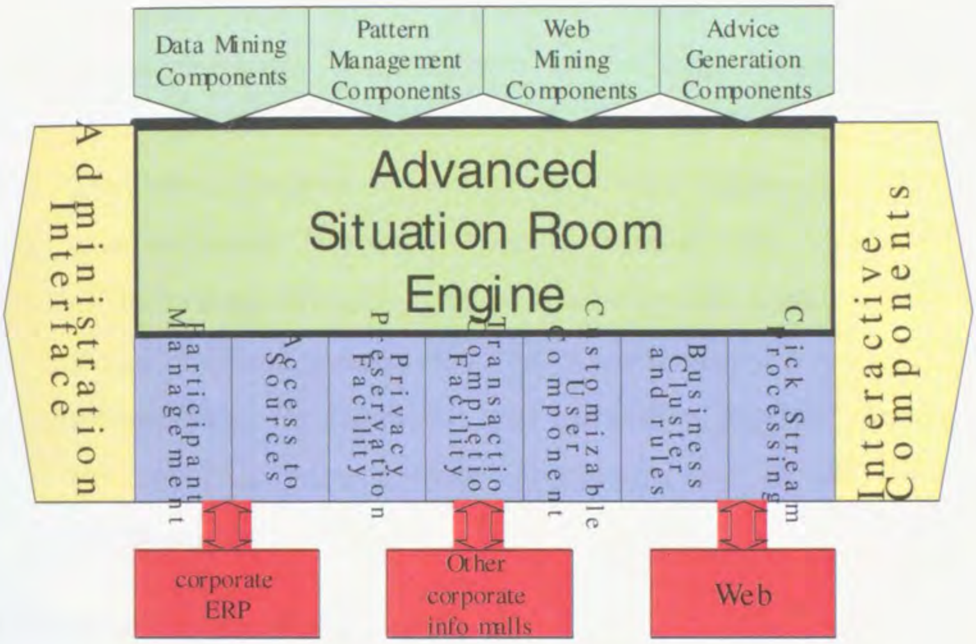

Figure 12 Components of a Situation Room Engine.

- *Overall goal:* The Situation Room Engine should automatically generate rules for on-line situation recommendations. Applications include online corporate intranet services, web applications, the corporate ERP system(s) or – selectively – parts of it.
- *The "Machine":* The Situation Room Engine "machine" is the central module of the architecture. It is a container with Business Logic, which contains learning / analysis components (top arrow boxes: Data Mining Components, etc.), user interfaces (bottom boxes: Participant Management, etc.), and communication interfaces (left and right arrow boxes, described below).
- *Learning / analysis components*: Contain analysis algorithms from Data Mining to estimate the model parameters (Data Mining Components), Pattern Management to capture time-shift in models (Pattern Management Components), Web Mining to reveal browsing behaviour (Web Mining Components), and Reinforcement Learning for self-learning and acting (Advice Generation Components).
- *User interfaces*: Define user interfaces to customize the Situation Room

Engine for various types of application(s). Include definition of data sources / situation recommendation rule targets (Access to source), interface for dynamic modes (Click Stream Processing), recommendation parameters like filters, exploration degree, numbers and types of recommendations (Customizable User Components). Some additional parameters are contained in packages of Participant Management, Transaction Completion Facility, and Privacy Preservation Facility.

- *Communication interfaces*: Used to connect with Administration (with GUI) for interactive management of user interfaces. Although the Situation Room Engine in general works fully automatically, it is useful to allow to include tools for interactive rule generation, e.g. by administration or external Data Mining tools. This forms the second communication interface for rules.

7.3.1. Impact of the SRA Engine

The Situation Room Engine shall encompass different types of recommendations and an aggregator mechanism to integrate them. Sensitivity to time is a central issue, referring to the ageing of the various information items (and thus of ratings made upon them) and to the introduction of new, yet unrated information entities. Innovative data mining techniques based on reinforcement learning shall be employed to deal with this challenge. A recommendations impact model will be designed and tested with game-theoretical methods; it is intended to help SRA users in selecting and prioritising among different types of recommendation mechanisms in a real world setting.

Traditional recommendation engines are based on collaborative filtering, on data / web mining or a combination of the two. Collaborative filtering techniques formulate recommendations for a given user by identifying users similar to them and then selecting the items preferred by those users. In the collaborative filtering approach, several major challenges must be addressed:

- First, the real-time identification of similar users is computationally expensive if there are already many users recorded in the system, while it is conceptually difficult if there are only few users recorded in the system.

- Second, collaborative filtering can deliver recommendations only for information entities that have already been selected and/or rated; recommendations for newly introduced info entities require different techniques (e.g. prediction).

Solutions are provided by data mining methods: Clustering methods are used to form groups of SRA users with similar preferences offline, so that the sole real-time operation is the (rather inexpensive) assignment of a user to one among given groups.

7.4. *High-level design aspects of the SRA Engine*

The SRA Engine forms core part of the research. As depicted in Figure 12, the SRA Engine encompasses components for data mining, web mining, pattern management and advisor support. We observe the SRA Engine across the dimensions of interaction, impact and robustness towards change.

In terms of human-web-interaction, the SRA Engine involves the interplay of three types of actor:

1. *advisors* that deliver advice in the form of preference rules, item ratings or item reviews,
2. *users* that acquire recommendations and take them into account when deciding whether and what to information or decision to "purchase" and an
3. *aggregator* that prioritizes and composes individual advices into a recommendation.

For example, an advisor may be an association rules' discovery module that returns information items frequently purchased together, whereupon the aggregator decides how many items should be suggested and in which order, so that the maximum utility effect can be achieved. If an additional advisor based on user similarity is available, the aggregator may decide to consider only frequent information items "purchased" together by users similar to the given user.

According to this conceptual model, the impact of the SRA Engine is determined by the quality of the advices delivered by the advisors, the priorities set by the aggregator (as part of the business model of the corporate SR owner) and the affinity of the users towards recommendations, subject to several factors, like past experience with good or poor recommendations, familiarity with the information items being communicated, reputation of the advisors and more. While it is possible to trace the affinity of users to recommendations in an obtrusive way, while the engine is in operation, the a priori assessment of the impact of alternative recommendations for different corporate user groups and item types is a challenge that must be dealt with.

The impact of the SRA Engine upon the behavior of the users is further affected by time, or rather the changes occurring over time: Changes in the portfolio of offered information and decision items imply that there are few rules involving newly introduced items.

Further, ratings on items may lose on importance, especially for seasonal, irregular and short-lived information items. Orthogonally, user preferences may change due to unobservable external factors, collectively resulting to "population drift". The SRA Engine needs mechanisms that adjust to drifts and capture portfolio changes.

The core of the SRA Engine is established in the following parts:

- it shall reflect the conceptual architecture of the engine;
- it shall deliver intelligent (non-human) advisor components in the form of data mining components, as well as one aggregator in the form of a Reinforcement Learning module;
- it shall deliver web mining components, upon which the advisor components will build;
- it shall focus on the management of patterns derived by the advisor components and shall provide mechanisms that adjust and re-prioritize the patterns in the presence of change;
- it shall design the impact model and deliver insights on the factors that affect the performance / acceptance of the SRA Engine by the corporate SRA users. Finally,
- it will integrate the components and models delivered by the other tasks into the operational core of the SRA Engine.

Below we elaborate for each of the above.

7.4.1. Architecture Specification

This shall deliver the final specification of the SRA Engine architecture as the result of a requirements analysis on the basis of the conceptual model shown in Figure 11. Requirements refer to the functionalities of the individual components, including scalability towards large click-streams of data to be processed in near real-time and robustness towards the cold-start problem pertinent in recommendation engines.

The Data Mining components list shall encompass intelligent advisors based on user profiling, collaborative filtering and/or association rules discovery among information items, an aggregator mechanism that prioritizes and weights the advices of the advisors to compile a recommendation towards the user and a Reinforcement Learning algorithm that is an intelligent advisor and an advanced aggregator in-one. The Web Mining components list shall encompass algorithms for clickstream data preparation and cleaning.

Pattern management shall cover the administration of the patterns discovered by the data mining components and exploited for the formulation of advices and, ultimately, recommendations. Pattern administration includes adjustment towards change, whereupon change can be triggered by modifications in the portfolio of items but can also be the result of drifts in the corporate user population.

The support for advisors extends the Data Mining components list by including a service for ratings or reviews delivered by human advisors. Moreover, it encompasses a formal model of recommendation impact, in which the influence of different types of advisor and advice upon the users shall be captured and the factors affecting them shall be studied.

7.4.2. Management of changing patterns

The Pattern Management component is responsible for the efficient representation, retrieval and adjustment of patterns. This component shall be detecting and understanding pattern changes.

The SRA Engine relies on the large numbers of patterns derived by the intelligent advisors. These patterns form the basis for future recommendations. Efficient storage, an adequately rich representation and fast access must be granted to the core of the engine, including the aggregator and the Reinforcement Learning technique. With respect to the representation, the results of work can be employed that is reported in

(Bartolini, 2004; Catania, 2004; Rizzi, 2003; Terrovitis, 2004; Theodoridis, 2003), whereupon it is necessary to extend the current static model into a temporal model, so that pattern changes can be properly modelled. For the temporal extension, the research of (Baron, 2001; 2002; 2003; 2004) may serve as basis. With regard to storage and access, there is need to work on SQL-based querying upon stored patterns and stored data, concentrating on techniques for efficient indexing and on the support of pattern retrieval for non-human components (services of the engine as opposed to humans that can formulate SQL queries).

A central aspect of pattern management for the SRA Engine is the treatment of change. Changes in a web environment have many sources. In the scope of the research, we concentrate on

- changes in the portfolio of information items being offered and
- drifts in the preferences of users.

With respect to portfolio change, we shall consider the side effects upon the performance of the SRA Engine caused by the introduction of new items and by the ageing of seasonal (or otherwise short-lived) items. In this context, there is a need to contribute on modelling items and advices as temporal objects, while also extending the querying and indexing services of the pattern management component to accommodate the new temporal information.

With respect to change in patterns, caused by portfolio change or user population drift, we consider mechanisms for pattern change detection, adjustment and alerting. Important are here contributions on pattern change detection and models of interesting change (Baron, 2001; 2002; 2003; 2004; 2005), building on changes upon clusters. These results shall be extended to cover interestingness in the context of recommendations.

7.4.3. Web Mining Preprocessor

The Web Mining components needed in the SRA Engine core are of two types:

- intelligent advisors, i.e. mining modules that deliver web patterns to the aggregator of the engine, and

- weblog preprocessing modules that should be run upon the click-stream data before data mining commences.

Here, the emphasis is on the preprocessing activities, namely click-stream data cleaning, sessionizing and integration of session data with data from the corporate ERP and data / document warehouse. These can be developed mainly on the basis of prior technology on weblog preprocessing (Berendt, 2002; Spiliopoulou, 2003).

Weblog preprocessing encompasses a series of challenges, including the recognition and elimination of robot entries, the mapping of individual object impressions to web page invocations and then to business objects (e.g. product impressions, product recommendations, price negotiations, purchase orders etc), the sequencing of user activities, the identification of non-recorded activities due to caching, the establishment of sessions and the identification of session borders, the connection of session data with the site topology and the enrichment of session data with information from the corporate warehouse. Technologies designed to perform those activities has reached some level of maturity, so that they can rely on findings reported in the literature (Masand, 2000; Kohavi, 2002a; Kohavi, 2002b; Zaiane, 2003, and Berendt, 2004a).

The exploitation of weblog preprocessing technologies requires a lot of human expertise. Present advances rely on human guidance and inspection of the results. For the proper incorporation of the web mining preprocessor in the SRA Engine, though, a non-interactive version is indispensable. Whilst tuning via an administration interface shall be possible, cleaning and preprocessing must be performed without the need for human inspection. The activities for the transformation of existing interaction-oriented technologies into non-interactive modules are performed on the basis of data preprocessing for non-web-based recommendation engines.

7.4.4. Model of Recommendation Impact

Here we need to analyze the behavior of the SRA Engine in a simulated environment, deliver insights on the factors affecting the impact of recommendations upon the users and result in a formal model of recommendation impact, building upon work on game design for the analysis of human interaction (Mueller, 2002a; 2002b; 2004; 2005a; 2005b).

Also, we observe the SRA Engine as an environment for recommendations, where advisors and users interact via the aggregator at the engine's core. The advisors deliver advice, whereupon intelligent advisor components deliver rules, while human advisors deliver ratings or reviews of items. The aggregator component prioritizes those rules and ratings according to some business-oriented heuristics (e.g. most expensive items first, least frequently asked items first or reward maximization in the Reinforcement Learning module). Users respond to the recommendations thus built by the aggregator, whereby the response may be positive or negative.

User response is influenced by several factors, including but not limited to:

- affinity towards accepting recommendations,
- prior positive experience with recommendation engines,
- quality of the recommendations themselves,
- reputation of the human advisors,
- age of the advice.

For the establishment of the "recommendations impact model", these factors should be identified, quantified and understood. Then, the model shall be incorporated into the aggregator of the SRA Engine; for Reinforcement Learning, the model shall be used to tune the rewards in the action-value model.

7.5. SRA Engine interface specification & realization

This part of the architecture specifies the interfaces of all components of the SRA Engine. Along with base interfaces this includes the interfaces for the learning components (advisors and aggregators), the user interfaces and the communication interfaces.

The interface specification makes the SRA Engine truly modular and extensible. Finally, the concept of the user interfaces allows for flexible customization of the recommendation engine to user-specific tasks.

Four parts are comprising the interface modules:

7.5.1. General Interface Specification

This defines the general framework of interfaces of the "SRA Engine". It is closely related to the architecture specification of the recommendation engine. A common set of base interfaces needs to be developed for use in all three interface types of the components. Base interfaces include the root element, data types and mappings, definitions of data access elements and transformations. The CWM (Common Warehouse Metamodel) standard should be used to some extent. Further, service interfaces for logging, naming, time, and security, required for the recommendation engine, need to be defined, too.

The resulting interface packages are the building blocks for the forthcoming high-level interfaces.

7.5.2. Specification of Learning Component Interfaces

The learning methods are used to generate and update recommendations following the adviser-aggregator framework.

The interfaces are structured in packages corresponding to the

- Data Mining,
- Pattern Management,
- Web Mining, and

- Advice Generation components, respectively.

More specifically:

- For Data Mining components the internal data access as mining stream, the algorithm type, the algorithm control parameters, and the mining model (association / sequence / link analysis models, classification and regression models) are specified.
- For Pattern Management the data access in transactional format, the pattern type (association / sequential), the time shift and controlling parameters, and the pattern structure are provided.
- For web mining, the data access in transactional format, the data source type (e.g. log file type, database), the pre-processing parameters for data cleaning, sessionizing, integration with user / directory data, and sequence analysis algorithm type are specified.
- For advice generation components, the aggregator parameters (filters, weights, methods) are specified.

Also, settings for ratings and reviews delivered by human advisors are incorporated. Finally, for reinforcement learning the type (Dynamic Programming - DP, Monte Carlo / Temporal-Difference Learning, approximation method), the model type (generated from one of the other learning components) used to model the environment (for DP), the DP algorithm type (policy / value iteration), the online-interface communication interface, RL algorithm parameters, and the rule selection type (from policy) are defined.

7.5.3. Specification of User Interfaces

The user interfaces are required to customise the recommendation engine. The interfaces are structured in 'packages' corresponding to the interfaces of the respective boxes in Figure 12.

The package 'Access to Sources' contains the information about static sources for analysis and rule generation. This includes the source metadata (transaction (fact) tables, info item table, user table, taxonomy tables), the source types (database, Excel/log files) and parameters, the meta data of the target rules including target data types and parameters.

The package 'Click Stream Processing' configures the dynamic sources for rule generation and updates. They refer to a simple web service API to commit new sessions and online information of actions provided by visitors and responding recommendations.

'Customizable User Components' contains business information like availability checks for recommended information entities, definition of filters for recommended entities (value, creation date, creator / owner and groups, also combined), numbers and types of recommendations, and recommendation mode.

'Participant Management' defines which participant groups to show what type of recommendations, also rules to exclude recommendations for SRA participant groups (e.g. depending on session ID) in order to measure the success of recommendations.

The package 'Privacy Preservation Facility' includes the interfaces for configuration of data sources and their combinations admissible for analysis and rule generation. It is required to satisfy different laws of privacy preservation in different countries.

The 'Transaction Completion Facility' package is a set of interfaces to synchronise the analysis with operational data because the SRA engine mostly works in an asynchronous mode.

7.5.4. Specification of Communication Interfaces

The communication interfaces allow an external control over the recommendation engine.

The Administration interface allows to fully control the recommendation engine e.g. by an Administration client with Graphical User Interface (GUI). Thus, this interface is a communication wrapper for the User interfaces along with basic functions to schedule, log, and verify the work of the recommendation engine.

The interface 'Interactive Components' is a low-level interface for external Data Mining tools to connect to the recommendation engine and to access and provide recommendation rules. It basically contains the specification of different rule types of the recommendation engine along with utilities for their remote exchange.

7.6. The SRA runtime environment

On the implementation side the SRA run-time environment will focus on the implementation of the distributed Architecture and of tools to create and manage shared corporate network resources. More specifically, the SRA run-time environment will comprise:

- **An open Distributed Service Network platform**, namely **the SRA platform**, as a prototype solution based on semantic web technologies, to achieve maximum flexibility for a wider applicability of SRA in the corporate world
- A **Seamless Semantic Interoperability Toolkit** that will enable corporate as well as external content and service providers and SRA users to communicate and transact through the SRA run-time environment.

The above-mentioned technical objectives will be based on an Information Mediation Architecture that will allow the semantic interoperability of heterogeneous information sources.

The following figure 13 shows the improvements, which can be gained by using the approach of semantic web technologies in the addressed domain.

Today, if changes occur on the application or service level or on the level of user requirements, the data structure has to be changed and often manually adjusted to the new situation. Developers mostly implement proprietary solutions which fit their current needs. The overall view is missing. This model will allow the automatic adaptation of the data structures to changing situations according to the rules and specifications defined in the SRA ontologies and the aggregation, exchange and synthesis of services in different levels.

The SRA run-time environment key objective is to deliver the semantic tools, components and guidelines in order to satisfy a series of representative Situation Room sessions as well as the underlying business cases, which cover data exchange, and service provision and synthesis based on content sharing between various corporate participants and resource "servers".

The SRA run-time environment tools mentioned above are the key achievements:

- The definition of an open, distributed and seamless Semantic Interoperability Framework
- The development of a Distributed Service Network Platform and a Semantic Interoperability Toolkit
- The demonstration and validation of the SRA run-time environment developments by executing test scenarios of the examined business cases

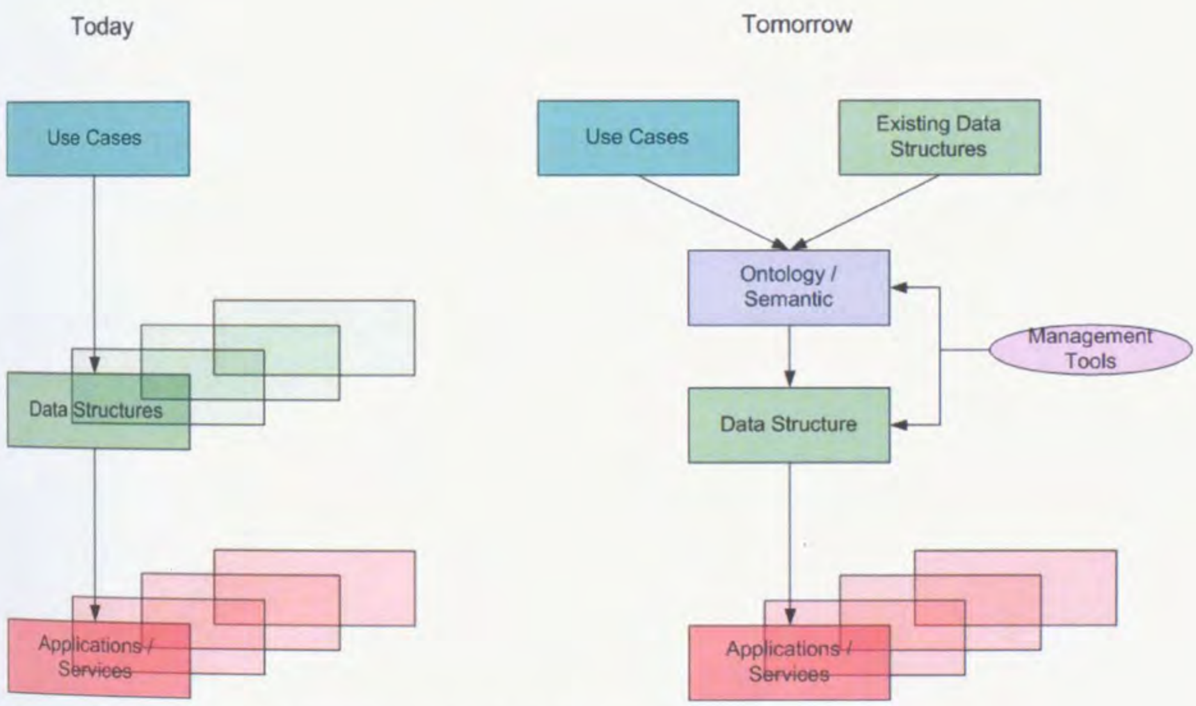

Figure 13 Improvement in using semantics in the addressed domain.

7.6.1. The Distributed Service Network platform and the Seamless Semantic Interoperability Toolkit

Ontology technologies are adopted as the technical basis for the information mediation architecture, which conforms to the state-of-the-art in information integration solutions. The platform provides a harmonized, open framework for services where multiple business partners as well as content providers and service providers can exchange data ensuring not only the syntactic, but also the semantic interoperability. Furthermore, the platform caters for interoperability with existing applications.

The development of a Distributed Service Network Architecture (DSN) requires two software architectures to be designed: a network architecture and an application architecture.

The network architecture depicted in Figure 14, accounts for how systems in the DSN should know and understand each others. At present the following kinds of system are envisaged:

- SRA client nodes, using services;
- SRA supplier nodes, providing services;
- SRA directories, providing a list of supplier nodes together with the offered services;
- SRA devices (handheld user devices, workstations, servers, …), normally supported by client nodes[28].

Protocols such as SOAP and UDDI (or ebXML) belong to this picture of the architecture, as well as "semantic enablers" suited for these protocols.

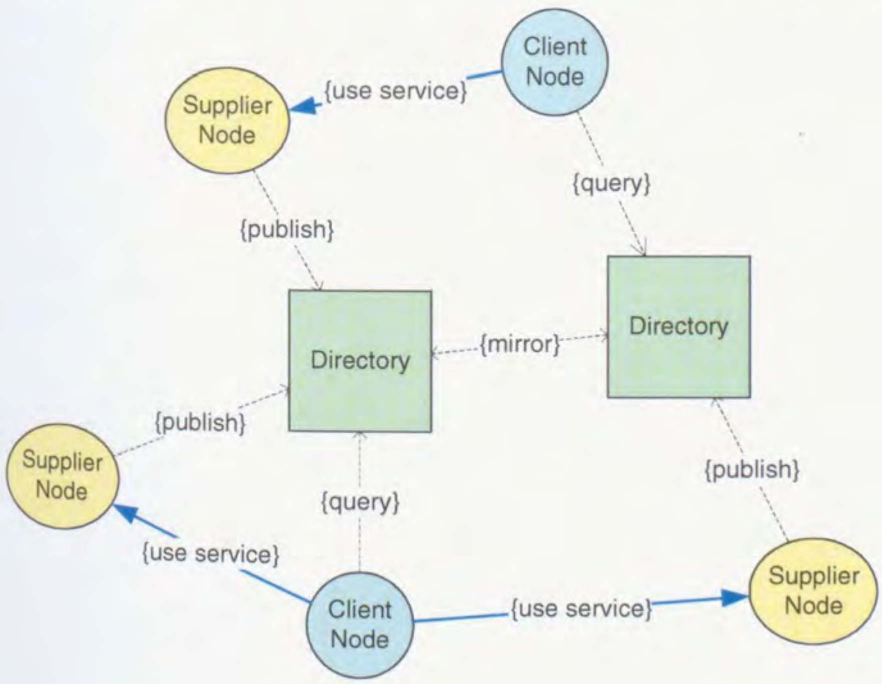

Figure 14 The SRA run-time environment network architecture.

[28] It depends on the creativity of the SRA adopters and implementers to map to an SRA device artefacts like e.g. a particular market index, or stock exchange indices, or cashflow-related and other financial corporate data, etc.

The application architecture shown below in Figure 15 describes DSN platform components and operations as provider peer and its interactions with the end-user and the Collaborating Provider Peer and the Provider corporate legacy systems. A detailed description of the components and their architecture is given below.

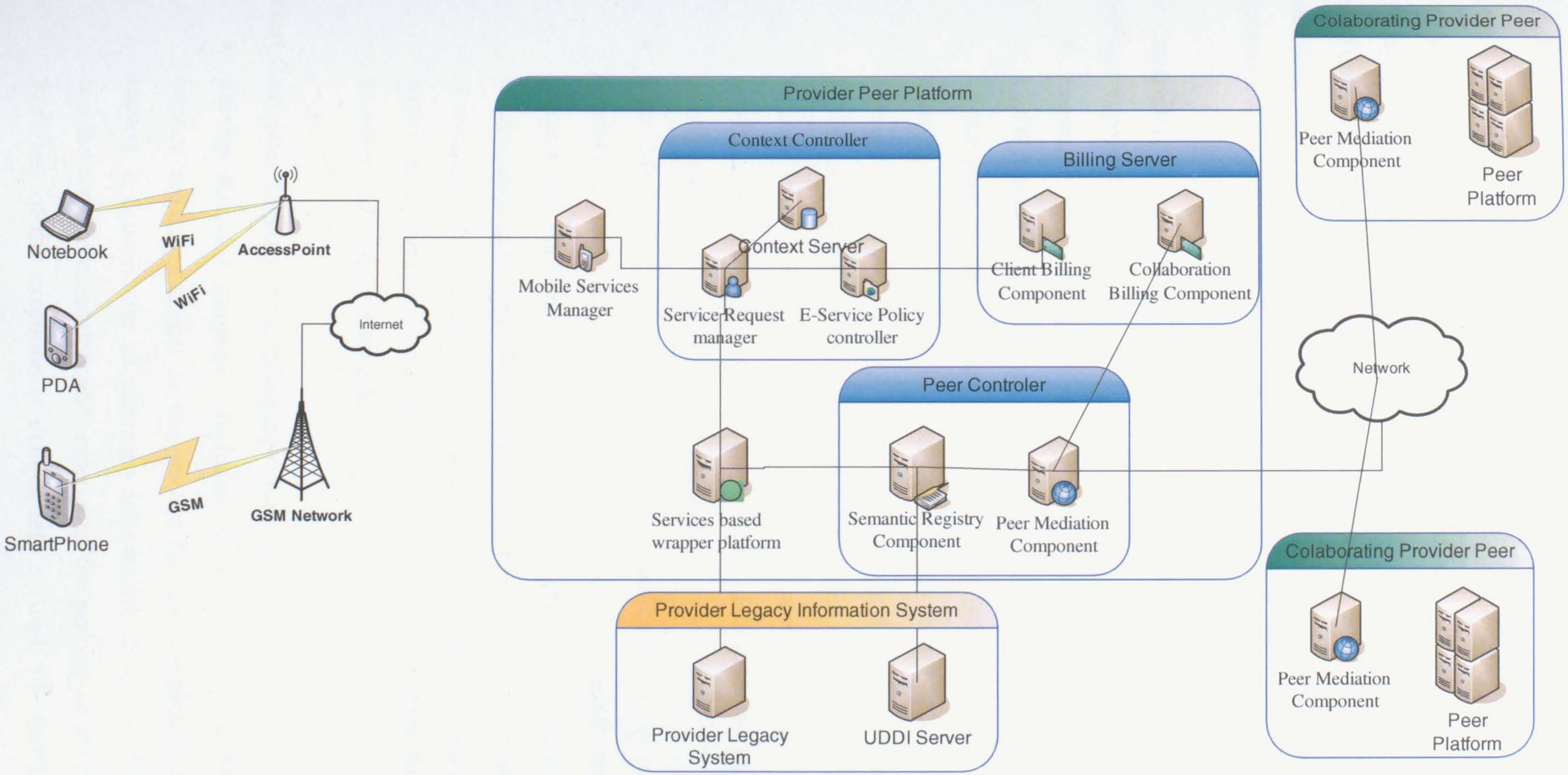

Figure 15 The SRA run-time environment application architecture.

7.6.2. Distributed Service Network platform (SRA platform)

The SRA run-time environment platform has a layered architecture with well defined components. In this architecture, each layer utilizes the services provided by the below layer as well as a layer abstracts the complexities of one service from the above layers. Furthermore, another advantage of the layered architecture is that it facilitates the development of the platform. In the architecture, basically, there are the following components, also shown in previous figure 15:

Peer Controller, for connecting with P2P Infrastructures, which is divided to the following components:

- **Semantic Registry component:** This component is responsible for the UDDI management by semantically registering services that are provided by the peer or are provided by collaborating providers. The component uses the UDDI server that is a part of the legacy information system of the Provider. Semantic registry component creates a semantically enhanced UDDI registry where the services of the provider node are published. The registry uses OWL-S profiles to create semantic descriptions for the services. The utilization of the component also facilitates the annotation of semantic context for web services utilization.
- **Peer Mediation component:** The Peer mediation component act as communication manager between the providers. It sends and receives requests for services to other peers. Two peers can communicate by sending request to Peer Mediation components. The Peer Mediator request is encapsulated in to standard messages. The definition of the message is based on a common message ontology that will be used from all the provider nodes of the network.

Context Controller consists of the following components:

- **Service Request manager:** Includes the **Computational Model.** The Service request manager is responsible for the completion of a client request. It consolidates all necessary information about the client request and the request execution and undertakes the process of execution. The workflow of the execution is defined into a BPEL file that is executed from the content manager. However in order to support dynamic orchestration the Service Request manager uses process templates (semi-structured BPEL files) that are completed and execute with the information retain from the context translation that takes place in the Semantic Context Server and the Policy Controller.

- **Semantic context Server** is a server that stores and manipulates information regarding the execution of a service request. It will navigate information collections with the use of ontologies and will allow the user to combine information for its particular purpose of use (context). The semantic context server is responsible for the translation of the client request message to set of concepts that define the nodes in the execution process. The translation is also based to context server repository that contains ontologies (OWL) for the inference of the semantic interpretation of the client request message context.
- **E-Service Policy controller:** It is a supplementary component that contains information regarding the execution of a client request. The E-Service Policy provides to the service Request Manager Information regarding the execution of the requests. This information depends on the service availability and the cost of the service. The Policy controller receives the translated information from the Semantic context and creates an orchestration based on the Policy that is defined by a rule based system. The component retains the optimum orchestration based on rule regarding the cost and the time of the process execution.

Billing Server is responsible for the billing of the services that are executed to the provider registered client or to collaborating providers. The billing server also provides information to the existing billing system of the provider. The billing system is manipulated by two sub-system that are the following:

- **Client Billing sub-system** contains all the information regarding the transaction of the provider client when they use the platform.
- **Collaboration Billing sub-system** is responsible for the billing of the collaborating peers billing.

Mobile Services Manager handles the client requests. The Mobile Services Manager enables location retrieval mechanisms in order to provide the necessary information to the service request manager. It will focus on Location Based Semantic and Information provider throughout the use of a Positioning Platform Middleware. The architecture of this part of the system will be based on systems that use and provide sufficient contents to exploit, based on location, the semantic information. Though this seems less relevant with the current mainstream of corporate environments, it is our firm belief that it may be used as a major enabler to achieve a higher degree of corporate agility in the (near) future.

Finally, the **Web-Services based wrapper platform** that is a set of web services that wrap the provider legacy system functionality and a set of components for administration and maintenance. The platform creates a service oriented infrastructure that is used for the integration of a particular peer to the Legacy system of the provider. The creation of the web-service is based to a platform independent Framework that wraps the legacy system of the provider based on semantic conceptualizations. The framework is consisted of software components that develop .NET web services from system conceptualizations. The conceptualization definition is facilitated from a graphical environment. The platform also supports the mechanism for the discovery and invocation of the produced web services.

7.6.3. Seamless Semantic Interoperability Toolkit (SSIT)

The Seamless Semantic Interoperability environment will be used as a base platform to create a toolkit for interconnecting content and service providers to the SRA run-time environment. SSIT consists of interfaces and utilities for users within the SRA scope of execution, and namely for publishing content, discovering and composing Web Services. This environment forms an integral part of the overall interoperability environment that includes common data formats for information exchange and service interactions.

The toolkit uses an ontology based approach to connect individual content providers with their own data formats to the SRA run-time environment. Corporate learning, based on the notion of the Situation Room, domain related ontology is used as a base for the toolkit and will be extended and generalized to cover the SRA run-time environment services.

By utilizing the developed toolkit, service and content providers are able to join the SRA run-time environment network and interface their content and services with the network and other providers. SSIT is comprised of the following components:

- **Semantic Context designer** creates context based on ontologies and registers this as publishable content to the context server. The latter graphically annotates semantic-defined information which flows with the various client request messages as part of the particular services.
- **Service oriented application integration module (SOAI)** facilitates the creation of a service oriented infrastructure that wraps the provider legacy system functionality. The SOAI module uses semantic conceptualization of the legacy system that can be defined by a composer and generates the set of web services that are responsible for the integration of the legacy system to the SRA run-time environment platform.
- **Semantic Registry configuration module** facilitates the registration of the services provided by the provider. Using OWL profiles the module enables the registry administrator to enrich web service descriptions with semantic information.

7.7. Synopsis

In its practical application, SRA addresses the needs for a solid technological basis for online recommendations and for corporate value creation through recommendations by an application orientation that will provide:

- the transfer of technology and expertise based on a lightweight web mining infrastructure for recommendations and
- the establishment of the corresponding recommendation services that go beyond the conventional model of exploiting the preferences of corporate users.

8. Conclusions

8.1. Relation of the research with the corporate Zeitgeist

Most forward thinking companies question, as part of their strategic processes, the appropriateness of their structures in achieving business outcomes. Indeed, even successful structural platforms need to be challenged if companies are to continue to succeed into the future. In order to increase corporate responsiveness and flexibility in a rapidly changing world, many companies have broken down the traditional, hierarchical bureaucracies that served them well in the past in favour of a number of smaller structures often clustered around different business activities. A feature of such restructures has been the doing away with levels of management coupled, in many instances, with the introduction of a form of 'self-directed' team work.

Restructuring along these lines broadens the scope of corporate strategy by providing for more specific strategies to be developed in respect of particular business activities.

Together with structural *delayering*, this increasingly brings the task of formulating strategy within the realm of senior and middle managers. No longer is their role restricted to merely implementing strategic directions and they have an increasing role in determining the corporate strategy (or, at least, some part of it).

This raises a number of issues including:

- *How* does this changing situation impact on the coordination role of the companies executives?
- *What* might senior and middle managers need to take on a wider strategic role?

A starting point to addressing these issues by means of the proposed Situation Room analysis is to settle on what is meant by the term *Situation*, at least for the purposes of this study. While definitions abound, in this study the notion of a *Situation* relates to:

- knowing *where you are* i.e. your current position;
- knowing *where you want to go* i.e. your target position; and

- knowing *how you are going to get there* i.e. the means to support the transition from your current to the target position, as well as the cost matters which you shall need to take into account in order to achieve this), and having the capability to respond to change on the way.

Inherent in this understanding of a Situation is its longer term focus and the notion that it comes from first understanding and then analysing the environment surrounding the company. For this, we can broadly recognize that:

- In the 1970's, strategic style emphasised an analytical and purposeful approach to a defined process. Such an approach is suited to a stable or slow-moving environment but tends to focus on yesterday's problems and restricts innovation.
- The 1980's saw the emergence of the visionary strategic style epitomised by the setting of long-term challenges. This style stretched organisations beyond previously conceived goals but was often beaten by reality and, ideally, needed visionary leadership supported by a capable, forward-looking organisational culture to be successful.
- The 1990's has seen the development of a more pragmatic learning style of strategy aimed at creating new opportunities by exploration and rapid response to change. This approach is suited to a fast moving environment but has the potential downside of producing an unclear strategy lacking in insight.

These three broad styles are set in parallel to the progressive organisational trends of:

- restructuring (getting smaller through delayering and downsizing),
- re-engineering (getting better through improved quality and customer satisfaction) and
- reinventing (being different through learning from the past, forecasting corporate or industry segment directions, thinking laterally and imaginatively, challenging the corporate and / or the industry boundaries, and enhanced strategic intent).

8.2. Hypotheses revisited

The conducted analysis and the business application scenarios indicate that 'prototyping' of a Situation Room instance within a corporate setting can contribute to the increase of the corporate intellectual capital in at least three key ways:

- By helping to develop understanding about the essence or essential factors of a corporate decision-making experience, as it simulates important aspects of the whole or parts of the relationships between people, events and contexts, as they unfold over time.
- In exploration, shaping and evaluation of ideas and attitudes: Situation Room Analysis can provide inspiration, confirmation or rejection of ideas based upon the quality of experience they engender. It produces answers and feedback to decision-makers' questions about proposed solutions in terms of 'what would it feel like if...?'
- In communication of issues and ideas: by enabling others to engage directly in a proposed new situation, it provides common ground for establishing a shared point of view. Such a point is to be regarded as a collective asset – not property of an individual but of the team that has contributed to its creation.

In this respect, a possible criticism might read like "Situation Room Analysis is not a new phenomenon within the decision-making community; decision-makers have always been ready to adopt and adapt methodology and technology and processes of many kinds to create early representations of their ideas and understandings". But the concept of Situation Room Analysis specifically, we believe, deserves a conscious focus. It should become a recognized and well-supported tradition within corporate decision-making practice. This belief is founded upon observation of our own practices which indicate that we can be more sensitive, can design better experiences for people, and can be more convincing about the value of the decision-making patterns, by intentionally adopting such an approach.

From this perspective, it follows that Situation Room Analysis is not about the creation of a formalized toolkit or set of techniques, but is about developing an attitude and corporate culture to solve problems.

As we move into a more conscious frame of mind about Situation Room Analysis, we are aware of much we do not yet understand about how to best utilize the principles for the most innovative and successful results.

What is the appropriate representation for different audiences? Situation Rooms might be designed primarily for ourselves, other members of the corporate team, stakeholders, and *internal or external clients*. The audience influences both the type of *Situation Room instance* we create and the degree of context and explanation we provide to frame the experience for them. For the corporate middle management it may be difficult to provide an early, low-fidelity improvisation prototype of sufficiently robust nature that they can have an experience in a naturalistic context without supervision. Higher levels of fidelity have their problems, too. As faced in one of the conducted experimental sessions, Situation Room participants may become unshakably attached to early ideas when they experience a single convincing manifestation of many different possibilities and perceive it as the final solution.

Clearly it is important for designers of corporate Situation Room to share their understanding of the intent behind a Situation Room as a corporate infrastructural asset, but perhaps there are also lessons to learn about communicating these intentions more effectively by carefully choosing the implementation or prototyping technique. Hence it is important to investigate the value of role-playing and improvisational theater (Laurel, 1993), rather than of watching someone else's experience. Is there any danger that active involvement, especially when an audience is present, tends to direct energy away from understanding the experience to acting as if you were having the experience?

Perhaps sometimes there is at least additional learning to be gained by observation and reflection of someone else having an experience as opposed to being fully immersed in it yourself and then transferring or generalizing your own personal and subjective experience without cross-checking with real users.

Situation Room Analysis focuses primarily on participatory, multi-party and team learning in relation to the precondition for organisational learning and on applying the theory from experiential learning as described by (Kolb 1984) and reflective learning as described by (Schön 1983, 1987). Important is to discuss the circumstances under which we can expect that problem-based, project-organised training / learning methods will be effective in relation to changes in corporate attitudes, values and behaviour. To be effective here means that the aim of the learning process encompasses more than participants / employees gaining new knowledge on the cognitive and affective levels: opportunities for subsequent organisational learning should also be ensured. Our opinion is that it is important for the facilitator of a Situation Room to have a clear approach in order to establish learning activities to support a consistent[29] style of corporate decision-making.

It is easy to recognize that when trying to establish a theoretical approach to learning, the first focus is to introduce reflection in the activities with which we worked in different learning situations in the past. The next focus point is the facilitators' role in the learning process; at this point, we were very much aware of the necessity of focusing on more structured experimentation, as it is in the cross field between reflection and experimentation that innovative processes take place (Schön, 1983).

It is essential to think of Situation Room Analysis as complementary to other decision-making methods. First, no matter how good Situation Room Analysis is at promoting empathy, we cannot actually *be* other people or dis(as)sociate ourselves from the emotional aspects of a situation we are part of. There will always be a place for other design and research methods to help us understand other people's points of view. Second, as in all forms of implementation, we inevitably make choices about what elements of the ultimate Situation Room to represent and what to omit. This means recognizing that a single prototype is never enough. Multiple Situation Room prototypes and other methods such as contextual observation, participants testing and participatory design all bring important perspectives to complete the picture.

[29] Or at least a convergent one.

These other methods help us in identifying the relevant factors of a Situation Room that we plan to implement. To create an appropriate prototype we need to determine, for example, whether we are interested primarily in the temporal/dynamic aspects of an experience, the physical/spatial and social aspects, or the cognitive and temporal/dynamic aspects. And, since we are developing only partially integrated prototypes, "setting the stage" for a particular Situation Room session becomes crucial. We need to be explicit about what needs to be ignored (e.g., because it "does not look like" or "would not be tethered") and about what context surrounds the participants' experience ("a high pressure emergency situation" or "a very insightful and personal moment").

Finally, we come back to the point that people's experiences with information products and systems are a complex integration of both personal and circumstantial factors. People will have experiences with the things we design, whether we intend them or not, and in ways that we cannot hope entirely to predict. Nevertheless, understanding, exploring and communicating the experiential aspects of adoption ideas are central activities in the implementation of Situation Rooms in the corporate world.

Situation Room Analysis, while it creates only approximate and partial simulations of the real experiences others will have, brings a subjective richness to bear on decision-making problems. It is an approach that, we believe, will benefit from more conscious attention and deliberate experimentation and adoption in the real world.

8.2.1 Utility of the research

The study has shown that the concept of Situation Room Analysis can be an extremely beneficial development tool in developing corporate intelligence and increasing their intangible assets value provided that certain problems are resolved and provided that the corporate Management demonstrate that they have the will to remove the obstacles that currently stand in the way of widespread business process and decision-making connectivity.

While it is all very well to call indiscriminately for adoption of collaborative practices such as the proposed SRA as a tool for development, the reality on the ground in the majority of the corporate world is that there are a number of problems, hindrances and issues which have to be squarely faced and resolved before the SRA concept can be used successfully as a development tool. These problems, hindrances and issues have been described as some length in the research and relate mainly to the kind of soft skills infrastructure and processes that are absolutely essential in any company before the SRA can function with maximum efficiency.

The study also indicates that SRA can be used not only to access information but also to engage in corporate planning and programming activities. The research also presents that SRA has a potential to provide current information to and facilitate communication among different layers of the corporate structure. Any sustainable adoption and usage of the SRA would require a careful case-by-case needs analysis to determine the form and extent of each company's needs for SRA adoption and specialisation. Finally, the research recommends specific, situation- and context-based SRA provision rather than indiscriminate whole scale corporate provision.

With this in mind, the research emphasises that needs analysis and market research need to precede any kind of SRA provision. Providers, suppliers and designers of SRA tools and methods should examine every aspect of each company's needs – as well as each company's readiness to use the SRA before facilitating access for that company.

If it is used in this way, the SRA will serve a specific function in a specific situation and therefore provide maximum benefit to particular group of people (rather than random benefits to diffuse and undefined corporate stakeholders).

The researcher's experience and evidence that results from the study has led to believe that situation-specific SRA-based collaborative decision-making would be far more beneficial for companies than any kind of ill-prepared attempt to provide universal access to corporate information resources. In other words, the research recommends that the SRA should be used as a precise and effective tool in any collaborative decision-making process that facilitates corporate development – not merely as an end in itself.

8.3. Observations on the research approach and contribution to the body of knowledge

The methods used were primarily qualitative and exploratory in nature. The explorative application scenarios method has been used to cover contextual conditions as they are believed to be highly pertinent to the area of study. The cultural and organisational context of implementing Situation Room Analysis can be much better understood if the history and specific circumstances over a given period in time are taken into consideration.

The application scenarios helped unearth details that may have been neglected in other research approaches and the richness of data more than compensates for any lack of generality. An understanding of entrenched organisational culture and the motivations of individuals can only slowly emerge by immersion in the particular organisational contexts over time. Divisive tensions within and between groups can create immense barriers to change. The intricacies of collaboration during a session of Situation Room Analysis require an understanding of existing tensions and the identification of new social and cultural situations generated by change. Such situations may be nebulous but invasive as change is thwarted by participants' often hidden agenda.

An *holistic* and *user-centric* approach to identify the inter relationships and dependencies between the corporate decision-making practices, the technology and the business and organisational aspects indicates the primacy of how organisational culture and individual motivations may thwart and inhibit the implementation of business objectives enabled through Situation Room Analysis. Indeed, the gap between how such plans are articulated and the social actions of participants may point to a different but unarticulated agenda. There emerged a descriptive understanding in terms of what happened in specific situations, an interpretive understanding in terms of what it meant to the actors involved and theoretical understanding in terms of specific concepts and their relationships which were used to explain actions and meanings.

The focus group sessions (we report on them in Section 4.4) in which the application scenarios were developed provided a real world basis for the exploration of divergent views and actions in the context of Situation Room Analysis and collaborative relationships and were chosen to reflect the common theme of collaboration in the decision-making process but in different industry sectors. The research was holistic in terms of it moving beyond the purely technical environment of Situation Room Analysis implementation and inductive in terms of uncovering different perceptions from diverse actors in the inter-organisational environment. The interpretive approach was deemed appropriate to explore the richly ambiguous organisational and relational consequences.

The critical question is whether the meanings in the qualitative data are correct and valid, and moving from the particular to generalities is potentially very problematic. The multiple perspectives, methods and observations in the study provide a strategy of triangulation to add rigour, breadth and depth to the investigation. People do sometimes, for example, have widely varying perceptions of the same phenomenon and the collection of new information from new informants and new events provided the means to reinforce or qualify earlier data by testing their validity and generality. Furthermore, gaining the trust of the respondents was a crucial element in gathering context rich and meaningful data, especially where the data may potentially threaten the informant's self interest.

Having this access to multiple respondents within the particular environments therefore enabled the validation of identified themes and trends. However, wherever possible the researcher double checked findings using multiple sources and modes of evidence to provide an element of verification. Regular visits to a number of companies that participated in the focus group session, as well as the researcher's inclusion into meetings, workshops and more informal discussions, meant that much behaviour and many activities were seen firsthand. Employee assertions on ways of decision-making, for example, could in some cases be cross-referenced and checked with company documentation concerning methods and principles of working. Access to the various actors also enabled impressions from group settings to be followed up in informal and one to one settings. Furthermore, the fact that what people say and what people do is not necessarily the same thing was also taken into consideration through observation and cross checking with the perspectives of others involved in various transactions in different settings. This seeing and hearing of multiple instances from different sources and using different methods were an integral part of the research process.

8.3.1 The Literature Search

The review of the literature enabled a set of hypotheses to be developed about the topic and the findings are broadly congruent with and confirmatory of the themes and theories from the literature search.

However, due to the pace of continuing development in the topic area the initial literature search was supplemented by further reading as the research continued and this further informed the analysis of the application scenarios findings.

The earlier themes identified from the literature search associated with Situation Room Analysis were still found to have resonance and applicability even as information technologies and capabilities develop. This reflects the fact that the addressed research field does not exist in a vacuum and that a holistic perspective is required of the interactions between the technical, organisational and business aspects within the inter-organisational context.

8.4. Implications of the research and further research items

The core argument of this research is that the concept of Situation Room (SR) may act as the central metaphor around which the main personal and corporate requirements, work and management practices, organizational issues, enabling technologies, implied by the future, new and increasingly content- / media-rich CWEs can be modelled, framed and validated within several business domains to support the product development process. However, the key, and as well the appeal, of the SR metaphor lies in bringing the key personnel together with key, live information about the current situation and the availability of tools for the modelling and evaluation of scenarios and the ability to thus reach well-informed consensus decisions and subsequently observe their impact in the field prior to the next round of assessment, planning and new decisions until the problem is resolved. This is by very nature a CWE with a high degree of semantics, where modelling approaches are used to assess impact and reach decisions. Consequently, the SRA paradigm implies an extensive use of semantic approaches as a powerful means to support the data fusion, modelling, scenario evaluation and decision making process. In fact, the SR-inspired ICT platform will be supported by semantic technologies to provide a semantic integration mechanism for the various components and their interoperability.

In the research, we aimed towards bridging different schools of thought to support the emergence of a new class of metaphor-driven Information Systems design, implementation and employment. The area of focus has been this of multi-party corporate decision-making.

Viability of the method has been verified in a set of different contexts by means of appropriately designed application scenarios and the feasibility of its implementation has been also successfully maintained. However, the most important and critical part – as in all similar cases - relates to the adoption difficulties.

The inherent weakness of Situation Room Analysis lies in the need of a committed corporate Management, which can fully understand the costs related to the introduction of the framework not as an expense but as an investment, not as a new corporate Cost Centre but as a Value Centre. Any of the technical limitations which can be identified are of secondary importance with respect to this. This type of transcendental and visionary thinking and acting is rather a rarity nowadays especially when considering the Information Technologies Market and the after-effects that (still) accompany the decline of the dotcoms and the diminished feeling of euphoria that has dominated the field. However the signals we have been receiving are in all respects encouraging: the potential of introduction of Situation Room Analysis as a framework that makes use of interdisciplinary paradigms will be experiencing more interest, as the technocratic approaches have nothing new or better to provide.

The acceptance of the research methodology and results in International Conferences and Scientific Journals, and the appreciation of the notion of Situation Room as a vehicle is a clear indicator of the validity of the approach. Furthermore, recent communications with the innovation financing community have also provided us with positive feedback regarding the exploitation and commercialisation of this research.

In one of the opening statements in the first chapters of this research we mentioned that companies now more than ever need explicitly defined ways to manage their decision-making activities as part of their broader intellectual capital and organize their learning capacities through them.

Enterprise modeling, according to the experiences we have from it, refers to the way in which business *realities* are described for which ICT-applications are designed. Such descriptions contain more and more business knowledge. It is impossible to study ICT-applications in corporate management without such business knowledge. Based on the SRA paradigm, we proceeded to the definition of a framework which can be used for developing a supporting IT infrastructure capable to assist the process of product development. We presented the research hypotheses in five different application scenarios which are targeted to the use of Virtual SRs for Decision Making.

There is no risk in foreseeing that new research in enterprise modeling is specifically required in the context of mainstreaming the notion of a Situation Room as a powerful metaphor for multi-party collaborative decision-making.

Actually, by the time we had already concluded the research, the European Commission through its Research Framework Programmes mechanism openly supported the idea of Living Labs as an important medium to support innovation in Europe. We elaborate on this and also showing how the SRA model can be compared with this modelling technique in Section 6.1.1, where we also give an indication as to how the model can be implemented and validated.

Previous modeling methods have proven weak in modeling organizational boundaries, interorganisational business processes and business transactions with more than two parties. Also, enterprise modeling methods have not been successful in incorporating people-related processes and knowledge representation methods in their enterprise modeling frameworks as social and cultural phenomena within the context where they appear exist.

A separate stream of work can be related with possible contributions to the PMML (Predictive Model Markup Model) standard which can be of two types:

- For adding a new PMML mining model for web usage patterns, thus helping to the SRA adoption as a daily infrastructure element for the people in the ICT sector.
- For extending PMML to support time evolution, thus addressing temporal aspects of SRA use in the active working environment.

Though both of the above separate distinct future research items, they can be addressed in a combined way, thus increasing possible gains in the usability of the provided solutions.

This said, it can be recognised that although geographic boundaries can be overcome with the use of SRA to support multi-party collaboration of non-collocated people and teams, there remain many practical, non-technological and non-trivial issues to overcome: for example, communication protocols, cultural differences in globally distributed project teams, trust and the personalisation of content and presentation. Integrating the experience of the described applications and new technologies like user profiling, intelligent agents and the use of mobile devices. All of them form another future step beyond taken by this research.

SRA application, by the nature of the topic and remit, can form an important component in future plans to increase corporate workers involvement in research and development activities.

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Appendices

Appendix 1. The five product development application scenarios

Below we describe each of the 5 selected application scenarios for product development, each of which is followed by a reference outline to a future / envisaged ('2015') scenario.

A.1.1. Application Scenario #1: Problem Solving in complex Product Development projects

The first product application scenario deals with a multidisciplinary team of IT practitioners that have to design innovative software to support 'problem solving in complex product development projects'. As it is easy to understand, product development projects generate and process a huge amount of different kinds of data and information like e.g. cost and quality figures as well as BOMs (: Bills Of Materials) or CAD drawings.

Project managers and team members must be able to access them easily to make appropriate decisions. Many components and modules of a product are developed in close cooperation with remote suppliers and design and engineering service providers in multi-tier partner networks, making the problem solving process very complicated.

Moreover, just accessing and displaying different kind of data and information using corresponding remote systems is not sufficient for troubleshooting. Solutions are developed by humans and need to be jointly analysed and evaluated inside and outside a virtual team before a final decision is made.

Research has shown that in practice there is not one "best" visual display format for every task but it actually depends on the character of the problem, the persons involved, and the surrounding environment (Meyer, 1999). However, there is evidence that the more complex a task becomes, higher levels of visualization lead to faster and better decisions (Crossland, 1995), (Smelcer, 1997). Additionally, usability of the human-computer-interfaces needs to be considered in order to ensure efficiency of the different, applied systems and to raise acceptance among the users.

Below we describe the outcome of the SR-based session in terms of a future scenario with an indicative date to the year 2015:

A.1.1.1. Situation in 2015 for product application scenario #1

Marc is an engineer in the development department of a big automobile company situated in Stuttgart. He is specialized on brake systems. Currently, he is looking for a solution to a malfunction in the control facility of the brake system that is linked to the automatic distance control. He has already found a way that could solve this problem but he is not sure about its implications on the automatic distance control.

The software for this component has been developed by an external software partner that is situated in Paris. Marc knows Pierre, the person in charge for this component from several (virtual and real) project meetings.

Marc calls Pierre and asks for some time to discuss the problem. They arrange a virtual meeting on afternoon of the same day. Pierre also calls in a second colleague at another location who has same experiences on the specific problem from another project. They all can access and display any user-defined contents together over the platform and modify them interactively (e.g. for simulations) while discussing the issues.

Their communication is supported by video conferencing and application sharing using broadband and streaming technology as well as large combined screens to present diverse kinds of data. Sharing common development facilities and following common guidelines for this kind of problem solving, both delivered by SRA, they have a long and creative discussion, almost as if they were physically together. This lets them forget the actual spatial distance and helps them to find an innovative solution within this initial meeting.

A.1.2. Application Scenario #2: Collaborative Authoring, Publishing and Delivery of Multimedia Content

Current digital content production workflow is usually treated as an one-way process: content is designed and delivered for a specific communication media/technology (end device).

Neither its re-use for other media technologies nor its interleaving in form and content with other media formats is practicable without considerable efforts and costs. State of the art specialised tools for the creation of digital media assets have now become highly sophisticated solutions in their respective areas (e.g. image processing, 3D computer animation, sound design and scoring, video editing, special effects, etc.).

Integration of these different media assets into fully interactive rich media turns out to be crucial in the years to come, as well as the development of new content formats which may get across the existing media platforms (mobile, TV, PC and Radio).

Therefore, integration aspects become of high concern for multimedia design as well as distribution. Furthermore, extended collaboration between creative people and teams in their various fields of activities (e.g. media art, education, film productions etc.) has to take place in order to bring together the diverse media contents of a typical multimedia application.

A.1.2.1. Situation in 2015 for product application scenario #2

Hannah is the business development director of a prominent channel that wants to expand its business in any possible area where there are synergies with their current core business. One idea that her team has been working at is the provision of personalized news services on a 24/7/365 base to a set of customers that are willing to pay for this exclusive service item. For this, she will need support in the acquisition of customer needs, and a continuous base for editing news and ensuring its provision to the appropriate recipients.

The SaRA platform can support communication with account managers and members of the technical team as well as the synthesis of the personalized / individualized news bulletins. This comprises all possible media such as (annotated) video, commented texts and articles for which Hannah's agency is paying other parties for news casting.

Furthermore, the decision-making process for the editions of the channel's programs, analysis with staff members and external professional collaborators (some of which might be in distant areas and/or in mission all over Europe or the world) is going to take place within the SR-like virtual environment.

A.1.3. Application Scenario #3: Individual Learning and Corporate Content Management in Industry

E-learning is defined as "*the use of new multimedia technologies and the Internet to improve the quality of learning by facilitating access to resources and services as well as remote exchanges and collaboration.*" This has now become widespread across Europe, especially since the EC launched a number of e-learning initiatives like the "*The e-Learning Action Plan: Designing tomorrow's education*"[30].

However, despite this relatively coherent European policy framework, the conditions for people's participation in e-learning projects differ greatly with regard to age, gender, education, work experience, language spoken, and other cultural, social, and economic factors and characteristics. Hence, in the design of 'quality' e-learning solutions it is becoming extremely important to assess the impact of the different cultural and socio-economic backgrounds on the perception and the personal ability to participate in the program. Moreover, technological support for e-learning methodologies implementation is often based on existing competencies and skills of the development team and is not benchmarked against the new and emerging innovations in the digital content industry. (Furthermore, those innovations experience the lack in integration that was mentioned in the previous scenario).

Finally, a wider collaboration between domain experts and developers is called for during both production and distribution of e-learning content.

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[30] See "The e-Learning Action Plan: Designing tomorrow's education" – Retrieved online on 08.02.2005 from http://europa.eu.int/eur-lex/en/com/cnc/2001/com2001_0172en01.pdf

In some state-of-art cases, technology support is acquired either through top in-house developed tools or via external collaboration with the state-of-art solutions providers[31].

A.1.3.1. Situation in 2015 for product application scenario #3

The embedding of a scenario-based / -driven learning session needs to employ a 3D computer animation. Laura is a software developer in a public institution managing the (mandatory) corporate insurance against workers accidents. She has received an assignment to create a highly interactive multimedia tool for self / remote training, with the aim of increasing use of personal protection devices by young and novice workers.

Currently she would involve an external team of developers, as integration of 3D-computer animation in the workflow turns out to be very difficult and may cause a patchwork of workarounds. For this kind of digital content, authors have to build up their own production line, which is limited in scope compared to the range of possible requirements. For instance, it's not possible to author a learning session interactively.

When the tool comes to distribution, technical restraints – depending on the front-end technology being used – narrow the scope of possibilities once again. In case of need for further adaptations, e.g. due to change in some relevant norms, the collaborative production process must be restarted.

With the SaRA platform as production line, circumstances turn over: digital content is no more a collection of learning resources. The grouping of data and metadata can be achieved without requiring an in-depth technical knowledge to form an abstraction of the particular situation, integration of digital media will increase the realism of the learning conditions to approximate those of real life / real world.

[31] Examples include the Ulysses programme of PWC - PriceWaterhouseCoopers - which enabled partners with clear leadership potential to work within a non-governmental or inter-governmental organisation in a developing country through video support, virtual communities and personal learning diaries (blogs).

A.1.4. Application Scenario #4: Knowledge Sharing and Management in Professional Virtual Communities

Recent research[32] has shown the importance of professional virtual communities as new social structures emerging from an Internet enabled society, where information, knowledge and ideas have taken the lead over the most traditional assembly lines.

According to McKinsey, in industries such as financial services, health care, high tech, pharmaceuticals, media and entertainment, professionals now account for 25 percent or more of the workforce and, in some cases, undertake most typical key line activities (Bryan, 2005). In the future, flexibility and mobility will replace many fixed and scheduled ways of working.

In this context, it frequently happens that business managers or specialists are working from a remote location, such as when on business trip. However, their experience and competences can be crucial to develop solutions or make decisions. That is why they must be included in the problem solving process as effectively as possible, using advanced information and communication tools supporting them to access necessary data and information in a suitable way and integrating them in team-based decision making.

Users of the SaRA platform will be able to interact with a great diversity of devices in dynamic contexts. Even though acting in a changing environment, a user's experience is constantly evolving and gaining expertise in certain configurations while remaining novice in others. Users of such a system will therefore have to be provided with a mechanism to make adaptation profiles persistent and distributable.

A.1.4.1. Situation in 2015 for product application scenario #4

Sonia is a Turkish physician who is examining a patient for whom she needs to write a specific prescription.

In order to be sure for the effectiveness and the suitability of the prescription writing, the physician needs to have a complete picture of all the drugs taken by the patient within the last one year. By using her mobile device, Sonia can acquire this kind of

[32] E.g. the ongoing FP6 IP entitled ECOLEAD (ECOLEAD, 2005).

information transparently in real time by communicating through her PC to the central data repository of the hospital where she gets a complete list of the medication given to the patient under examination.

In another case, think of the same physicians who flies to Brussels for attending a workshop on her area of expertise, and while she is on her trip she needs to assist a team of junior physicians that are in the middle of a serious operation. The team can communicate with their fellow physician by sending her a real time video of the situation under consideration. Without any delay, Sonia, after evaluating the seriousness of the condition, can provide her recommendations either in a text form, or by jotting down in a frame of the received video shot, the area/segment of focus.

A.1.5. Application Scenario #5: Augmented reality and experiential systems in remote and rural areas

Since the first industrial revolution, economic growth and social development have been associated with the 'agglomeration' of companies and people within industrial areas and city outskirts. This has led to increasing costs of land property and time waste in workers commuting, and a poorer quality of life in urban congested environments. None the less, according to EUROSTAT, 8 out of 10 European citizens still live in sparse rural areas (Boscacci, 1999), i.e. in local communities with a population density below 100 inhabitants/km^2.

In the 21st-century, these may become "privileged" locations, due to lower cost of living and better environmental conditions, provided that a new global business organization may avoid commuting workers unless it proves necessary, hence reducing time and cost disadvantages of individual and collective transport.

Residents in rural areas of Europe must have the same employment possibilities as the inhabitants of the big metropolitan cities. Furthermore, quality of life and of the environment parameters are strongly supporting the decentralization and the adoption of novel working models that will perform in an improved way from those that are currently dominating the labor market.

A.1.5.1. Situation in 2015 for product application scenario #5

Yannis is a free-lance consultant with large experience in sourcing projects in the retail commerce sector and who has for personal reasons decided to leave a job in Brussels to live back in his native place in Metsovo of Epirus in Greece. Apart from the applications that he is using for carrying out his work, he has a permanent contract with his former employer Luc in Belgium. He has also kept a part of his time for providing services on a temporary contract (usually 3 to 6 weeks) for several other actors in Kozani (about 100 kms. from his home), Thessaloniki (about 250 kms. from his home) and Athens (ca. 350 kms. from his home).

The type of involvement in all these "projects" is different. For instance, with his former employer his role is of more of an advisory role, aiming to make recommendations to the less experienced people of the company, while in certain cases he is assigned analyst tasks. On the other hand, in the case of the temporary assignments, these comprise mainly of entire "subprojects" and need intensive communications under time pressure and with lots of documents sharing and exchange. Yannis is able to operate a lightweight version of the SaRA platform, mainly employing off-the-shelf products that are open source and for which he is not expected to pay anything else besides the telecommunications and IP provider costs. Furthermore, by making use of a local initiative from the regional Chamber of Commerce, these costs are subsidized to cover part of his expenses.

In his future plans, Yannis aims to develop a loosely-coupled form of cooperation between professionals (see also interactions with the previous scenario) so that they will be able to apply for bigger assignments. Again, for intra-participants coordination and communications, the SaRA tools will be employed – but not necessarily in the same fashion as now used by him only.

Appendix 2. Hypothesis validation questionnaire

Qt. nr.	Question	Definitely No	No	Weak No	Weak Yes	Yes	Definitely Yes
		Not at all	Very Low	Low	Medium	High	Very High
P1 - Existence hypothesis							
	General						
1.1	Are you familiar with the terms 'metaphor', 'paradigm', 'conceptual schema'?						
1.2	How much are you exposed to the use of metaphors in your daily life?						
1.3	How much are you exposed to the use of metaphors in your work?						
1.4	What is the role of metaphors in your daily work tasks?						
1.5	What is the value that metaphors bring in your daily work tasks?						
1.6	Where do you get the ideas and background for the metaphors you use in your daily work tasks?						
1.6.a	Every day life and other activites.						
1.6.b	Transfer of paradigm from other domains and disciplines.						
1.6.c	The corporate reality and market sector the company is operating.						
1.7	Are metaphors affecting the style of your work?						
1.8	Are metaphors affecting the culture of yourself, your colleagues and your working environment?						
1.9	Do you see gains from the use of metaphors in the working environment?						
1.10	Is the ratio of gains and benefits against costs and problems in the use of metaphors in the working environment well-balanced?						
1.11	Did you ever develop a new type of working style or task for use by your own or with your colleagues?						
1.12	Which tasks are easier for you to conceptualise?						
1.12.a	'Simple' or 'straightforward'?						
1.12.b	'More abstract', 'sophisticated' or 'complex'?						
1.13	Do you invest time in thinking about the ways you perform tasks?						

1.14	Culture in your work is defined by…						
1.14.1	Yourself						
1.14.2	The team you belong into						
1.14.3	The company and its Management						
1.14.4	The market you are operating						
1.15	Is there space for improvements in the use of metaphors in your work?						
1.16	Whose responsibility is to introduce a metaphor in the work?						
1.16.1	You on your own						
1.16.2	The team you belong to						
1.16.3	The company and its Management						
1.16.4	The market you are operating						
1.17	Whose responsibility is to impose the adoption of a metaphor in the work?						
1.17.1	You on your own						
1.17.2	The team you belong to						
1.17.3	The company and its Management						
1.17.4	The market you are operating						
	SR related						
1.18	What is your perception of a Situation Room?						
1.19	Do you understand the concept and the connotations it brings with?						
1.20	How do you judge its appeal for use in the corporate environment?						
1.20.1	Too difficult to use.						
1.20.2	Too much related with critical and emergency cases.						
1.20.3	Too much emotionally loaded with negative cases.						
1.20.4	Interesting for a new type of situation based collaboration and culture in the corporate environments.						
1.20.5	Will not change things at all. Not worth to introduce.						
	Product development related						
1.21	How is product development regarded as a process in your company?						
1.21.1	There are strict procedures to follow.						

1.21.2	It is a process open to improvements and new styles.						
1.21.3	It is a strongly collaborative process.						
1.21.4	Many people are involved but collaboration follows strictly defined paths.						
1.22	Are there any reasons for improving your product development process in your company?						
1.22.1	Financial / economical (e.g. high costs)?						
1.22.2	Organizational (e.g. too many people, not the right mix of people, no hierarchy, too much hierarchy, etc.) ?						
1.22.3	Related to the technologies (out of date production plan, inability to address today's challenges, etc.)?						
P2 - Improvement hypothesis							
2.1	How do you judge the appropriateness of a metaphor or a conceptualization for a particular work task?						
2.1.1	By its appeal to you.						
2.1.2	By the overall success of its application.						
2.1.3	By the efficiency it brings in the communication aspects of the work.						
2.1.4	By the acceptance from your colleagues in the team.						
2.1.5	By the acceptance from the company and its Management.						
2.1.6	By the acceptance from the market you are operating.						
2.2	For working tasks that, according to your opinion, are suboptimally executed - how much do you think depends on the choice of a wrong metaphor or no metaphor at all?						
2.3	For working tasks that, according to your opinion, are optimally executed - how much do you think depends on the choice of an appropriate metaphor?						
2.4	Improvement in the work through metaphor use is the core criterion for you?						
2.5	Will metaphor use work better for simpler tasks than to complex ones?						
2.6	Will metaphor use work better for concrete tasks than to abstract ones?						

P3 – Business-as-War hypothesis							
3.1	Product development, introduction of a new product, watch of the competition for improving your own products, launch of a product to the market – how close are these activities to a 'war'?						
3.2	Do you draw analogies with war or war-like notions in your work?						
3.3	Do you see gains from the use of war-like notions in the product development process?						
3.4	Do you see positive or negative aspects (emotional, conceptual, motivational, etc.) in the reference to a Situation Room?						
3.4.1	Mainly positive.						
3.4.2	Mainly negative.						
3.5	What are the main disadvantages of applying the Situation Room metaphor in the product development process?						
3.5.1	Transforms a 'peaceful' activity in one with negative connotations (in war ethics are wounded and killed, there are lots of innocent casualties, etc.).						
3.5.2	The time aspect – it is tiring to be in a 'war' continuously, as imposed when applying this to the product development case which companies need to face continuously.						
3.5.3	No disadvantages at all - it reflects exactly the conditions faced in the corporate world and how the companies need to organize their response to the environment.						
P4 – Learning hypothesis							
4.1	Is the concept of the Situation Room facilitating learning?						
4.2	Is the operation of a Situation Room by the company facilitating learning?						
4.3	Why is the corporate learning process facilitated by the concept of the Situation Room?						
4.3.1	'War' analogy applies (better) when dealing with our own self-development and improvement.						
4.3.2	Learning is a continuous process. The corporate						

	intelligence exercise is therefore well served by the notion of a Situation Room.						
4.4	How is the corporate learning process facilitated by the concept of the Situation Room?						
4.4.1	Makes easy to organize tasks and activities.						
4.4.2	Gives a feeling of comfort and facilitates the culture of sharing for processes and activities.						
P5 - Corporate capital hypothesis							
5.1	Companies with or without a Situation Room – does it make a difference in the valuation of the two companies? The one with a Situation Room has an advantage.						
5.2	Increase of the corporate knowledge capital should be made directly on Situation Room related benchmarks e.g. frequency and intensiveness of operation, amount of tasks performed, etc.						
5.3	Increase of the corporate knowledge capital should be made indirectly on Situation Room related benchmarks e.g. number of new products, increase in sales, improvement of product development cycles, etc.						
5.4	Valuation of the Situation Room should be made directly on Situation Room related benchmarks e.g. frequency and intensiveness of operation, amount of tasks performed, etc.						
5.5	Valuation of the Situation Room should be made indirectly on Situation Room related benchmarks e.g. number of new products, increase in sales, improvement of product development cycles, etc.						

Appendix 3. Participants' responses on the hypothesis validation questionnaire

Qt. nr.	Question	1st Pass						2nd Pass						3rd Pass					
		0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
P1 – Existence hypothesis																			
	General																		
1.1	Are you familiar with the terms 'metaphor', 'paradigm', 'conceptual schema'?	2	5	4	7	4	1	0	6	9	4	2	2	0	1	7	6	5	4
1.2	How much are you exposed to the use of metaphors in your daily life?	1	3	6	7	4	2	1	2	4	8	6	2	1	3	6	7	5	1
1.3	How much are you exposed to the use of metaphors in your work?	5	7	4	3	4	0	2	4	6	5	3	3	1	4	5	8	4	1
1.4	What is the role of metaphors in your daily work tasks?	6	9	3	4	1	0	3	6	6	5	3	0	4	5	7	4	3	0
1.5	What is the value that metaphors bring in your daily work tasks?	4	6	6	3	4	0	2	3	9	7	2	0	2	7	6	5	3	0
1.6	Where do you get the ideas and background for the metaphors you use in your daily work tasks?																		
1.6.a	Every day life and other activites.	0	0	2	3	1	0	0	0	5	4	3	2	0	0	5	6	2	1
1.6.b	Transfer of paradigm from other domains and disciplines.	0	0	3	3	1	0	0	0	2	4	0	0	0	0	2	3	1	0
1.6.c	The corporate reality and market sector the company is operating.	0	0	5	2	3	0	0	0	2	1	0	0	0	0	2	1	0	0
1.7	Are metaphors affecting the style of your work?	7	6	5	2	3	0	4	5	3	6	4	1	2	5	7	5	4	0
1.8	Are metaphors affecting the culture of yourself, your colleagues and your working environment?	5	6	4	4	3	1	4	6	3	5	3	2	2	5	6	3	5	2

1.9	Do you see gains from the use of metaphors in the working environment?	4	5	5	6	3	0	3	7	6	4	2	1	2	7	6	4	3	1
1.10	Is the ratio of gains and benefits against costs and problems in the use of metaphors in the working environment well-balanced?	6	6	4	5	2	0	4	6	7	4	2	0	3	8	5	4	1	2
1.11	Did you ever develop a new type of working style or task for use by your own or with your colleagues?	2	1	4	7	4	3	1	1	3	7	8	3	1	1	4	7	7	3
1.12	Which tasks are easier for you to conceptualise?																		
1.12.a	'Simple' or 'straightforward'?	6	3	5	3	4	2	4	3	6	4	4	2	3	3	7	3	5	2
1.12.b	'More abstract', 'sophisticated' or 'complex'?	3	5	7	2	4	2	2	5	8	4	3	1	1	5	6	5	5	1
1.13	Do you invest time in thinking about the ways you perform tasks?	5	3	4	6	4	1	2	4	7	3	5	2	2	4	5	6	4	2
1.14	Culture in your work is defined by…																		
1.14.1	Yourself	0	0	0	2	1	0	0	0	0	1	0	0	0	0	0	0	1	0
1.14.2	The team you belong into	0	0	0	1	2	0	0	0	2	4	2	1	0	0	1	3	4	3
1.14.3	The company and its Management	0	0	4	7	3	0	0	0	2	3	3	2	0	0	1	2	2	3
1.14.4	The market you are operating	0	0	0	2	1	0	0	0	2	1	0	0	0	1	1	1	0	0
1.15	Is there space for improvements in the use of metaphors in your work?	3	6	8	4	2	0	2	3	7	8	2	1	1	4	6	7	4	1
1.16	Whose responsibility is to introduce a metaphor in the work?																		
1.16.1	You on your own	0	0	1	2	1	0	0	0	0	2	1	2	0	0	0	2	1	0
1.16.2	The team you belong to	0	0	1	4	2	0	0	0	1	5	4	1	0	0	3	4	7	2
1.16.3	The company and its Management	0	0	2	4	3	0	0	0	0	3	2	0	0	0	0	2	2	0
1.16.4	The market you are operating	0	0	0	2	1	0	0	0	0	1	1	0	0	0	0	0	0	0

1.17	Whose responsibility is to impose the adoption of a metaphor in the work?																		
1.17.1	You on your own	0	0	1	2	2	0	0	0	0	2	2	0	0	0	0	1	3	0
1.17.2	The team you belong to	0	0	0	2	1	0	0	0	0	3	4	1	0	0	0	6	7	2
1.17.3	The company and its Management	0	0	3	6	5	1	0	0	2	3	4	1	0	0	0	2	2	0
1.17.4	The market you are operating	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	SR related																		
1.18	What is your perception of a Situation Room?	3	5	7	4	2	2	0	4	7	5	6	1	0	3	6	6	7	1
1.19	Do you understand the concept and the connotations it brings with?	3	6	9	4	1	0	2	6	8	4	3	0	0	4	9	5	5	0
1.20	How do you judge its appeal for use in the corporate environment?																		
1.20.1	Too difficult to use.	0	0	1	1	2	0	0	0	0	1	2	0	0	0	1	0	0	0
1.20.2	Too much related with critical and emergency cases.	0	0	1	3	3	0	0	0	2	2	1	0	0	0	0	3	2	0
1.20.3	Too much emotionally loaded with negative cases.	0	0	0	2	2	1	0	0	2	2	3	0	0	0	3	3	0	0
1.20.4	Interesting for a new type of situation based collaboration and culture in the corporate environments.	0	0	0	2	2	0	0	0	0	6	0	1	0	0	3	4	0	0
1.20.5	Will not change things at all. Not worth to introduce.	0	0	0	1	2	0	0	0	0	1	0	0	0	0	0	2	1	0
	Product development related																		
1.21	How is product development regarded as a process in your company?																		
1.21.1	There are strict procedures to follow.	0	0	0	4	2	0	0	1	3	2	0	0	0	0	2	2	1	0
1.21.2	It is a process open to improvements and new styles.	0	0	3	0	0	0	0	0	2	4	2	1	0	0	0	3	4	1

1.21.3	*It is a strongly collaborative process.*	0	0	5	2	2	0	0	3	2	0	0	0	0	1	1	3	3	0
1.21.4	Many people are involved but collaboration follows strictly defined paths.	0	0	0	2	3	0	0	0	1	1	1	0	0	0	0	1	1	0
1.22	Are there any reasons for improving your product development process in your company?																		
1.22.1	Financial / economical (e.g. high costs)?	0	0	0	2	3	0	0	0	0	1	2	0	0	0	0	0	2	0
1.22.2	Organizational (e.g. too many people, not the right mix of people, no hierarchy, too much hierarchy, etc.) ?	0	0	2	4	4	0	0	0	2	5	2	2	0	0	0	6	3	2
1.22.3	Related to the technologies (out of date production plan, inability to address today's challenges, etc.)?	0	0	3	2	3	0	0	0	0	3	4	2	0	0	0	3	5	2
P2 - Improvement hypothesis																			
2.1	How do you judge the appropriateness of a metaphor or a conceptualization for a particular work task?																		
2.1.1	By its appeal to you.	0	0	0	0	1	0	0	0	0	0	3	0	0	0	0	0	2	1
2.1.2	By the overall success of its application.	0	0	0	2	2	4	0	0	0	1	4	1	0	0	0	1	1	1
2.1.3	By the efficiency it brings in the communication aspects of the work.	0	0	0	0	1	2	0	0	0	1	3	2	0	0	0	1	5	2
2.1.4	By the acceptance from your colleagues in the team.	0	0	0	1	2	0	0	0	0	2	2	0	0	0	0	2	4	1
2.1.5	By the acceptance from the company and its Management.	0	0	0	1	4	0	0	0	0	1	1	0	0	0	0	0	1	0
2.1.6	By the acceptance from the market you are operating.	0	0	0	0	3	0	0	0	0	0	2	0	0	0	0	0	1	0
2.2	For working tasks that, according to your opinion, are suboptimally executed - how much do you think depends on the choice of a wrong metaphor or no metaphor at all?	3	4	5	7	4	0	0	3	4	6	6	4	0	2	5	6	7	3

2.3	For working tasks that, according to your opinion, are optimally executed - how much do you think depends on the choice of an appropriate metaphor?	2	4	4	5	6	2	1	1	4	5	8	4	0	2	4	5	8	4
2.4	Improvement in the work through metaphor use is the core criterion for you?	1	2	2	5	6	7	2	3	2	5	6	6	2	3	4	6	4	4
2.5	Will metaphor use work better for simpler tasks than to complex ones?	3	2	7	3	3	5	2	2	7	2	4	6	1	2	8	2	4	6
2.6	Will metaphor use work better for concrete tasks than to abstract ones?	2	3	3	4	6	5	1	4	4	3	7	4	0	5	5	5	6	2
P3 - Business-as-War hypothesis																			
3.1	Product development, introduction of a new product, watch of the competition for improving your own products, launch of a product to the market – how close are these activities to a 'war'?	4	7	3	2	4	3	2	3	4	4	6	4	2	3	1	2	7	8
3.2	Do you draw analogies with war or war-like notions in your work?	4	3	4	7	2	3	4	3	4	5	2	5	2	2	3	7	4	5
3.3	Do you see gains from the use of war-like notions in the product development process?	6	7	2	6	1	1	3	4	5	5	3	3	3	3	6	4	7	0
3.4	Do you see positive or negative aspects (emotional, conceptual, motivational, etc.) in the reference to a Situation Room?																		
3.4.1	Mainly positive.	0	0	2	4	6	1	0	0	3	5	5	0	0	0	2	4	3	0
3.4.2	Mainly negative.	0	0	1	2	3	4	0	0	2	4	2	2	0	0	5	3	4	2
3.5	What are the main disadvantages of applying the Situation Room metaphor in the product development process?																		
3.5.1	Transforms a 'peaceful' activity in one with negative connotations (in war ethics are wounded and killed, there are lots of innocent casualties, etc.).	0	0	0	2	4	2	0	0	0	1	2	0	0	0	0	1	1	1
3.5.2	The time aspect – it is tiring to be in a 'war' continuously, as imposed when	0	0	0	4	2	1	0	0	2	3	5	1	0	0	2	5	6	1

	applying this to the product development case which companies need to face continuously.																		
3.5.3	No disadvantages at all - it reflects exactly the conditions faced in the corporate world and how the companies need to organize their response to the environment.	0	0	0	2	3	3	0	0	0	4	4	1	0	0	0	3	2	1
P4 - Learning hypothesis																			
4.1	Is the concept of the Situation Room facilitating learning?	0	2	5	4	7	5	0	0	4	5	9	5	0	0	2	5	9	7
4.2	Is the operation of a Situation Room by the company facilitating learning?	0	1	4	5	7	6	0	1	6	3	8	5	0	0	4	5	8	6
4.3	Why is the corporate learning process facilitated by the concept of the Situation Room?																		
4.3.1	'War' analogy applies (better) when dealing with our own self-development and improvement.	1	3	0	3	2	3	0	0	0	1	3	5	0	0	0	0	3	5
4.3.2	Learning is a continuous process. The corporate intelligence exercise is therefore well served by the notion of a Situation Room.	0	0	0	2	5	4	0	0	0	7	5	2	0	0	0	6	6	3
4.4	How is the corporate learning process facilitated by the concept of the Situation Room?																		
4.4.1	Makes easy to organize tasks and activities.	0	0	0	2	7	4	0	0	0	2	6	4	0	0	0	2	4	3
4.4.2	Gives a feeling of comfort and facilitates the culture of sharing for processes and activities.	2	0	3	2	3	0	0	0	2	3	3	3	0	0	2	3	4	5
P5 - Corporate capital hypothesis																			
5.1	Companies with or without a Situation Room – does it make a difference in the valuation of the two companies? The one with a Situation Room has an	3	3	7	3	6	1	2	2	3	4	9	3	0	1	3	6	8	5

	advantage.																		
5.2	Increase of the corporate knowledge capital should be made directly on Situation Room related benchmarks e.g. frequency and intensiveness of operation, amount of tasks performed, etc.	1	2	4	5	4	7	3	6	4	4	2	4	4	7	2	2	4	4
5.3	Increase of the corporate knowledge capital should be made indirectly on Situation Room related benchmarks e.g. number of new products, increase in sales, improvement of product development cycles, etc.	0	2	7	5	3	6	0	1	3	7	5	7	0	4	3	3	6	7
5.4	Valuation of the Situation Room should be made directly on Situation Room related benchmarks e.g. frequency and intensiveness of operation, amount of tasks performed, etc.	2	1	6	4	2	8	0	2	5	7	4	5	0	4	4	7	4	4
5.5	Valuation of the Situation Room should be made indirectly on Situation Room related benchmarks e.g. number of new products, increase in sales, improvement of product development cycles, etc.	1	1	4	7	6	4	0	0	3	5	6	9	0	3	4	4	6	6

Appendix 4. Assessment questionnaire

	A. Definition of the Situation Room
1	**A Situation Room is…**
1.1	a source of intelligence information
1.2	an access point to external or internal sources of intelligence information
1.3	a repository of intelligence information
1.4	none of the above
2	**A Situation Room is…**
2.1	a decision-making body
2.2	a strategic think-tank with advisory nature
2.3	a knowledge-management vehicle to increase corporate IQ
2.4	none of the above
3	**A Situation Room is…**
3.1	populated by high level and key personnel, only for special – emergency or crisis – purposes
3.2	populated by high level and key personnel, for periodic gatherings and with conventional corporate thematics as this found in any other decision-making body
3.3	populated by high level and key personnel for assessing past cases and planning future responses to situations
3.4	none of the above
	B. Cost matters
4	**Costs for organising and maintaining the corporate Situation Room should be**
4.1	Regarded as overhead costs of other management activities
4.2	Apportioned to the different Department or Unit each Situation Room session is related with
4.3	Considered as another Cost / Profit / Value Centre of the company, and treated with the normal corporate accounting practices
4.4	none of the above
5	**Costs for the establishment of a Situation Room should be**
5.1	ca 5% of the annual comapny turnover

5.2	ca 10% of the annual comapny turnover
5.3	ca 20% of the annual comapny turnover
5.4	none of the above.
6	**Costs for operation, maintenance and support of a Situation Room should be**
6.1	less than 2% of the annual comapny turnover
6.2	ca 5% of the annual comapny turnover
6.3	ca 10% of the annual comapny turnover
6.4	none of the above
	C. Establishment and maintenance of the Situation Room
7	**Establishment costs for the Situation Room mean**
7.1	Costs for acquiring equipment and technology and human resources (systems, software, personnel) [C^{Est}_1]
7.2	The above plus the investigation of the specific aims, goals, procedures, business processes taking place within it [C^{Est}_2]
7.3	The above plus the establishment of the necessary interfaces and integration components with different departments and units [C^{Est}_3]
7.4	none of the above
8	**Even if you disagree with the aggregate of the three types of Costs listed in Q 7, please provide an estimate of the ratio amongst them** $(C^{Est}_1 : C^{Estr}_2 : C^{Est}_3)$ **from one of the following:**
8.1	100 : 100 : 100
8.2	100 : 50 : 100
8.3	50 : 100 : 100
8.4	none of the above
9	**Operation, maintenance and support for the Situation Room mean**
9.1	Costs for upgrading equipment and systems, and for SR personnel payroll, as well as any new acquisitions [C^{Oper}_1]
9.2	The above plus the costs of people using it (SR members and participants, cumulatively with the time and resource allotments they contribute to the SR) [C^{Oper}_2]
9.3	The above plus the support documentation, processing and source management tasks for keeping SR abreast of corporate and overall market developments [C^{Oper}_3]

9.4	none of the above
10	**Even if you disagree with the aggregate of the three types of Costs listed in Q 9, please provide an estimate of the ratio amongst them** $(C^{Oper}_1 : C^{Oper}_2 : C^{Oper}_3)$ **from one of the following:**
10.1	100 : 100 : 100
10.2	20 : 100 : 100
10.3	20 : 50 : 100
10.4	none of the above
	D. Valuation of the Situation Room ROIs
11	**The value of the operation of the Situation Room should be calculated against**
11.1	The improvement of the overall corporate performance, i.e. as a generic Knowledge Management vehicle
11.2	The rate of relative performance in regard to situations encountered for a given period of operation
11.3	As an intangible intellectual asset of the company that helps value creation in general.
11.4	none of the above
12	**Situation Room should be regarded as**
12.1	*an asset*, which can be valuated and traded as part of the other corporate assets, increasing the value of the company to its shareholders
12.2	*an expense*, which is directly related with the overall corporate policies for time and expense management
12.3	*an investment*, which is expected to create its own sources of value or to assist new types of value within the existing corporate grid of activities
12.4	all of the above
12.5	none of the above
	E. Launch of a corporate Situation Room
13	**In order to launch its Situation Room, a company should**
13.1	select a horizontal inter-disciplinary matter or treat one matter as such (innovation, new products and markets, customer relaitionships, corporate ethics, etc.), involving key people from different areas and professions
13.2	select a vertical case and involve key people from one department or unit, with a

	given assignment, around which differentiations and new directions may potentially take place
13.3	do both of the above concurrently
13.4	none of the above
14	**In order to launch its Situation Room, a company should**
14.1	select a safe or harmless case, upon which the Situation Room shall be built
14.2	select a controversial and critical matter, upon which the Situation Room shall be built
14.3	do or enable both of the above
14.4	none of the above
15	**In order to launch its Situation Room, a company should**
15.1	keep a very close eye, control everything and impose a fine grained implementation policy, with explicit do's and don't's, expectations, etc.
15.2	welcome and encourage innovation in the patterns of use, the practices to be developed and the culture around it
15.3	combine both i.e. start with a given approach, but be open-minded and adopt change if necessary and considered as a requirement to achieve any preset goals
15.4	none of the above
	F. Learning by acting, acting by learning or both
16	**A Situation Room is**
16.1	helping people to *learn more* on the complexity of the actions they used to perform without too many second thoughts, thus increasing the rationality of their actions or helping them to better manage and exploit their ideas
16.2	helping people to *act and perform better*, by means of organising the information threads around them as well as the interactions they have with other parties
16.3	doing both of the above concurrently
16.4	none of the above

Appendix 5. Participants' responses on the assessment questionnaire

		Group A 'decision makers'		
A.	***Definition of the Situation Room***	***1st pass***	***2nd pass***	***After trial***
1	**A Situation Room is...**			
1.1	a source of intelligence information	11	10	8
1.2	an access point to external or internal sources of intelligence information	7	9	11
1.3	a repository of intelligence information	3	3	4
1.4	none of the above	2	1	0
2	**A Situation Room is...**			
2.1	a decision-making body	8	8	13
2.2	a strategic think-tank with advisory nature	7	8	4
2.3	a knowledge-management vehicle to increase corporate IQ	7	7	6
2.4	none of the above	1	0	0
3	**A Situation Room is...**			
3.1	populated by high level and key personnel, only for special – emergency or crisis – purposes	5	4	7
3.2	populated by high level and key personnel, for periodic gatherings and with conventional	9	11	3

	corporate thematics as this found in any other decision-making body			
3.3	populated by high level and key personnel for assessing past cases and planning future responses to situations	6	7	13
3.4	none of the above	3	1	0
B.	***Cost matters***	***1st pass***	***2nd pass***	***After trial***
4	**Costs for organising and maintaining the corporate Situation Room should be**			
4.1	Regarded as overhead costs of other management activities	2	2	3
4.2	Apportioned to the different Department or Unit each Situation Room session is related with	11	12	15
4.3	Considered as another Cost / Profit / Value Centre of the company, and treated with the normal corporate accounting practices	3	4	0
4.4	none of the above	7	5	5
5	**Costs for the establishment of a Situation Room should be**			
5.1	ca 5% of the annual comapny turnover	2	1	1
5.2	ca 10% of the annual comapny turnover	4	1	0
5.3	ca 20% of the annual comapny turnover	3	2	2
5.4	none of the above.	14	19	20
6	**Costs for operation, maintenance and support of a Situation Room should be**			
6.1	less than 2% of the annual comapny turnover	13	12	10

6.2	ca 5% of the annual comapny turnover	4	4	7
6.3	ca 10% of the annual comapny turnover	2	3	2
6.4	none of the above	4	4	4
C.	***Establishment and maintenance of the Situation Room***	***1st pass***	***2nd pass***	***After trial***
7	**Establishment costs for the Situation Room mean**			
7.1	Costs for acquiring equipment and technology and human resources (systems, software, personnel) [C^{Est}_1]	3	1	1
7.2	The above plus the investigation of the specific aims, goals, procedures, business processes taking place within it [C^{Est}_2]	4	2	3
7.3	The above plus the establishment of the necessary interfaces and integration components with different departments and units [C^{Est}_3]	9	15	11
7.4	none of the above	7	5	8
8	**Even if you disagree with the aggregate of the three types of Costs listed in Q 7, please provide an estimate of the ratio amongst them ($C^{Est}_1 : C^{Estr}_2 : C^{Est}_3$) from one of the following:**			
8.1	100 : 100 : 100	1	4	4
8.2	100 : 50 : 100	7	8	9
8.3	50 : 100 : 100	9	10	8

8.4	none of the above	6	1	2
9	**Operation, maintenance and support for the Situation Room mean**			
9.1	Costs for upgrading equipment and systems, and for SR personnel payroll, as well as any new acquisitions [C^{Oper}_1]	3	4	4
9.2	The above plus the costs of people using it (SR members and participants, cumulatively with the time and resource allotments they contribute to the SR) [C^{Oper}_2]	6	9	8
9.3	The above plus the support documentation, processing and source management tasks for keeping SR abreast of corporate and overall market developments [C^{Oper}_3]	11	10	10
9.4	none of the above	3	0	1
10	**Even if you disagree with the aggregate of the three types of Costs listed in Q 9, please provide an estimate of the ratio amongst them ($C^{Oper}_1 : C^{Oper}_2 : C^{Oper}_3$) from one of the following:**			
10.1	100 : 100 : 100	2	4	5
10.2	20 : 100 : 100	6	7	4
10.3	20 : 50 : 100	11	12	13
10.4	none of the above	4	0	1
D.	***Valuation of the Situation Room ROIs***	***1st pass***	***2nd pass***	***After trial***
11	**The value of the operation of the Situation Room should be calculated against**			

11.1	The improvement of the overall corporate performance, i.e. as a generic Knowledge Management vehicle	7	5	2
11.2	The rate of relative performance in regard to situations encountered for a given period of operation	11	7	12
11.3	As an intangible intellectual asset of the company that helps value creation in general.	2	3	5
11.4	none of the above	3	8	4
12	**Situation Room should be regarded as**			
12.1	*an asset*, which can be valuated and traded as part of the other corporate assets, increasing the value of the company to its shareholders	6	3	7
12.2	*an expense*, which is directly related with the overall corporate policies for time and expense management	2	2	0
12.3	*an investment*, which is expected to create its own sources of value or to assist new types of value within the existing corporate grid of activities	9	12	10
12.4	all of the above	0	1	0
12.5	none of the above	6	5	6
E.	***Launch of a corporate Situation Room***	***1st pass***	***2nd pass***	***After trial***
13	**In order to launch its Situation Room, a company should**			
13.1	select a horizontal inter-disciplinary matter or treat one matter as such (innovation, new products and markets, customer relaitionships, corporate ethics, etc.), involving key people	8	7	7

	from different areas and professions			
13.2	select a vertical case and involve key people from one department or unit, with a given assignment, around which differentiations and new directions may potentially take place	3	3	10
13.3	do both of the above concurrently	7	6	2
13.4	none of the above	5	7	4
14	**In order to launch its Situation Room, a company should**			
14.1	select a safe or harmless case, upon which the Situation Room shall be built	8	6	2
14.2	select a controversial and critical matter, upon which the Situation Room shall be built	5	7	11
14.3	do or enable both of the above	9	2	4
14.4	none of the above	1	8	6
15	**In order to launch its Situation Room, a company should**			
15.1	keep a very close eye, control everything and impose a fine grained implementation policy, with explicit do's and don't's, expectations, etc.	3	7	5
15.2	welcome and encourage innovation in the patterns of use, the practices to be developed and the culture around it	8	12	11
15.3	combine both i.e. start with a given approach, but be open-minded and adopt change if necessary and considered as a requirement to achieve any preset goals	9	2	5
15.4	none of the above	3	2	2

F.	***Learning by acting, acting by learning or both***	***1st pass***	***2nd pass***	***After trial***
16	**A Situation Room is**			
16.1	helping people to *learn more* on the complexity of the actions they used to perform without too many second thoughts, thus increasing the rationality of their actions or helping them to better manage and exploit their ideas	9	10	7
16.2	helping people to *act and perform better*, by means of organising the information threads around them as well as the interactions they have with other parties	5	5	11
16.3	doing both of the above concurrently	6	5	4
16.4	none of the above	3	3	1

Appendix 6. Reflections of the workshop sessions

The workshop participants considered a range of practical applications and used them to generate an overall perspective on the organizational and techn(olog)ical challenges as well as a number of specific research opportunities. In this Appendix, we compile the findings of the workshop sessions for each of the five application scenarios. For completeness reasons, we provide also references to related bibliography and tried to homogenise the structure to improve readability and further usage. In this respect, one purpose of this Appendix is to reflect on the workshop outcomes while a second purpose is to recall some of the content of the workshop, not only for its usefulness for the addressed matters, but also because of its continuing relevance with respect to the use of Situation Room Analysis as a tool for collaboration.

We walked away from the workshop with a keen sense of irony, recalling that business education tends to discourage normative analysis in favor of "hard facts". (Normative approach tries to find out not only how things *are,* but above all how they *should be*, which means that it will be necessary to define also the subjective point of view that shall be used, in our case the workshop participants who should formulate their own proposals for the different application scenarios.) Yet we had just observed several of the participants gravitate quite naturally to questions that go beyond the level of profiling an application's functionality.

Of course, these participants had a distinct advantage - they had been instructed to *not* focus narrowly on the particular exercise and the vested interests of their organizations: their broader view was reflected in our introductory remark that it is fundamental to understand that not only we are dealing with function definition or profiling issues for each of the five application scenarios, but also the overall market environment and market context that these applications appear as part of.

A.6.1. Application scenario 1: Problem Solving in Complex Product Development Projects

Companies must bring new products and services to the market quickly and efficiently. To achieve this, the *New Product Development (NPD)* process is employed, which is a sequence of steps or activities to conceive, design, and commercialize a product (Ulrich and Eppinger, 2000). This process entails a complex set of activities that cuts across most functions in a business (Clark and Wheelwright, 1992).

Problems occurring during product development are various; they can appear unpredictably at virtually any point of the process and frequently lead to product changes. Manifold interdependencies between the development phases and over all change processes cause iteration loops that result in a return to earlier stages in the process. Thus, it becomes necessary to repeat specific development activities or whole development phases in search of a new and optimized solution concept (Hiller, 1997).

No systematic method in industrial practice is applied to solve urgent problems. Until now, only *ad-hoc* approaches are being used. In the following sections, the requirements are determined to solve urgent problem during complex product development. Afterwards, a solution concept is presented that fulfils these requirements to a large extent.

There are a number of key issues that need to be considered as follows:

Product Development is affected by frequent changes and iterative workflows

Troubleshooting in product development is directly linked to the engineering change process: it adds high urgency to the restrictions and thus cuts the time to solve the problem to a very short period of time. Most evolution has taken place in the latter phases of the engineering change process, whereas only little research has been conducted on the earlier phases of 'problem identification' and 'decision making'. However, much time can be saved during troubleshooting if these two phases are improved, as it is described in the next section.

Decision making is not problem solving

Decision making is the central act of the engineering change process, but decision making is just a part of the overall problem solving process. A systematic troubleshooting approach in product development is directly related to this problem solving process.

Keeping this in mind, when an urgent problem occurs, it is not the main task for project managers to come to a quick decision to save time but instead to speed up the overall problem solving process and reduce the overall problem solving costs. It has become obvious through discussions with experts from industry that decisions in troubleshooting situations are often made very fast but then because of this they frequently lack of quality and realization speed and cause high expenditures. This means that the next realization phases are not considered sufficiently during the decision making process and that decisions are not optimized for the overall problem solving process, regarding quality, time, and costs.

Problem solving in product development projects is urgent

Today, product development projects are under pressure concerning quality, costs, and time-to-market. A delay of start of production must be avoided. Investigations reported by (VDI, 2001) show e.g. that delay of market introduction is more expensive for car manufacturers than design changes shortly before start of production. Delays in later phases of the process can not be made up easily. Thus, problem solving for engineering changes is very urgent, particularly in these later phases of the product development process and a lack of realization speed becomes unacceptable. In this context, it is comprehensible that direct implementation of decision results (i.e. the chosen alternative) is crucial to speed up troubleshooting. Eisenhardt (Eisenhardt 1989) links fast decisions to several factors, including the use of more real-time information, multiple alternatives, applying an advice process emphasizing input from experienced counselors, resolving conflicts using consensus with qualification and integrating strategic decisions with one another and with concrete tactical operating plans for execution.

Complex products create unclear project situations

A major difficulty, a project manager has to deal with during the development processes of complex products is the unclear situation of actual project conditions when a problem occurs. Complex products, such as cars, consist of several thousand parts. Some parts together are commonly gathered in modules. Modules and parts build up interacting systems, e.g. in functionality or packaging. The arrangement of modules and parts differ in a lot of diverse variants for the same model of car.

In order to apply the commonly accepted simultaneous and concurrent engineering approaches or the digital factory concept in the following development phases, it is important that any person involved be informed about technical and organizational interfaces and dependencies, by which they are affected (Assmann et al, 1999). It is useful to include external partners - like e.g. suppliers of parts or of production equipment - in the decision making and problem solving process to make sure that no additional successive changes become necessary.

Solutions are developed by humans on up-to-date information

To make decisions, diverse kinds of information and data are needed. According to studies conducted by (Eisenhardt 1989a and 1989b), managers make fast and profound decisions on data and information which are not obsolete. Thus, in order to guarantee latest available information, the persons working out the solution alternatives need real-time retrieval of data and information and access to any corresponding information system.

Therefore, it is necessary that information is processed as fast as possible by the persons involved. The motivation for visualization of data and information lies on the fact that humans are able to perceive a lot of information by their eyes at the same time and quickly process the information in their brain. According to (Meyer, 1999), about 90% of all information is perceived by the visual system. Hence, the most suitable way for humans to perceive a huge amount of information is by means of visualization. Suitable visualization can simplify the complex perception process, accelerate perception, and thus achieve a cognitive relief.

Solutions need to be evaluated before a decision is made

As previously mentioned, decision making during product development projects usually comprises selection of the most adequate solution in terms of its product and process characteristics. In order to assess the different solution alternatives, their effects and risks on the ongoing project have to be evaluated before a choice (i.e. the decision) is made. For this assessment, different kinds of simulations and analyses are conducted. These simulation activities can include technical simulations like e.g. strength calculations with FEM tools or packaging examinations with DMU tools as well as economic and operational simulations like e.g. production cost calculations or time and resource plan analyses. For this purpose, access to any necessary information system is important.

Problem solving is team work

Development of cars and other complex products is characterized by close co-operation of numerous specialists and responsible managers of different areas like e.g. design, engineering, testing, production planning, controlling. Frequently, this also includes specialists and managers from suppliers. Thus, whenever a problem occurs during development projects, and particularly concerning product-related issues during the later phases of the process, all persons affected need to work intensively together to remove the problem in a short time.

To support intensive team work for troubleshooting, an environment needs to be developed where any kind of available project information can be displayed and much of it simultaneously as is the case in a Situation Room or War Room. It is therefore necessary to foster this collaboration by extensive visualization possibilities.

Multi location NPD

Comparing different approaches on NPD process descriptions, a rough distinction of four major process steps can be made: idea generation, idea evaluation, product development, market introduction (Goffin et al, 1999). With ongoing process steps, ideas become more focused and the realisation of a product concept becomes more concrete. Over the process, the kind and number of involved participants changes and customer needs meet different requirements of technological and environmental nature. In addition to the complexity of the process itself, globally distributed project teams, new communication technologies and increased co-operation with external partners require different approaches to communication and decision-making (Picot et al, 2003); (Daft 1984a and 1984b).

The proliferation of types of communicating devices makes co-ordination and interoperability key success factors for rapid decision-making. Asynchronous media like e-mail and written letters have a high importance because they do not require high co-ordination but cannot transmit unlimited richness of communication which aggravates problem understanding and the identification of interdependencies. "*Common complaints are of too much data and too little analysis*" (KPMG, 1990).

Collaboration and Communication

Sharing knowledge across organisational boundaries is key to the effective exploitation of knowledge. To ensure that the information passed cross these boundaries is translated into effective knowledge requires effective Human Machine Interfaces (HMIs). Within the military environment, electronic 'birdtables', 3 dimensional displays and augmented reality systems are being developed to enhance the presentation of complex information.

Although geographic boundaries can be overcome with these technologies, there remain many non-technological issues to overcome: for example, communication protocols, cultural differences in globally distributed project teams, trust and the personalisation of content and presentation. Integrating the experience of the described applications and new technologies like user profiling, intelligent agents and the use of mobile devices could be another future step beyond taken by this research.

Support by Information and Communication Systems

There are several information systems used in the product development process with interfaces to many other functional departments such as accounting, controlling, procurement, and production. The spectrum of systems reaches from CAD- (Computer Aided Design), DMU (Digital Mock-up), and CIM- (Computer Integrated Manufacturing) applications over Project Management- and ERP- (Enterprise Resource Planning) systems to PDM/PLM- (Product Data Management/Product Life-cycle Management) systems, and a manifold variety of additional expert systems such as controlling or simulation systems (Bullinger et al, 1999). However, none of these systems are used extensively during the decision making phase of the engineering change process. They don't meet the different requirements described above and lack of necessary flexibility, which is essential for the diverse kinds of problems and solutions that occur during complex product development projects.

The following table summarizes how SRA can contribute for improving the state of the art in the NPD process.

Shortcomings	Challenges to be met
Poor interoperability between different products, manufacturer specific technology and interfaces	Provide a tool box based on an open software architecture which is based on standards and provides connectivity both legacy products, and new tools / tools to be developed
Poor process oriented workflow integration, therefore poor support of content re-use and / or of collaborative production and virtual engineering concepts	Provide an integration framework which allows to flexibly support and integrate collaborative workflows in heterogeneous and distributed technical environments, in order to enable the improved re-use of existing media assets for new attractive services; provide systematic methodology to solve virtual design engineering change problems quickly
No tools which are scalable for different distribution platforms (i.e. which efficiently support the specific authoring as required for the diverse distribution channels)	Provide new tools which are optimised for re-authoring and re-programming purposes, therefore enabling increasingly efficient production scenarios for new types of rich media services
High cost to operate heterogeneous platform operation	Provide a concept of distributed monitoring & control tools, software distribution & configuration mechanisms and standardised architecture which will serve to decrease system cost of ownership
Insufficient tools to manage IPR issues	Provide applications which are capable to efficiently handle IPR issues by integrating with existing IPR management systems and new DRM technologies. Special emphasis shall apply to the question of re-using existing material in additional services, e.g. re-using radio programmes on the web or on other interactive services.
Heterogeneous Engineering-SW landscape, poor manufacturer-specific interoperability between different IT tools	Provide new visualisation-based data integration concepts in order to enable collaboration using IT tools without application integration.
Lack of integration of knowledge carriers which are only externally available	Provide integrated information and communication systems to include the experience and knowledge of external persons
Insufficient information supply for proper decision making and problem solving	Provide real-time access to any technical and operational descriptive set of data and information by integration of necessary information systems to enable analysis of problems, elaboration of solutions, evaluation and simulation of decisions, and distribution

Shortcomings	Challenges to be met
	of thė agreed tasks in real-time
Users/ Project team members in large projects are confronted with information overload, i.e. the amount of information exceeds perception capacity	Provide extensive integrated visualization possibilities to support perception of the large information load, which is usual e.g. in complex development projects
Poor user-friendliness as barrier for acceptance of complex systems leading to insufficient usage	Provide high usability of the facility to guarantee acceptance of all stakeholders

Table 18 Challenges to be met with the use of SRA in the NPD process

A possible Solution Concept

A SR-like environment can be designed and built up including flexibly usable large-screen visualization technologies, wireless and mobile communication technologies, and real-time access to all information systems and data bases relevant to the product development and engineering change process to integrate up-to-date data and information, available internally in the company and externally (e.g. by "intelligent agents" in the internet).

It is not planned to integrate all existing IT-systems in a new one but to apply interfaces to all relevant IT-systems for the product development unit in the company and use them to visualize the data. The next illustration shows a possible concept and layout of the SR.

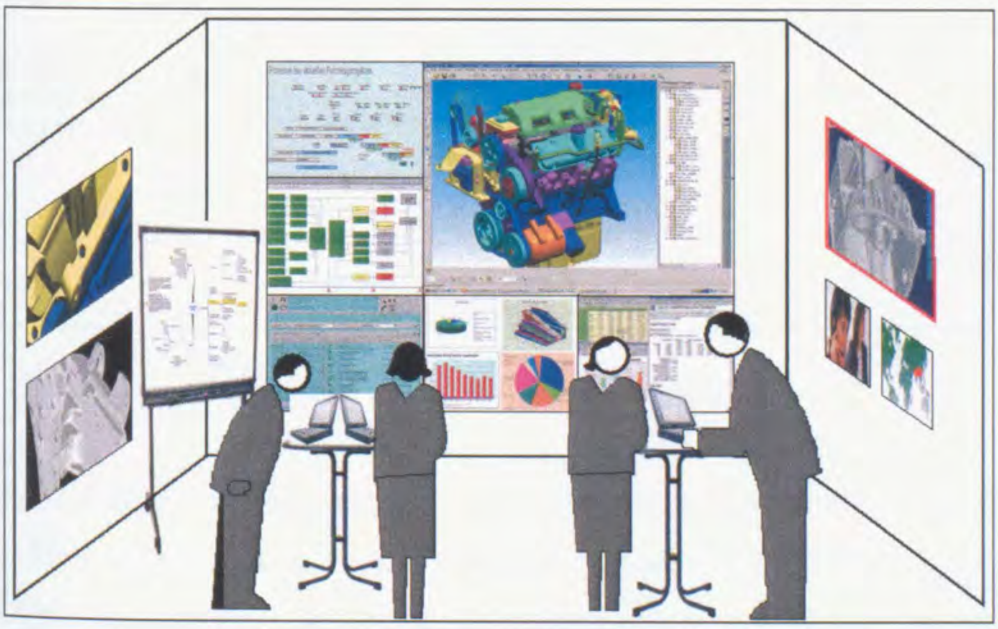

Figure 16 A possible SR Layout

Virtually any kind of data and information can be visualized, as can be seen in the illustration above, also in different sizes as necessary for perception.

The SR layout improves decision making by enhancing communication. Therefore, the concept includes several small high tables instead of one large conference table to facilitate group conversations and discussions between the participants and simplify walkthroughs. However, new table concepts enable the assembly of the small tables to a large conference table, if necessary. The participants will be able to bring along their own notebooks, tablet PCs, and PDAs, which can be adopted to the information system infrastructure by wireless technologies.

The next illustration demonstrates a possible application of the environment for developing and selecting the best alternative.

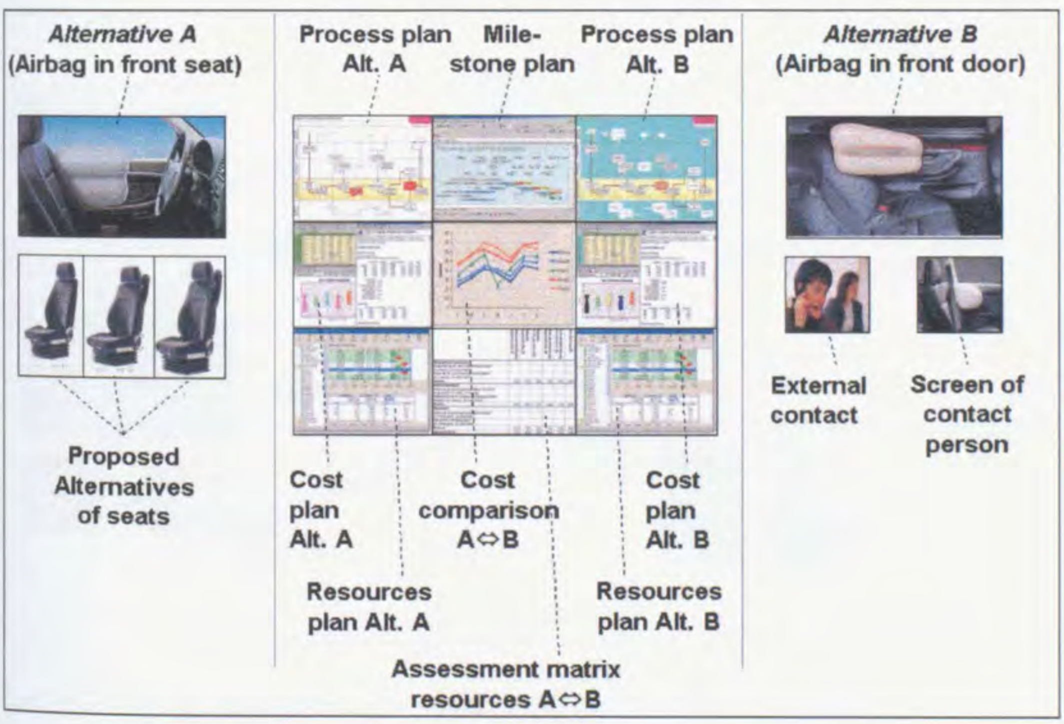

Figure 17 Comparison of two alternative solutions for decision making

Multiple screens enable presentation and comparison of two alternative solutions (A vs. B). They permit concise visualization and immediate modifiability of financial, operational, organizational, and technical data and information. Making the process of decision making and problem solving more transparent for the participants and within the organization is an additional goal. To support the entire problem solving process, the environment must be capable to give the participants a top-down view e.g. of the car model to develop and allow them to drill down to greater levels of detail, such as to modules, components, and single parts in order to analyze problems, their causes, and potential interrelations. It can also be used for reporting the alternatives and possible decisions to the executives and to the project management, concentrating information at a central location. Real-time access to all required data and visualization enables also transparency of the project status.

Another goal of the SR concept is to support troubleshooting by effective integration of external persons by means of net-based and mobile information and communication technologies and applications to guarantee communication and information exchange between all necessary internal and external participants as it is shown in the following illustration.

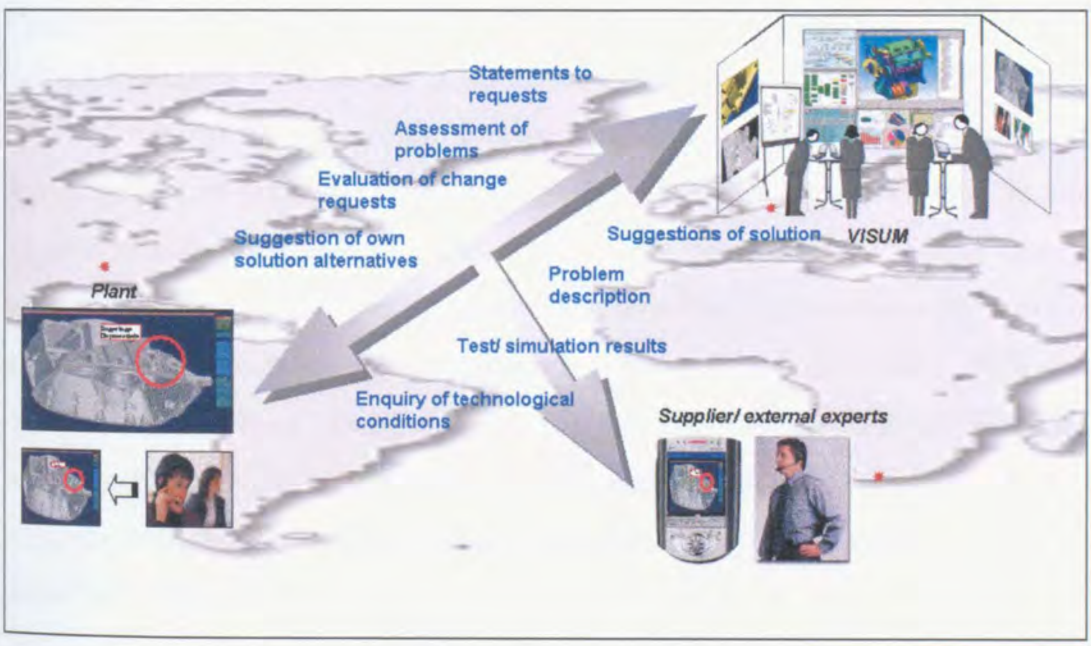

Figure 18 The SR concept for global communication and information exchange

For real collaboration, it is important that data is not only shown but actually shared between the partners, i.e. the contact persons can actually process, manipulate, and change data simultaneously with the participants at the 'war room' environment. In this context, 'actually shared data' means that data can simultaneously be used (manipulated and changed) at different locations.

Ongoing research about future collaboration leads towards the concept of "virtual war rooms", i.e. a technology based collaboration concept, where the members of a team are actually not physically in one room but can be anywhere working together as intensively as if they were in a such a SR-like environment. A major challenge is how suitable information can be assigned to each user and be visualized appropriately.

Above all, an essential part of the solution concept is the elaboration of a good practice process, how to perform urgent problem solving in product development using such an environment as described above. The development of a methodology to support troubleshooting in complex product development projects can be regarded at least as beneficial for practice in industry as the design and usage of the described application environment.

A.6.2. Application scenario 2: Collaborative Authoring, Publishing and Delivery of Multimedia Content

In 1999 Bill Gates outlined the "*digital media revolution*" (Mack, 1999). According to his view, the driving force of the forthcoming changes was to be the transmission of digital audio and video over the Internet. A critical factor to make this "revolution" possible was the availability of broadband to the general public. While there is still some road to go in this direction, nowadays broadband access is much more readily available than six years ago, particularly in the European Union. However, the "revolution" has been strongly restrained not only by the lack of adequate data communication channels, but more by the absence of an efficient platform capable to integrate available technologies at every stage of the digital content process into a unified environment.

This lack of integration at the levels of authoring, production, post-production, distribution and consumption makes it difficult to provide high-quality and attractive content for the consumers and may, hence, seriously reduce or even risk the interest in emerging technologies.

Most of digital content creation tools have now reached a level where creative people are finally able to work intuitively and productively, but the next step towards integration has yet to be made. Today's media production gains more and more complexity (e.g. film production or computer games) as it arises out of a very intense collaborative work of many individual specialists, but although a stunning new world is already possible with digital tools, most of these productions are tediously hand-made masterpieces with enormous production costs. In film-making Hollywood was the first to realise this approach of standardisation and production line productivity: the power and worldwide success of the US "dream factory" derives from its highly integrated way of production. This has to be achieved for the digital content creation of the 21st century in Europe as well.

The evolving concept of Digital Content

The following description, quoted from "The Digital Media Manifesto" (Digital Media, 2003), is the background behind this application of the SRA:

> *"The creation and distribution of media content, together with associated manufacturing and replication, are major global economic activities i.e. the cumulative worldwide turnover is huge amounting to several hundred billion $/€ per year. The impact of media on society, business and the personal lives of billions of people can hardly be overstated.*
>
> *Although content can be packaged in different ways, they each share the common feature that the actual media content is intangible. Whereas physical devices are required to create, move, store and use (CMSU) content, it exists on a fundamentally separate level from its physical carriers. The older technologies for these carriers - now referred to as "analogue" - were employed throughout history to CMSU all content media until about 20 years ago. Traditionally, the tight connection of content media with the CMSU technology employed was a major feature. Examples include vinyl discs, VHS tapes, radio and TV broadcasting and cable TV distribution In each case the technology used materially affected the content; blurring the distinction between the medium and the message.*
>
> *The physical nature of analogue CMSU technologies played a major role in shaping media businesses, imposing specific and various limitations on cost, delivery, consumption, etc. This union between the technology and its intangible content also shaped public policy and legislation, for example laws concerning intellectual property and usage rights such as "fair use".*

Starting about 20 years ago and accelerating through the last decade, digital technologies have been employed for media "digitization". The digital technologies offer radically different and easier ways to CMSU media. Their most noteworthy features are the ability to replicate media perfectly an unlimited number of times and the ability to detach media from its tight union with physical carriers. These features can exercise a substantial positive impact on the way media business is conducted. At the same time, they also "disable" some of the historically effective ways to exploit media economically."

The Digital Content Process: limitations in potentialities, productivity and distribution

Current digital content production is usually a one-way process: content is created and delivered for a specific communication media/technology (end device). Neither its re-use for other media technologies nor its interleaving in form and content with other media formats is practicable without considerable efforts and costs.

This has led to the realisation that due to the lack of sufficient integration of the variety of tools for content creation and the authoring of its interactivity, ambitious concepts and potential ideas often experience the harsh constraints of technical realisation. In the end, the original vision has to be dramatically cut down to meet all the technical requirements and restrictions.

State of the art specialised tools for the creation of digital media assets have now become highly sophisticated solutions in their respective areas (image processing, 3D computer animation, sound design and scoring, video editing, special effects, etc.). The demand to integrate these different media assets into fully interactive rich media turns out to be the very core of digital production. Contemporary rich media production demands a highly integrated production process, in order to bring together the diverse media contents of a typical multimedia application.

The emergence of new digital consumer technologies – especially in the areas of mobile communications and media – demands the development of new content formats which will exploit existing media platforms (mobile, TV, PC and Radio).

Therefore, integration aspects become of concern for production as well as distribution.

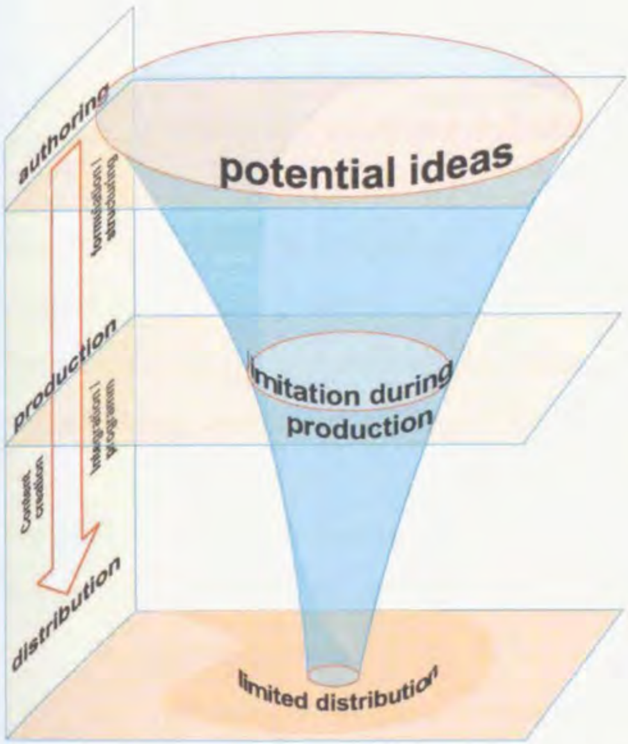

Figure 19 Current technologies impose limitations at every stage of the multimedia design workflow

New value chains & content

With a collaborative production line, circumstances turn over: more focused ideas can have a much wider distribution and an extended life-cycle on different media platforms. This may lead to new forms of digital content and to the rise of small budget productions that do not aim at commercial mass production, but rather focus on specific subjects. This fits very well to the character of cultural production in Europe (i.e. media-art, education, film productions etc.) and enables a more democratic, individual and cultural multifaceted use of the future content creation methods in the digital age: to give creative people and production teams all over Europe the production power of a Hollywood studio without ending up in their uniform culture industry.

To make this possible, a SR-based platform will provide standard interfaces, protocols and file formats for the integration of new tools and existing commercial products. The combination of hosting proprietary and very specialized production technologies as "plug-ins" and the unhindered data exchange between them is the general design and the integrative philosophy of SRA implementation. This will enable a cost-efficient content creation process by providing ease-of-use and interoperability between:

- different production tools,
- authoring and production tools,
- production frameworks and distribution channels.

New tools are to be developed and integrated into the SaRA platform together with existing commercial products. These new tools will focus on cross-media productions that incorporate parallel distribution channels (mobiles, iTV, console, PC) and the interaction e.g. interdependencies across different media.

For deriving the requirements, innovative cross-media-content needs to be developed that involves the distribution via the markets of :

- Mobile devices
- Television & interactive Television (TV-Sets & set-top-boxes)
- Personal computers
- Game consoles
- Add-hoc and upcoming devices

The consumption of this cross-media content will give rise to interactivity and interleaving of all media (e.g. cell-phone-controlled TV-formats, TV-gameshows with participants on the internet, multi-user-games influencing the storylines of TV-series, virtual characters as TV-host or a gamer who is a "hero" in a computer-game can have a television appearance in a show, etc.). In sum, the digital content production with SRA will allow much more flexibility and a higher productivity, ensuring an integrative workflow during production, where more attention will be focused on the creative process than on its technical implementation. On the distribution side, the new potentialities for broadcasting on all media channels can give even to a small production a big audience.

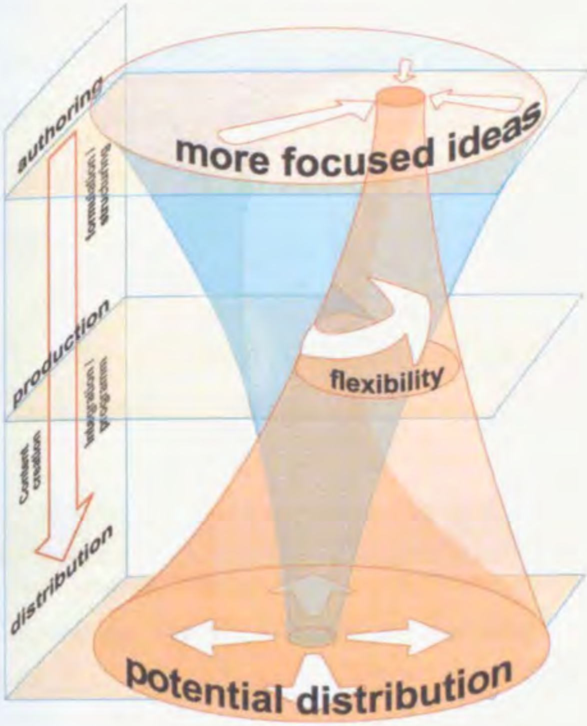

Figure 20 SRA use may positively affect the increase of the possibilities for production and distribution of cross-media content

The SRA framework reaches out for speeding up the digital revolution in content creation and new forms of distribution and consumption; users will participate in the evolution of media industrialization and standardisation; even more, it has the ambition to become the common Media Operating System to be used by media professionals.

The Solution Concept

While the design phase of the project aims to exploit the full potential of digital media, it should at the same time strives to eliminate its drawbacks. Toward this goal, the project will adopt the concept of "digital item" that has been introduced by the newly emerging MPEG-21 standard. According to this concept, media content is not just a collection of resources. It is the grouping of data and metadata that forms an abstraction of packaged media. This approach allows the tight union of media with its identification, description, playback instructions and usage rights, without dependency on physical carriers. Combined with protection technologies, this approach may be the basis for new ways to exploit media economically.

Obviously the "digital item" concept, as well as its associated protection technologies, can only be effective if applied from the first production stages. They will be the basis of the project work and will be handled consistently during the design, development and the integration of the SaRA platform. The platform will generate *digital items*, not just content.

To conclude this overview we present the following table summarizing how the SRA can contribute for improving the state of the art of the digital content process.

Shortcomings	Challenges to be met
Poor interoperability between different products, manufacturer specific technology and interfaces	Provide a tool box based on an open software architecture which is based on standards and provides connectivity both legacy products, and new tools / tools to be developed
Poor process oriented workflow integration, therefore poor support of content re-use and / or of collaborative production concepts	Provide an integration framework which allows to flexibly support and integrate collaborative workflows in heterogeneous and distributed technical environments, in order to enable the improved re-use of existing media assets for new attractive services
No tools which are scalable for different distribution platforms (i.e. which efficiently support the specific authoring as required for the diverse distribution channels)	Provide new tools which are optimised for re-authoring and re-programming purposes, therefore enabling increasingly efficient production scenarios for new types of rich media services
High cost to operate heterogeneous platform operation	Provide a concept of distributed monitoring & control tools, software distribution & configuration mechanisms and standardised architecture which will serve to decrease system cost of ownership
Insufficient tools to manage IPR issues	Provide applications which are capable to efficiently handle IPR issues by integrating with existing IPR management systems and new DRM technologies. Special emphasis shall apply to the question of re-using existing material in additional services, e.g. re-using radio programmes on the web or on other interactive services.

Table 19 Challenges to be met with the use of SRA in the digital content authoring, publishing and delivery processes

A.6.3. Application scenario 3: Individual Learning and Corporate Content Management in Industry

The potential of instant access and instant creation tools becomes more and more important to foster easy transfer from knowledge experts to content consumers. In industrial learning content engineering, there is often a need for highly trained experts in content creation. Beside high quality content, it is essential to have an easy creation of content through rapid content creation tools where the sharing of those resources becomes essential.

The state of the art in current digital learning content production is exemplified by the SCORM standard and tools that adhere to this standard. These attempt to make courses RAID compliant i.e.

- *R*eusable: easily modified and used by different development tools,
- *A*ccessible: can be searched and made available as needed by both learners and content developers,
- *I*nteroperable: operated across a wide variety of hardware, operating systems and web browsers, and
- *D*urable: do not require significant modifications with new versions of system software.

This has proved to work well for learning content that is delivered to students as a one-way process in a large number of EU projects and initiatives. But it does not address the issues that arise in collaborative learning workspaces, where students interact and cooperate in a variety of ways, and where the pedagogical models used are less linear, step-by-step or prescriptive.

Summary of requirements

It is in these situations, which are particularly common in business training, that training teams need to be able to rapidly integrate training elements to achieve tailored training objectives, without requiring the in-depth technical knowledge currently needed to integrate the disparate digital media elements.

Such a training support environment should be able to determine which elements are most appropriate, select and run the tools needed to integrate these elements, and arrange the presentation for the platform that these elements run on, so that the training team can concentrate on the training elements required to meet the training objectives, and not on the technical problems to be overcome to achieve their objectives.

Currently, the production of learning scenarios tailored to a specific student team's training objectives is not economically viable, due to:

- lack of sufficient integration of the variety of tools for learning content creation,
- lack of tools to author the training session interactivity,
- the detailed technical knowledge and time required to integrate a tailored training scenario.

Digital learning content production also is a one-way process. Content is created and delivered for a specific communication media / technology and in the majority of cases without putting any special attention to the accompanying learning models, which are not regarded as an integral part of the learning process and content (at least as such); of course for the rich(est) media elements – the most expensive ones – if there is enough memory and bandwidth – reusability is easier. But the pedagogical/concept approach is crucial. Neither its re-use for other media technologies nor its interleaving in form and content with other media formats is practicable without overwhelming efforts and costs.

In many situations, providers of learning content for corporate learning have significantly advanced the learning methodologies used. The uptake of the concept of the "learning organization" has lead led over the past 20 years to the total reconsideration of the role of HR departments within companies and has enabled them to incorporate new learning methodologies such as learning networks, action learning, contemplation etc. European associations and experts groups (often with the support from the European Commission DG Education and Culture) have significantly contributed to the development of innovative learning methodologies.

Technological tools are widely used in learning programmes. Capturing learning on camera, connecting to relevant resources via e-learning tools, blogging of personal learning journey etc. However, there is hardly an example which encompasses on the variety of media tools used and that is available on the market in a meaningful combination.

The production itself forces creative people and producers to come down to earth: due to the lack of sufficient integration of the variety of tools for learning content creation and the authoring of its interactivity, ambitious concepts and potential ideas often experience the harsh constraints of technical realisation.

In the end, the original vision has to be dramatically cut down to meet all the technical requirements and restrictions. (It is easy to understand that these factors negatively affect the optimal development of the learning market.)

The Solution Concept

With SaRA platform as production line, circumstances turn over: the SR idea is used as a powerful metaphor to drive corporate learning both at the methodological and at the presentational / perception levels. In this way, more focused ideas can have a much wider distribution and an extended life-cycle on different media platforms, which increases the residual value of all steps in the production process of learning content media production.

According to the SRA concept, learning content is not just a collection of learning resources. It is the grouping of data and metadata that forms an abstraction of packaged media for a particular situation faced by a company or group of companies, and with a set of involved actors and parameters, thus increasing the realism of the learning conditions to approximate these of real life / real world.

This approach allows the tight(er) union of learning content and the media with identification, description, "playback" instructions and usage rights, without dependency on physical carriers. Combined with content protection technologies, this may be the basis for new ways to exploit learning media economically[33].

[33] In this direction, problems encountered when considering the use of instant production of e-learning content from a physical environment, cross-sectional learning, as well as linkage with the action

SRA-based content management in e-learning

The project will develop a content management system which allows adaptation of existing learning content solutions into a personalized scenario. Content will be provided for users or organizations in both on-line and off-line version. This will help to deliver information between different systems and allow spreading of learning content in easy way. Intelligent content management will be designed for larger businesses and organisations specialized on learning and business activities where information needs to be regularly updated. The benefit will be particularly great in cases where customers (business partners, students ...) interact with the site (www, application ...) or where their experience will be enhanced if there is a degree of personalisation. In such cases, intelligent content management can turn the web site from being a cost-centre to being a profit centre.

In order to allow multi-operability between different terminals, a standardized environment must be created. For this purpose, W3C standards have to be used. As technology evolves, opportunities for more effective tools and methods will arise and bring always new standards which have to be considered when new content management is created.

Defining the balance of audience characteristics

Uptake of the training products and e-learning in particular depends to a large extent on how projects manage to address the following gaps:

1. *IT-literacy gap*: between learners requiring advanced technological solutions and/or learning models and methodologies (example being corporate staff members with PDA, DSL connection, easily able to use video files, e-learning tools and how have attended 10+ training programmes) with the learners in the beginning of their technological and/or methodological capacity building. Both groups could easily coexist in one organization.
2. *Linguistic gap*: Europe is a diverse place culture and language wise, which has big implication on any technological developments. The most cited example is the attention which Nordic countries as well as Southern European countries

learning methodology are important to take into account. A further issue relates to the operationalization of the learning organization concept.

are attaching to mobile communication, wide-spread use of e-government tools in Baltic states.

3. *Infrastructure gap*: there are different levels of broadband connectivity, mobile penetration, availability of TV is training organizations etc. across different European countries and even regions within one country (urban vs. rural gap)
4. *Generations gap*: targeting learning content and its production on a special age group could lead to better acceptance of underlying learning concept and combination of learning methodology and technological solutions provided. Persisting habits should be taken into account in case learning is to be accepted as a concept among the targeted group.

Only when the aforementioned gaps will have been successfully addressed in the design of the SaRA platform, will it make a learning industry-wide impact, as often potential users of the project's output are working with particular target audiences.

In sum, today's e-learning applications and services available are hardly adapted to accommodate the European multi-cultural dimension. The aim of the project is to allow Europe to overcome the barriers holding back the uptake of digital technologies and to step up the e-learning training drive, which can be made far more effective when solutions are adjusted to individual needs.

The Project therefore seeks to produce a significant impact on improving the design and application of e-learning solutions. The team will focus on easy-to-use and efficient e-learning models and solutions, either as a standard for the whole of Europe or for each region separately, which will help integration into the everyday environment. User-friendly e-learning solutions will improve trust in the new technology and will contribute significantly to expanding the knowledge society. By doing so, the project aims at demonstrating next-generation learning solutions.

A.6.4. Application scenario 4: Knowledge Sharing and Management in Professional Virtual Communities

Just 25 years ago, a "standard equipment" for work environment consisted of a telephone, a typewriter, correcting tape, carbon paper sets, a copying machine and a dictionary. Today, a standard office includes a PC linked to the World Wide Web with modem equipment for faxing and e-mailing, a laser printer (colour or not), a voice mail, a copying machine that collates and staples, a television and a VCR. The future of workers mobility is paving the way for the flexible, team-based working practices and *communities* are emerging as associations bringing together people of similar interests in order to communicate, share and exchange information, or just to have fun and fulfil the needs of social belonging and empathy. Typical examples include communities of sportsmen, tourists, chess players, etc.

Virtual communities are those specific associations that are enabled and empowered by Internet technologies such as bulletin boards, list servers, newsgroups, chat rooms, and the like. These communities invent new social relationships, resulting in new behavioural patterns and new ways of sharing and creating knowledge, activities which create specific and original value.

Communities of practice have been around for many years and are described as "groups of people informally bound together by shared expertise and passion for joint enterprise (that) share their experiences and knowledge in free-flowing, creative ways that foster new approaches to knowledge".

Von Krogh and Roos (1997) point out that communities of practice have become more prominent and formalized in recent years because they develop critical organizational knowledge assets. Most communities are "boundary-spanning units in organizations, responsible for finding and sharing best practices, stewarding knowledge, and helping members work better".

When communities of practice adopt computer networks and most of the habits and tools of virtual communities, they become *Professional Virtual Communities (PVC)*. These communities, spontaneously created or induced by work relationships, are bound to certain social rules resulting from the members commitments to their respective organizations.

This is the case, for instance, of concurrent or collaborative engineering where teams of engineers, possibly located in different enterprises, cooperate in a joint project such as the co-design of a new product. This outlook is confirmed by other communities of professionals (e.g. chartered accountants, physicians, etc.) who share a common knowledge of similar working cultures, problem perceptions, professional values, and patterns of behaviour. The goals of these PVCs may vary considerably from increasing productivity, customer affiliation, up to more abstract goals like mutual support and lobbying. However, there is no clear methodology to guide and frame the constitution and management of PVCs nor, for example, our capability of assessing the impact of these communities and measuring their return on investment.

However, in order to exploit PVCs as a paradigm to achieve the most efficient availability and processing of collective knowledge, an adequate supporting environment is needed that addresses technology, social, legal and human aspects and allows a sustainable and exploitable integration of human/machine computing and decision making power.

Distributed knowledge carriers

Decision making is a knowledge-intensive activity (Holsapple, 2001). Nonaka and Takeuchi (1995) state that knowledge can be categorized in two different categories: explicit and tacit knowledge. (Johannessen et al, 2001) explain that explicit knowledge "*can relatively easily be formulated by means of symbols and can be digitalized*" and "*can thus with relative ease be transferred to others by e.g. the use of IT" while tacit knowledge is difficult to communicate to others as information, and can at best be difficult to digitalize.*"

This aspect leads to two different knowledge management approaches, codification for explicit knowledge and personalization for tacit knowledge (Hansen et al, 1999). The personalization of tacit knowledge requires a constructive integration of absent persons in the process for successful problem solving.

It frequently happens in business that managers or specialists are working from a remote location, such as when on business trip. However, their experience and competences can be crucial to develop solutions or make decisions. That is why they must be included in the problem solving process as effectively as possible, using advanced information and communication tools supporting them to access necessary data and information in a suitable way and integrating them in team-based decision making.

Outline of requirements

Users of the SaRA platform will be able to interact with a great diversity of devices in dynamic contexts. Even though acting in a changing environment, a user's experience is constantly evolving and gaining expertise in certain configurations while remaining novice in others. Users of such a system will therefore have to be provided with a mechanism to make adaptation profiles persistent and distributable.

Adaptation to situational and contextual parameters will not be the only requirement of the user interface system to be developed requiring rules and mechanisms for mapping context data to user interface parameters.

Various issues related to the scenarios presented above, like security and confidentiality of personal data, QoS provision, optimisation of usage of available resources will be taken into consideration by individual work packages. The identification of user specific requirements such as privacy, user-friendliness, adaptiveness etc. in the environment is also important in this task to ensure feasibility of the scenario validation by user centred methodologies.

A.6.5. Application scenario 5: Augmented Reality and Experiential Systems in Remote and Rural Areas

For more than 20 years Europe has been a leader in conceiving and programming telework and remote work initiatives. However, an entire generation of innovative ideas (like telecottages etc.) did not show any signs of approval and adoption by the users and the market in general.

Currently, telecommunications infrastructures permit the high speed access and transmission of data and the execution of many services that even a decade before were either impossible or extremely costly to support. However, it is generally lacking an embracing concept that would organize collaborative working environments of the future and which would support all the following types of employment for residents of rural areas that count for more than 80% of EU territory:

- Big companies and organizations need to leverage on decentralization of their human resources, making use of alternative modes of corporate to labor engagement and working practices;
- SMEs residing in remote areas of Europe need to develop business collaborations with partners from elsewhere, with emphasis on the value creation aspects (not necessarily limited to price differentiation and lower costs of operation);
- SOHO (Small Office – Home Office) owners need to improve the negative and skeptical attitude towards the added-value of partnering with actors with bigger financial and organizational capacity and that are geographically dispersed.

Workplaces will then start to be moved around within the enlarged 'office' concept into greener or more 'open' spaces. Meeting rooms, 'desks', workstations, touchdown points, and video conferencing suites will be fitted with high speed broadband links with top levels of security. Narrow viewing angle monitors and wearable computers will be used alongside this secure network connection to facilitate ubiquitous and confidential work in a mixed-business environment.

On the other hand, this means that soon information will increasingly become part of the "life" of working people in a seamless way, and people will continuously change your current status taking it for granted that computing systems and multimedia data sources will adaptively support the context where collaboration at work takes place.

As people perform actions, these will be captured, transmitted, and presented to other remote people giving to both groups the experience of working together.

As already mentioned above, knowledge usually belongs to humans (in contrast to data and information). Very often, special knowledge is necessary from external partners such as suppliers, external experts, or production planners at plants abroad to make profound decisions.

Such environments will exhibit many characteristics of augmented reality and experiential systems. In order to be effective, they should allow people the flexibility to combine their individual knowledge resources with the physical resources available in the space, while presenting appropriate information, taking into account the larger process within which a collaborative activity takes place. This demands richer ways of capturing content and actions, new ways of presenting multimodal information, and the development of an architecture and infrastructure that unifies individuals, spaces, and processes (Pingali and Sukaviriya, 2003).

Additional Use Cases

Mr Renwick is a British farmer. He has a sick cow which has a strange rash. He e-mails a photo of the rash to his local vet who cannot diagnose the rash and decides to visit the farm. She travels out to the farm with her laptop, equipped with a webcam. On arrival, there is a wireless connectivity around the farm buildings so she takes a short film of the animal and logs into a web video conference with a specialist from Glasgow University.

Looking at the symptoms the animal is displaying and the images, the vet is able to provide the correct medication, without making another journey to the farm. There is a cost and time saving for the farmer and the vet, plus the cow is treated faster, improving animal welfare.

James manages Precision Products, a company which manufactures precision castings for factories across the UK and Europe in a small rural town. Richard's engineering factory in Cornwall needs to improve the design of one of the castings. He sits down with his local engineer in their situation room and contact James who is sitting in the Precision Products situation room. They use a digital whiteboard to annotate designs on the screens in both rooms. At the same time they can access online resources – such as the market values of alternative metals that can be used.

Hodgson Brothers is a small quarrying company based in the North of England. They quarry stone and cut it, sending it across the country to building firms and landscape gardeners. One problem is that clients occasionally send ambiguous orders for stone which – they want it cut in a certain way but fail to communicate this effectively. The stone is delivered and the builders are not happy about the way it has been cut. As a result, the stone has to be returned to the workshop. This is a costly exercise. The situation room at the builder's office can be used to post designs on a large screen in Hodgsons' situation room. Hodgsons can use modelling software to show 3D view of the design on the client's screen. They can then request modifications or look at alternatives designs. Ultimately, it saves Hodgsons' time and effort in shipping bulky and expensive specialist goods which do not meet the customers expectations. The builders get the right stone first time, allowing them to stick to their timetable.

All of the above cases show how a business can improve their performance through adopting rich media streams in live situations to become more efficient and reduce waste. But it is also evident from the description above that the last focus area of the product development exercise is in some way unifying the others, containing elements of all the previous ones.

Appendix 7. Elaboration of two special cases for the literature review

A.7.1. Multiple reality decision-making in the corporate environment

How important is reality? Most corporate decision makers are too busy, too worried, or too ambitious, superficial and greedy to attend to this question with any sustained depth of serious inquiry.

For the majority, the reality question is impractical and unimportant, even if there will be future catastrophe and suffering as a direct result of failure to be truly realistic. And it is not a rarity that members within a corporate Board are not necessarily analysing the reality but only a biased fraction of what they perceive and manage as such.

Short-sighted and blinkered corporate decision makers are caught up in their assumptions and beliefs because they are too busy acting out those very assumptions and beliefs. Future shock will prove their assumptions and beliefs to be delusional, but as long as the majority in their organisation share the delusion, adhere to the corporate consensus reality, the constructed reality of the day, they can put away the reality question until it 'burns' them (out). However, by keeping the reality question an issue of philosophy or academia, the corporate world keeps it out of sight and out of mind.

The reality question thus turns into a question of *ontological nature*, as recognised in later parts of this research. If we think carefully about the possibilities, we might begin to realise that more than one alternative reality is a possibility and we should have contingency plans to cope with it.

Also from the field of military decision-making, several theorists as Czerwinski (1999), Alberts and Czerwinski (1997) and Luttwak (1976) point out that much of the fixation of a model to reality is 'socially driven'. In fact, that idea is fundamental to the hypothetico-deductive (H-D) method itself, even though this 'positivist' approach of H-D methods is now taken as an example of rigid and limited dogmatisim because it only deals with experimental procedure[34].

H-D methods presume up front, however, that nothing can be fully known conclusively, hence the emphasis on disproof (by experiment) rather than proof - the idea was that we can never say our model of reality is correct, we can only look for its flaws and in their absence gain confidence. However, the positivist approach is too rigid because it lacks the necessary means for shifting the whole basis, or paradigm, for theory construction. As all theory depends on one's beginning assumptions, it is possible to develop good theories (as well as bad ones) from different starting points, and each starting point has its merits and demerits. The point is that H-D methods work very well within a given worldview (or paradigm), but if pursued rigorously will eventually exhaust the explanatory possibilities of that view.

In this respect, any differentiation for a decision-making process should involve a shift in perspective, worldview, assumptions, or paradigm - but this is not a random shift. There are most often definite consistencies that are maintained when switching paradigms. Even though a 'common' corporate reality can be seen from many different perspectives, what we learn from those perspectives must be consistent between views - that is if we maintain the belief in a singular reality (as opposed to a singular description) and thus a basis for seeking synthesis and integration (i.e., the ultimate goal of interrelating different / various corporate theory elements to show consistency between theories[35]).

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[34] As for this we adopt the Popperian methodological approach (Popper, 1959). Karl Popper suggested that it is impossible to prove a scientific theory true by means of induction, because no amount of evidence assures us that contrary evidence will not be found. Instead, Karl Popper proposed that proper science is accomplished by deduction which involves the process of falsification. Falsification is a particular specialized aspect of hypothesis testing. It involves stating some output from theory in specific and then finding contrary cases using experiments or observations. The methodology proposed by Popper is commonly known as the *hypothetico-deductive method.*

Popper's version of scientific method first begins with the postulation of a *hypothesis*. A hypothesis is an *educated guess* or a theory that *explains* some *phenomenon*. The researcher then tries to prove or test this scientific theory false through *prediction* or *experimentation*:

- A *prediction* is a forecast or extrapolation from the current state of the system of interest. Predictions are most useful if they can go beyond simple forecast.
- An *experiment* is a controlled investigation designed to evaluate the outcomes of causal manipulations on some system of interest.

[35] Or alternatively: to support synthesis capability for different / various *partial theories*.

This is a very key distinction - the theories themselves may not be interchangeable or derivable from each other, or amalgamated into one 'super theory', but what they describe or explain must be consistent, otherwise we are altering the basic nature of a unitary reality.

Of course, neither view, single versus multiple reality, can be tested scientifically, and the choice is therefore rather transcendental. *If, on the other hand, a singular reality is correct, knowing about it would certainly constitute greater knowledge than knowing only the separate views and not their connection.*

However, a basic difference lies in the number of hierarchical levels one tries to represent: while phenomenological models do not go beyond 1 level (i.e., the surface), mechanistic models go deeper, representing 2, 3, or more hierarchical levels. Different phenomena tend to have common deep hierarchical layers. Thus mechanistic models are more integrated with each other, whereas phenomenological (instrumental) models do not form a system. Mechanistic models are more stable historically because they form a coherent system (therefore they can be employed for simulation).

A basic distinction to make is in the method and goal, not strictly in the construction of the model. The phenomenological model, the instrumental model, and the use of metaphors do not seek explanation at deeper levels or interconnection between phenomenological models (unless connections appear at the phenomenological level). They simply don't look deeper for understanding and as a consequence, don't look rigorously for where they are wrong. Where they are wrong, they just don't apply because it is presumed to be a separate reality. Reality in this view is phenomenological (and fragmented). They don't seek generality and consequently can't address it.

Managers at tactical and operational levels in many organizations frequently encounter similar decision problems. Decisions taken by different managers for a given problem in an organization vary due to differences in their decision making styles and / or subjectivity. Discovering 'classes' or categories of decision makers with similar decision-making styles can contribute towards organizational learning through better understanding current decision making patterns and changes in those patterns over long periods of time.

In this respect, the introduction of the concept of a Situation Room and the establishment of methods to apply this in the corporate product development decision-making can be regarded as a tool to help companies for *discovering 'classes' of decision models* from a large number of past product development situations as a step towards discovering decision-making styles and patterns.

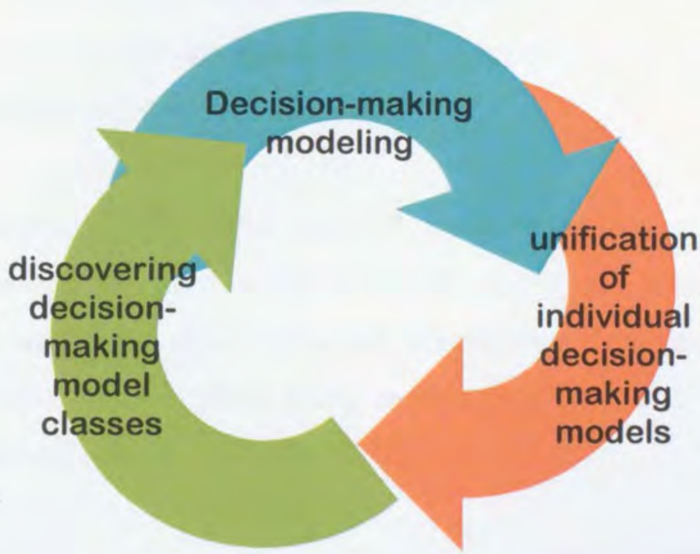

Figure 21 The three stages for discovering 'classes' of decision models in Situation Room Analysis.

A.7.1.1. On decisions

How do we make decisions? By thinking about the problem for a little while and then deciding in favour of 'what feels right'? Does the way people make a decision depend on how important the decision is? Have we ever overlooked critical information at the time when we originally made the decision and why did we? Do we ever have to go back, re-think, and then decide differently, and if so, how did we do that?

In spite of all the trouble with decision-making in practice, most decision-making follows a fairly simple "base process". Its key components are (Chen, 2000) in sequence: (of course, iterations are normal):

- *framing the problem* or question that requires a decision or an answer (example question: 'How can we increase revenue in the next fiscal year'?);

- *collecting* as much *information* as it appears reasonable which can help making a better decision (in this example: sales projections, competitive intelligence, information about new products etc.);
- *generating ideas* for alternatives, or proposals for potential courses of action (e.g. opening up an office in a neighbour country, reducing manufacturing cycle time etc.) and analyzing their impact;
- selecting a *measure of 'goodness'* (i.e. quality, or 'cost' as approached in the context of optimization) by which the merits of the ideas can be evaluated: on an absolute scale, and against each other (e.g. impact on the sales forecast, risk, environmental compliance, or a mixture of all them);
- *Deciding* to pick that one of the previously generated ideas that is 'best' according to the selected measure of goodness.

Complex decisions may often involve many more steps, sub-decisions, side conversations and many other items. On the other hand, even in case of simple decisions, if any of the above items are missing in a decision-making process, the resulting decision is most likely going to be sub-optimal, and, in a group scenario, often very contentious.

Is there a way to provide electronic tools (i.e. software) which can help people "making decisions"[36]? To analyse this, it may be useful to imagine the not-so-uncommon situation where a group needs to make a decision, and for various reasons, it is not possible to assemble everyone in the same meeting room and 'lock the doors until the decision has been made', which is (allegedly) one time-tested way groups can be forced to actually make decisions.

What kind(s) of software tool would people ideally like to use in order to facilitate such a collaborative decision-making process in order to arrive at the best decision, in the shortest possible amount of time, with the strongest support by as many members of the group as possible, while also enabling new members of the group to easily

[36] It is not new the difficulty in defining 'making' in decisions: of course, 'taking' decisions is a step after the different options are presented to someone. But in order to come to this, one has to 'design' the decisions within a given decision 'space'.

understand why a certain decision was made one way and not another, even after several months or even years later?

A.7.2. Contexts and interactions of decision-making

Aumann and Heifetz (2001) claim that "*in interactive contexts such as games and economies, it is important to take account not only of what the players believe about substantive matters (such as payoffs), but also of what they believe about the beliefs of other players.*" (p. 23)

With respect to the research, the interesting part of their work relates to the fact that they demonstrate how work that has been carried out before several years internationally and opened the road to what we call modern game theory, as well as recent one in what we tend to describe as 'the Semantic Web' (Berners-Lee et al, 2001) can be used for coping with the matter of dealing with incomplete information. Both Aumann and Heifetz (2001) proceed by using two different but equivalent ways of dealing with this matter, namely the *semantic* and the *syntactic*; they also proceed in "defining and using canonical and universal semantic systems for formulating the concepts of 'common knowledge' and 'common priors'".

While the syntactic approach is conceptually more straightforward, the semantic one is more prevalent, especially in game and economic contexts. Each appears in the literature in several variations:

- *In the syntactic approach,* the beliefs are set forth explicitly: One specifies what each player believes:
  - about the substantive matters in question,
  - about the beliefs of the others about these substantive matters,
  - about the beliefs of the others about the beliefs of the others about the substantive matters,
  - and so on ad infinitum.

This sounds - and is - cumbersome and perhaps even unwieldy, and from the beginning of research into the area, a more compact, manageable way was sought to represent interactive beliefs. Such a way was found

- *In the semantic approach,* which is "leaner" and less elaborate, but also less transparent. It consists of a set of states of the world (or simply states), and for each player and each state, a probability distribution on the set of all states.

Again, Aumann and Heifetz in the same source prove that both approaches provide the same information.

A.7.2.1. On incomplete information

The theory of incomplete information has historical roots in a concrete application: games.

Until the midst of 60s, game theorists did not think carefully about the informational "underpinnings" of their analyses. Luce and Raiffa (1957) did express some malaise on this score, but left the matter at that. The primary problem was due to each player's uncertainty about the payoff – or, else, utility - functions of the others; to a lesser extent, there was also concern about the players' uncertainty about the strategies available to others, and about their own payoffs.

It is easy to relate this with the above example, when we think e.g. of a set of competing teams t_1 to t_N of Sales people from competing companies, each one populating their own Situation Room SR_1 to SR_N, and where each of them is aiming to organise their own commercial product policy (be it new products or price-setting) in a way that would bring others in a weaker position.

In path-breaking research Harsanyi (Harsanyi, 1967, 1968a, 1968b) succeeded both in formulating the problem precisely, and in solving it. In brief, the formulation is the syntactic approach, whereas the solution is the semantic approach. Let us explain: Harsanyi started by noting that though usually the players do not know the others' payoff functions, nevertheless, each has a (subjective) probability distribution over the possible payoff functions of the others. But that is not enough to analyze the situation: each player must also take into account what the others think that he thinks about them. Even there it does not end; he must also take into account what the others think that he thinks that they think about him. And so on, ad infinitum. Harsanyi saw this infinite regress as a Gordian knot, not given to coherent, useful analysis.

To cut the knot, Harsanyi invented the notion of *type*[37]. Consider the case of two players, the Salesman John and the Salesman Arnold. According to his work, each player may be one of several types. The type of a player determines his payoff function, and also a probability distribution on the other player's possible types. Since John's type determines his payoff function, Arnold's probability distribution on his types induces a probability distribution on his payoff functions. But it also induces a probability distribution on his probability distributions on John's types, and so on John's payoff functions. And so on. Thus a *type structure* yields the whole infinite regress of payoff functions, distributions on payoff functions, distributions on distributions on payoff functions, and so on.

It is easy to see that the infinite regress is a syntactic belief hierarchy: the states of nature being n-tuples of payoff functions; whereas a *type structure* is a semantic belief system, i.e. the states of the world being n-tuples of types. In modern terms, Harsanyi's insight was that a semantic system yields a syntactic system[38].

Since Harsanyi's seminal work, the theory of incomplete information games has been widely developed and applied. Several areas of application are of particular interest. Repeated games of incomplete information deal with situations where the same game is played again and again, but the players have only partial information as to what it is. This is delicate because by taking advantage of his private information, a player may implicitly reveal it, possibly to his detriment.

Other important areas of application of what later became more widely known as experimental economics include auctions, bargaining with incomplete information, principal-agent problems, inspection, and several other application fields.

Finally, as it came out by Harsanyi's own work, games of incomplete information are useful in understanding 'ordinary' games of complete information.

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[37] With nowadays cliché language, he would have used the term *ontology*.

[38] Though this may seem obvious today, it was far from obvious at the time; indeed it was a major conceptual breakthrough, which enabled extending many of the fundamental concepts of game theory to the incomplete information case, and led to the opening of entirely new areas of research.

Here the applications are of two kinds. In one, the given complete information game is 'perturbed' by adding some small element of incomplete information. For example, Harsanyi later (Harsanyi, 1973) uses this technique to address the question of the significance of mixed strategies: Why would a player wish to randomize, in view of the fact that whenever a mixed strategy μ is optimal, it is also optimal to use any pure strategy in the support of μ?

His answer is that indeed players never actually use mixed strategies. Rather, even in a complete information game, the payoffs should be thought of as commonly known only approximately. In fact, there are small variations in the payoff to each player that are known only to that player himself; these small variations determine which pure strategy s in the support of μ he actually plays. It turns out that the probability with which a given pure strategy s is actually played in this scenario approximates the coeffcient of s in μ.

Thus, a mixed strategy of a player i appears not as a deliberate randomization on i's part, but as representing the estimate of other players as to what i will do.

The second kind of application of incomplete information technology to complete information games is where the object of incomplete information is not the payoffs of the players but the actual strategies they use. For example, rather than perturbing payoffs, one can say that even without perturbed payoffs, players other than i simply do not know what pure strategy i will play; i's mixed strategy represents the probabilities of the other players as to what i will do.

The key to all these applications is Harsanyi's *type* definition - the semantic representation - without which building a workable model for applications would be hopeless.

A.7.2.2. A word on (bypassing) infinite regress

Activities related to both the preparatory actions needed for establishing a decision-making session as well as for organising information management and processing during its course can make apparent the fact that there are plenty of infinite regress problems and that we need to disaggregate the concept of information before we can get a better understanding of the arguments. To use a quite widely known example (Smith, 1987), in short:

- it seems true that before we make a decision we have to make a decision on how much information to collect
- but, before we can make a decision on how much information to collect we also need to collect information about how much information we should collect to make that decision and so on.

This is a problem in two ways:

- First, it produces an infinite regress.
- Second, it may be impossible to get reliable information even when one decides to spend time seeking the information.

We believe this is important because it demonstrates that rational choice theory has to be complemented by psychological theories in order to explain behaviour.

The infinite regress problem makes it impossible to make a rational decision in some situations: if rational behaviour is logically impossible, then behaviour in those circumstances can not be explained as the outcome of rational choice (Elster, 1986).

In the context of this study, we can consider at least three kinds of infinite regress problems:

1. First, we have to decide how to decide (and this may lead to an infinite regress). Assuming we have decided how to decide,
2. We have to find the optimal level of information and deliberation before the decision rule can be used. Once again, it is possible that this leads to an infinite regress.
3. Finally, we might ask about the optimal use of a given set of information.

Now, we should not need to provide evidence that these problems are separate. For instance, deciding how to decide requires us to collect information, and this leads to the second problem. We nevertheless tend to think that even if we could collect an optimal level of information, one might still have an infinite regress problem in deciding how to decide. Even if we assume that the optimal level of information is known at every stage, this does not automatically ensure that there is a final end-point.

Decision theorists often note the infinite regress problem briefly, only to assume it away or decline to discuss it – however, it is something that has direct and practical implications. In this respect, that for Radner (1996) it is convenient to classify the costly (resource-using) activities of decision-making into four groups:

1. *observation*, or the gathering of information,
2. *memory*, or the storage of information,
3. *computation*, or the manipulation of information,
4. *communication*, or the transmission of information.

The use of the above analysis shall become clearer in Chapter 6 where the Situation Room model will be presented.

A.7.2.3. Representation of decision-making actions

A further important aspect of decision-making model relates to the ability for representing all actions performed or attributed to particular information entities.

In this respect, what is actually needed is a 'device' that guards some conditions and performs some actions when the conditions are true. This idea is not new in Computer Science theory and practice as it is expressed by well-known metaphors like demons in AI and triggers in databases, and it is used in a number of modelling languages (Widom and Ceri, 1996) (Baclace, 1992) (Genesereth and Ketchpel, 1994).

For this we can make use of the notion of a *linker element* (in brief: *linker*). This realises this idea in a slightly different fashion. While normally, a condition is defined by a universal predicate, which means that the guard needs to observe the whole, or a large part of a database to find any place where the condition is true, our notion of a linker works locally, as it guards only its own operands.

According to the approach taken the linker is the only way:

- To express relationships amongst information entities, be they passive or active relationships. Thus, we use the same notion for describing both static information entities and actions to them. The uniformity allows treating actions in the same way as static links, i.e. we can add and delete actions in the same way as we add and delete static relationships during a database transaction.
- To define actions on information entities. In this respect, any action that takes place within a decision-making session to enrich or decodify or interpret or explain or ... an infornation entity is simply linked to the previous state of the entity, providing also the last inherently proprietary characteristic of that last action.

An algebra of calculating the values of information entities would be interesting and highly useful for some specific contexts of use, but out of the scope of this research. To give an example of its potential utility, let's imagine the case of examining the potential size of a market for a product. For increasing the simplicity of our example, let's assume that the people that are populating the decision-making session are all coming from the same discipline, i.e. Marketing: some of them are coming from the corporate Marketing Department, while some others come from independent market research and analysis companies, companies A, B and C.

During a discussion related to the market size of that product-soon-to-be-launched, each of them brings some figures to the stage, reflecting his personal or corporate assessments. Though it is easy to link each of these figures with its creator / owner, it would be useful if each of them could provide some hint on whether each figure is an upper- or lower-level approximation and with which specific level of certainty. It would be totally different to base further discussions on an underestimation or an overestimation, in the same way that it would provide different type(s) of risk to build consensus on data that were negatively biased from the beginning of that session.

A.7.2.4. Interoperability matters

In the Levels of Information Systems Interoperability (LISI) model, developed by the MITRE Corporation (Zugby, 1999) for usage both as a maturity model and as an interactive process for assessing and improving interoperability amongst different organisational systems, a common basis for requirements definition and for incremental system improvements has been defined as follows:

Level type definition	What takes place and how?
Level 4 – Enterprise – Interactive manipulation – Shared data and applications	– Cross-domain information & applications sharing – Advanced collaboration (e.g. for "Event-triggered global database update")
Level 3 – Domain – Shared data – "Separate" applications	– Shared databases – Sophisticated collaboration (e.g. by means of a "Common Operational Picture")
Level 2 – Functional – Minimal common functions – Separate data and applications	– Heterogeneous information exchange – Basic collaboration (operation and process maps with overlays)
Level 1 – Connected – Electronic connection – Separate data and applications	– Homogeneous information exchange (e.g. voice, tactical data links, text files, messages, e-mail)
Level 0 – Isolated – Non-connected	– Manual Gateway (e.g. with floppy disks, hard copy exchange, etc.)

Table 20 Levels of Information Systems Interoperability (LISI) model

Though it is quite easy to position a similar levelling of the information that govern informatioin management activities within the decision-making session with respect to the above approach, a closer look might provide the following interesting items for consideration[39].

[39] No need to say that the LISI layering is not the sole approach, however it is one that best matches our research context as it is more closer to apply in the context of networked decision making activities. Except from the Levels of Information Systems Interoperability (LISI), there are a number of existing technical references such as the Joint Technical Architecture (JTA), and numerous policies, directives, and conventions, in addition to Service-level and Agency-level technical architectures. In many cases, an effort to develop a technical architecture view consists of extracting the portions of these sources that are applicable to the scope of the architecture description being developed, and tailoring their guidance to the purpose at hand. These issues have been of concern to us, and are in detail addressed in

For the sake of information, in the next Figure 22 we present the NATO Levels of Interconnection and how these are mapped to the 5 LISI levels (Zugby, 1999).

It is thus easy to see that one may:

- either specialise a layer by refining its attributes in terms of a stepwise analytical process,
- or proceed to a synthetic process by means of aggregating attributes of the LISI layers in new, compound ones.

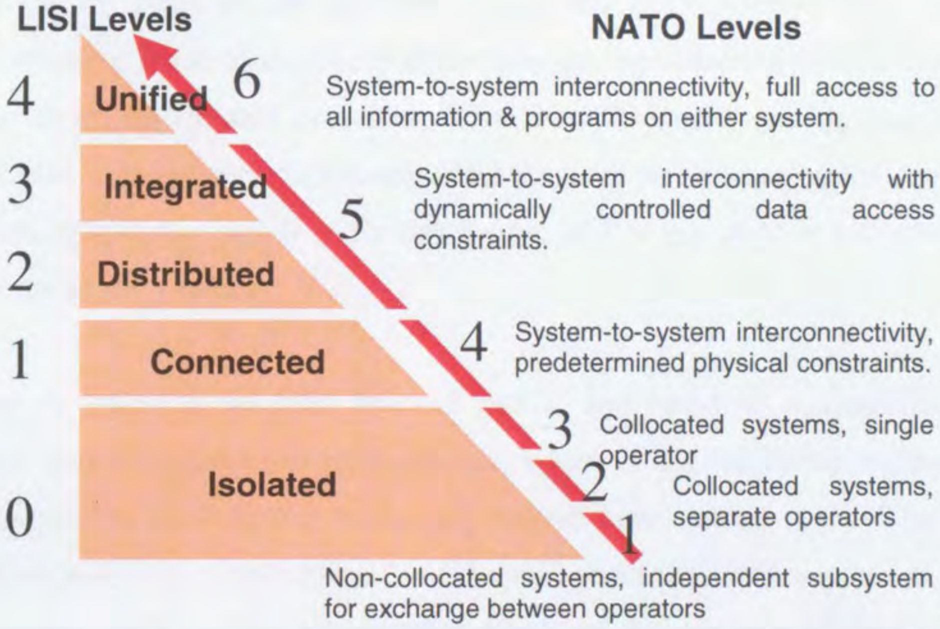

Figure 22 Mapping of the NATO Levels of Interconnection to the 5 LISI model levels

Note should also be given to the underlying notions for each of the 5 levels of LISI:

- Level 0, concerns Isolated processes;
- Level 1 concerns Connected ones; while
- Level 2, originally named Functional, concerns the ability of a company or an organisation to distribute process categories and classes of operations. It is at this level where this study is centrally positioned for leveraging the transition from a function oriented paradigm to this of process orientation.

later parts of this research in Chapters 6 and 7. Especially with respect to system-to-system interoperability, the technical architecture view of the SRA framework delineates the technical implementation criteria or "rules" with which the system(s) should comply as reflected in the systems architecture view.

- Level 3, originally named Domain in the LISI model, concerns integration as this has traditionally been approached by a company's management: adjacent tasks were attributed to a company's department or unit, thus there was no need for "sharing" processes or jointly treating a case, etc.

This approach, reflected in the majority of today's businesses, was aiming to integrate a widely set of more or less "scattered" activities, resources and processes under the same contextual umbrella.

Care should be given to the fact that though the NATO model was originally developed for the context of military operations, its specialisation was centred at the lowest level of the Isolated processes: there, NATO experts coming usually from highly skilled military practitioners identified the need for fine tuning the qualities of an isolated *information supply chain component*, as it is that specific component that supports the entire pyramid.

However, in regard to the LISI levels 2 and 3, and based on malpractices to be frequently found in enterprise environments, which if applied in the military field would be proven fatal causing potentially severe losses of all types. The NATO layering promotes the combination of both levels in a flexible way, capable to express highly differentiated contexts of operation which are the rule in a military operation but have been treated as exceptions in the business environment.

Having in mind the imminent requirement for agility in nowadays turbulent business environments, it is this combined approaching of Levels 2 and 3 that needs to take place.

- Level 4, originally named Enterprise in the LISI model, concerns unification in terms of supporting all levels (strategic included) that may facilitate qualitative treatment of information sharing and collaboration activities within the enterprise context.

We come back to the combination of Levels 2 and 3 of the LISI model, and the attempt to view them as a unique layer, as exemplified in the NATO Levels of Interconnection.

A company responds to external stimuli and signals for change in terms of adapting the chart, e.g. by increasing a chart component's resources, or minimising them, or even cutting out a complete department or unit. This mobility, having in mind the costs for achieving it, is generally viewed as a necessity to which the company should respond (reactively for the majority of businesses, and for a very few companies as part of a proactive strategy). However, the whole design of the IT infrastructure is characterised by a tendency for low mobility.

Activities and resources had been distributed once (LISI Level 2) and then had to be integrated (LISI Level 3). Process-orientation from within the decision-making perspective concerns the provision of the company with the necessary organisational as well as technology means for enabling it to continuously respond to differentiations and changes of external conditions. In this respect, a combined treatment of the distribute and integrate levels is needed, both:

- at the level of micro-planning, programming and conducting enterprise decision making activities, as well as
- at the level of macro-planning, programming and conducting enterprise decision making activities.

It is easy to see that this goes beyond the conventional paradigm of coordinating workflow activities in a predefined workflow sequence, to the case of providing IT means for enabling within the decision-making session, without the need to each time adapt the IT framework or even the IT applications:

- organisational structures to appear and disappear,
- working practices to emerge and vanish,
- organisational constraints to fade in, get tested and in case of a positive assessment to dominate the work field, and in the opposite case to fade out,

The latter is extremely important as it enables the decision-making session to be regarded as an intangible asset of the company, in which the company invests to increase its competitiveness and responsiveness to the turbulent market environment.

In this context, a company should regard the activities related to the establishment of the corporate Situation Room as an intangible investment, that affects all three aspects of an intangible, namely the organisational grid of the company, the (involved) human resources and the know-how that the company holds both regarding their core business as well as their other value-adding business processes.

A.7.2.5. Decision-making assessment

The decision-making assessment determines the benefit of a particular business decision options by quantitative and qualitative assessments. In literature there are well-established scenario techniques which allow the impact analysis of different assumptions with regard to (any particular) value adding benefits (Adriaans and Dolf, 1996; Chen et al, 1996; Chen, 2000). A result of this is the creation of preferential roadmaps.

This part of the model has to describe the procedure of how to develop different scenarios and carry out an environmental analysis according to the specific scope and needs of a company. What is to be taken for sure is that working in and with networks together with the mastery of key processes enables change in enterprises through evolutionary processes of which an instance is this of the proposed Situation Room Analysis. In the current context, change should be regarded as an enabling factor for enabling adaptation of a corporate structure, so that the latter better responds to external conditions and the given context.

Actually, the idea of introducing change as the result of evolutionary processes is not new at all. Furthermore, it can be regarded as one of the most important consequences of game theory in that it can be used to determine situations where one behavior is more fit than all known alternatives, or alternately, a specific mix of behaviors where no one behavior is more fit than any other (Friedman, 1991).

In both cases, the result is considered as an *evolutionary stasis* with respect to the behaviors being considered - there is no *change* in relative frequency of the employed strategies over time. These situations are named, according to the game theoretical terminology as Evolutionarily Stable Strategies (henceforth: ESSs). More specifically, in the literature of game theory we identify two types of ESS:

- "Pure" ESS is where one strategy totally out-competes all others. In our case, this should be read as follows: mastery of a key process by a specific corporate environment, or alternatively, by a specific corporate scheme, should out-compete any other scheme. That means that regardless of its frequency, it is always more fit than any known alternative. A strategy that is a pure ESSs is considered as immune to invasion by other known strategies. In the old paradigm of doing business in a controlled environment, such a strategy might be sought and considered as ideal.
- "Mixed" ESS is where two strategies permanently coexist, thus increasing the complexity of the implementation, as in a real world application any actor should distribute its resources for achieving a certain / acceptable level of "mastery" in several key processes. From a computational perspective, in contexts where there are three or more strategies to play, it is possible to have a situation where there is no devisable ESS.

It is at this stage that ad hoc or heuristic approaches are employed that may either attempt to simplify the complexity of the given context, or alternate the actual problem to be addressed.

A further implication of this is that all business relations in an enterprise (internal and external) actually and potentially may take the form of a co-operative game. Working groups (comprised either by intra- or inter-enterprise personnel) seem to play an increasingly important role in business activities, both at the low 'operational' level and at the high 'strategic' one. The importance of this phenomenon is reflected in the emergence of endogenous policy models.

The latter concentrate on the interaction between working groups while the corporate management tends to keep for itself the role of the policymaker (or the arbiter?). Of course, in the case of inter-enterprise working groups, where people are involved in a cross-enterprise Situation Room, representatives from the management boards of the participating companies are included.

These models are typically focussing on Nash equilibriae of a properly defined game with complete information, where the various working groups (paricipantts of a Situation Room) and the corporate management are the (fully rational) players.

These issues are of obvious empirical relevance, since neither the set of working groups (and of the respective Situation Rooms which they are populating) nor their cardinality appears to be constant over time. In fact, organisational maintenance and attracting of new members (or getting rid of old ones that show sub-performances) is a continuing concern for such groups. Moreover, the realism of assuming complete information and (any type of) sophisticated strategic behaviour can be seriously questioned given the complexity of the business environment being dealt with.

Taking into account that game theory is, after all, the part of economic theory that focuses not merely on the strategic behavior of individuals in economic environments, but also on other issues that will be critical in the design of economic institutions, such as;

- how information is distributed as approached by (Harsanyi, 1967, 1968a, 1968b),
- the influence of players' expectations and beliefs and
- the tension between equilibrium and efficiency (Myerson and Satterthwaite, 1983).

In general, game theory has already achieved important insights into issues such as the design of business contracts and resource allocation mechanisms which take into account the sometimes counterintuitive ways in which individual incentives operate in complex environments having decision makers with different information and objectives.

There have been two means for "confronting" game theory with evidence: in the laboratory and in the field. More specifically, in laboratory studies, expected utility theory, as originally formulated by von Neumann and Morgenstern (Neumann and Morgenstern, 1944), was one of the first subjects to attract the sustained attention of experimenters.

From the very beginning this effort has both provided indications of the extent to which the predictions of the theory are approximate guides to individual choice behavior, and identified particular situations in which a significant proportion of subjects consistently violate the predictions of the theory. Using procedures of this kind, experimental methods allow investigators to measure some of the parameters on which the predictions of a theory may depend, and which would be unobservable in non-experimental situations[40].

Experimental data can also provide insights into field data. More specifically, field studies, as opposed to laboratory studies, are what economists traditionally do, in terms of concentrating their research efforts in studying behaviour of existing (operational) systems or of ad hoc developed, in order to check the validity of assumptions and of any hypotheses made.

Conclusively, we note that any interactions between members of a decision-making session, as these would be described in the accompanying model according to a generic process classification scheme, may build on the notion of a co-operative game and according to various modelling perspectives.

In thinking about coalitions, these may be for instance formed between:

- A working group, which is considered as a single part of a product development task force, and the corporate Management for achieving a

[40] For example, the classical game theoretic models of bargaining which date from the work of Nash were unusually resistant to tests with field data because their predictions depend on difficult to observe elements of the bargainers' preferences. However, laboratory experimentation presents the opportunity to measure or control these factors, and thus permits bargaining to be observed in environments for which the predictions of these theories can be known, and therefore tested. When examined in this way, the evidence supports some of the qualitative predictions of these models, for example concerning the effect of risk aversion on the outcome of bargaining, while contradicting others, concerning, for example, what constitutes complete information about a bargaining problem.

particular business objective. In this case, the basis for the formation of the coalition would be related to the achievement of a mutually wished management of corporate resources (e.g. minimisation of new product deployment times, which would be combined with an increase in the monetary returns for the workers).

- Two working groups representing parts of two distinct product development teams, both involved in the same product development process. In this case, the involved groups may identify a window of opportunity for forming a coalition for achieving their (perhaps common) goal. In any case, even when considering the case of two competitive working groups, formation of a coalition might be justified in terms of minimising the overall uncertainty that might exist when no communication and joint planning had existed, which would imply bigger operational costs.

Appendix 8. Publications

The following papers have been published as a direct result of this research.

Conference papers

1. A. Koumpis, B. Roberts, *A framework for Situation Room Analysis and exploration of its application potential in the IT sector*, in First International Conference on Performance Measures, Benchmarking and Best Practices in New Economy – Business Excellence '03, University of Minho, Guimaraes, Portugal, June 10-13, 2003.
2. A. Koumpis, B. Roberts, *A framework for Situation Room Analysis and exploration of its application potential in corporate decision-making*, in 9th International Conference of Concurrent Enterprising (ICE2003), Espoo, Finland, 16-18 June 2003.
3. B. Roberts, A. Koumpis, *Enhancing the design of a multi-party collaboration framework with the use of ontologies*, Invited Session on "Intelligent Infrastructures for advanced Interoperable Organizations", IEEE International Conference Intelligent Systems: Methodology, Models, Applications in Emerging Technologies, Varna, Bulgaria, June 22-24, 2004.
4. B. Roberts, K. Bone, J. Xuerebe, J. Scherer, A. Koumpis, *The SaRa :-) Project: Development of a Situation Room Analysis framework and exploration of its learning potential in the corporate world*, IADIS International Conference e-Society 2005, Qawra, Malta, 27-30 June 2005.
5. A. Koumpis, B. Roberts, *Investing in the intangible assets and intellectual capital for leveraging e-Learning in Africa*, 1st International Conference on ICT for Development, Education and Training 'eLearning Africa', UNCC, Addis Ababa, Ethiopia, May 24-26 2006.

Journal papers

6. A. Koumpis, B. Roberts, *Economies and Diseconomies of Scale in the Information Society: An assessment by means of Situation Room Analysis*, ACM's Ubiquity magazine, Volume 4, Issue 20, July 8 - 14, 2003.
7. B. Roberts, A. Koumpis, *Use of ontologies to enhance the design of a framework for multi-party collaboration and decision-making activities: the*

case of the Situation Room Analysis*, Journal of Knowledge Management Practice, Vol. 4, 2003.

8. B. Roberts, A. Koumpis, *A framework for Situation Room Analysis and exploration of its application potential in the Information Technologies market*, Management Decision Journal, Vol. 42, No. 7, 2004.
9. B. Roberts, A. Koumpis, *Use of ontologies to support the Situation Room metaphor as an auction engine for corporate information and knowledge exchange*, in 'Electronic Markets' International Journal of Electronic Commerce & Business Media, Vol. 15, Issue 1, 2005.

Edited book chapters

10. A. Koumpis, B. Roberts, *Use of Situation Room Analysis to enhance business integration aspects of a virtual enterprise*, in Goran D. Putnik and Maria Manuela Cunha (eds) "Virtual Enterprise Integration: Technological and Organisational Perspective", Idea Group, London, 2005.
11. B. Roberts, A. Koumpis, *i-accounting: an integrated approach (method + practices) to account for intangibles*, in Manuela Cunha, Bruno Cortes and Goran Putnik (eds) "Knowledge and Technology Management in Virtual Organizations: Issues, Trends, Opportunities and Solutions", Idea Group, 2006.
12. B. Roberts, A. Koumpis, *Sharing views, information and enterprise culture in the corporate Situation Room*, in Nicos Protogeros (ed) "Agent and Web Service Technologies in Virtual Enterprises", Idea Group, London, 2007 (to appear).