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A SECI-based Framework for Professional Learning Processes

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1. INTRODUCTION

The end of labour-intensive manufacturing leaves us with organizations, which receive their added value from the knowledge and the creativity of their employees rather than from their muscle-power. Fewer people, thinking better, and supported by clever machines and computers add more value than gangs or lines of unthinking "human resources". The result is not only a requirement for different people, but different organizations, organizations which recognize that they cannot do everything themselves. They are smaller and more flexible organizations than their predecessors, and they are flatter and less hierarchical. They are often called knowledge-based organizations, or knowledge-intensive organizations, and Peter Drucker has coined the term "knowledge worker" for the employees of such organizations. Taken together, these individuals and organizations form the basis of what we call the "knowledge economy" or even the "knowledge society". Today there is consensus among politicians and economists that developing and strengthening the knowledge economy should be the main strategy for the developed countries to maintain a competitive edge in the increasingly global economy.

In order to remain competitive, individuals and organizations must re-think (re-cognize) the nature and details of their (micro- and meso-level) competences and skills and their (meso- and macro-level) thinking tools (e.g., the Systems Method), their insights and their wisdom, so that they are better able to discuss, deploy, refresh, extend and eventually replace/upgrade their knowledge-age assets and improve their thinking habits and core assumptions. Working individually and in concert with others, across new geographies and discipline boundaries, this will necessarily require them to engage in a life-long learning process, involving much socialization, and aiming at increased organizational performance in the market place.

1.1. Structure of the deliverable

This deliverable focuses on the link between individual and organizational learning based on the interaction processes at the workplace, and key implications for personal and organizational knowledge management as they relate to organizational performance. Building on the results from PROLEARN D5.3, which introduced the SECI process framework, we here modify the SECI model so that it better fits the observed interaction processes that go on between employees at the workplace. The aim is to capture the semantics of these interactions in an enriched process model, which allows for management to get a better view of what is going on inside their organization as well as how their organization interacts with external stakeholders. The style of modelling introduced in section 7 could in fact be called "managerial modelling".

The sequence of the initial discussion in this deliverable is close to a reversal of the topics listed in its title (A SECI-based framework for learning processes @ work). In section 2 we discuss the "@work" aspect in terms of the "multi-dimensional" concept of organizational culture. After reviewing its definition by several authors, we discuss its relation to sense-making, identity-creation and shared purpose within the organization. We also review Robert Fritz's ideas on organizational structure [29], especially how *structural tension* and *structural conflict* within an organization can cause it to advance or to oscillate, depending on which one is the dominating force. We finish the section by discussing some of the cultural barriers to knowledge sharing which can exist within an organization, and what can be done to overcome them. This prepares us for a discussion of learning processes at work.

In section 3 we set the background for that discussion by considering the increasing ubiquity of learning at the workplace, and the trend to move away from traditional courses towards competency- and performance management. In section 4 we introduce the process modelling technique that we will make use of in the rest of this deliverable, and apply it to learning-process modelling, competency-gap analysis, and business-process driven learning scenarios @ work. Section 5 describes the different roles that connect the various business and learning processes that take place within companies and organizations, and ends with the presentation of a business roles ontology for professional learning.

Section 6 discusses the concept of mental models and introduces the distinction between *tacit* and *explicit* mental models, which makes it possible to make effective use of the concept of mental models within the SECI framework. Section 7 briefly reviews the SECI process framework of PROLEARN D5.3 and discusses some problems that have to be dealt with in order to effectively model the interactions that go on in the workplace. It then introduces the idea of SECI-based work processes, and shows how the SECI-model can be modified and adapted to become an effective modelling framework for intra- and inter-actions at the individual, team, group, organizational, and societal levels. An enriched form of process notation is introduced in order to capture the semantics of these inter-intra-actions, and an examples are given in the form of a model of a conferencing process (section 7.4), and a dynamic model of group inter- and intra-action within an organization (section 7.5).

In section 8 we present an overview of Charles Handy's theory of learning and Peter Senge's ideas on how to create a learning organization, which feature mental modelling as a key ingredient. We also discuss the concept of the "caring organization" and introduce Moss Kanter's ten rules to stifle initiative. Then we introduce the concepts of single-loop and double-loop learning developed by Argyris and Schön and discuss the problems with double-loop learning among experts [4]. We also introduce the ontologies of "learning categories" and "learning strategies" and show by examples how they can help an organization to improve learning among its members. Finally, we discuss the connections between this deliverable (D1.10) and the related deliverables D1.11 (with a focus on IMS Learning Design), and D6.7 (with a focus on informal learning, Web 2.0 and social software).

In the closing sections we integrate the points made in earlier sections, in line with the order of topics in the title of the deliverable. Section 9 introduces Kim's integrated model of organizational learning, which connects the learning of individuals and their organization(s) in terms of the interplay between individual and shared mental models. Section 10 deals with the application of Knowledge Management in order to support increased organizational performance through learning. Here we discuss the integrated KM model of Gorelick, Milton and April [31], which was developed by British Petroleum over a period of 10 years, and which has proven to be effective in increasing organizational performance within a number of different companies.

Section 11 brings together most of the pieces from the earlier sections and formulates a SECI-based Professional Learning Process Framework (PLPF), which aims to provide a project-based framework for professional learning that includes double-loop learning among professional learning providers. The PLPF is applied from the two different perspectives of Business Roles and EU-projects. Finally, in section 12 we present some conclusions, as well as some future efforts with a focus on sustainability of the PROLEARN network.

2. ORGANIZATIONAL CULTURE

A major theme of this deliverable is the link between individual and organizational learning. Just as individuals learn by updating their individual mental models (section 6.3), organizations learn by updating their collective mental models, which form an essential part of their specific culture.

2.1. What is organizational culture?

The *Webster's New Collegiate Dictionary* defines culture as the "integrated pattern of human behaviour that includes thought, speech, action, and artifacts and depends on man's capacity for learning and transmitting knowledge to succeeding generations." The literature on organizational culture borrows heavily from anthropology and sociology. According to Dalkir ([19], p. 178):

> Originally an anthropological term, culture refers to the underlying values, beliefs, and codes of practice that make a community what it is. The customs of society, the self-image of its members, the things that make it different from other societies, are its culture. Culture is powerfully subjective and reflects the meanings and understandings that we typically attribute to situations, and the solutions that we apply to common problems. The idea of a common culture suggests possible problems about whether organizations have cultures. Organizations are only one constituent element of society. People enter them from the surrounding community and bring their culture with them. It is still possible for organizations to have cultures of their own, for they possess the paradoxical quality of being both part of and apart from society. […]
>
> Schein, who is generally considered to be the father of the concept of "organizational culture", provides the following definition in [73]:
>
> Organizational culture is a pattern of basic assumptions – invented, discovered, or developed by a given group as it learns to cope with its problems of external adaptation and internal integration – that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think and feel in relation to those problems. […]
>
> Morgan [52] found that some key elements of organizational culture include:
>
> • Stated and unstated values
> • Overt and implicit expectations for member behavior.
> • Customs and rituals.
> • Stories and myths about the history of the group.
> • Climate – the feelings evoked by the way members interact with one another, with outsiders, and

with their environment, including the physical space they occupy.
• Metaphors and symbols – may be unconscious or embodied in other cultural elements.

2.2. Sense making and culture

According to Gorelick et al. ([31], p. 56):

> The sense-making actions can be characterized as levers that are available to a person, a team, or an organization to develop and maintain some sense of order or culture. An example is the commitment to learning, which a team or an organization has before a project begins. There is a shared value that learning is important, and there may be a common process. Sense-making actions include:
>
> • Policies.
> • Procedures.
> • Creating symbols.
> • Reflecting beliefs and values.
> • Common language and artifacts.
> • Basic assumptions and containers for storing and retrieving knowledge.

The sense-making actions are important to understand because they represent the culture. Specific sense-making levers that have been identified as impacting Knowledge Management initiatives and contributing to organizational learning are:[1]

• *Shared context, mission, objectives, and goals* include an understanding of what is being done, or what is desired, and why. In a knowledge-friendly culture, there is collective awareness of what the organization stands for, what it is trying to do (missions and goals), why the organization is trying to do what it is doing (the purpose), and how it will be accomplished.
• *Language and symbols* are the building blocks of sense-making. Weick [83] states that "people only know what they think when they see what they say". In other words, thought is based on language.
• *Values and assumptions* represent an understanding of the operative culture. An organization's value system is a large component of its culture. Shared values and assumptions are significant for creating a knowledge-friendly culture. Value alignment is arguably the most difficult sense-making element to achieve. In order to create alignment, organizational values need to be explicit.
• *Schema, scripts, and stories* are frameworks within which meaning is created. Schemas represent shared meanings, mental models[2], or frames of reference. Scripts are special types of schemas. They contain context-specific knowledge about events and event-sequences. Stories communicate knowledge derived from experience, by presenting that experience in a personal, emotional, and context-rich way, which makes it far easier for the listener to identify with.

2.3. Organizational structure

In his remarkable book *The Path of Least Resistance for Managers – Creating Organizations that Succeed*, Robert Fritz [29] adds a missing piece to the management literature – the structural causes of success and failure – and explains how to redesign an organization for success. According to Fritz, the main strategy is to focus the organization on what he calls "structural tension" between the desired and the present organizational state of affairs.[3] Once established and aligned within the organization, structural tension will move the organization forward along its "path of least resistance", in analogy with a commonly occurring type of mechanical system[4], which follows a path determined by the so called *Hamilton's principle of least action*. Fritz formulates the following nine laws of organizational structure:

> 1) Organizations either oscillate or advance.
> 2) In organizations that oscillate, success is neutralized. In organizations that advance, success succeeds.
> 3) If the organization's structure remains unchanged, the organization's behavior will revert to its previous behavior.
> 4) A change of structure leads to a change of the organization's behavior.
> 5) When structural tension dominates an organization, the organization will advance.
> 6) When structural conflicts dominate an organization, oscillation will result.

[1] This bullet-list represents a condensed version of the discussion in [31], pp 56-61.
[2] For example, a mental model in Knowledge Management is that learning is a mandatory and valuable component of every project.
[3] The concept of structural tension is quite similar to Senge's concept of "creative tension" as described in [74].
[4] Which technically is called a *Newtonian potential system*.

7) An inadequate organizational structure cannot be fixed. But you can move from an inadequate structure to a suitable structure.
8) When a senior organizing principle is absent, the organization will oscillate. When a senior organizing principle is dominant, the organization will advance.
9) The values that dominate an organization will displace other competing, lesser values.

In his foreword to Fritz's book, Peter Senge gives the following overview:

> Fritz argues that there are two dominant structural dynamics that shape how organizations function. Organizations that consistently "advance" do so because "structural tension" dominates. Those who consistently "oscillate" do so because "structural conflict" dominates. […]
>
> Structural conflict predominates when people find that they are trapped, repeatedly, between the proverbial "rock and a hard place". The theory of structural conflict explains how people consistently, and often sincerely, espouse the importance of being result-oriented and yet produce organizations that work in the opposite fashion. In essence, many other considerations supersede the espoused pursuit of results – like maintaining power, not upsetting the boss, looking good, and avoiding surprises. [...]
>
> On the other hand, structural tension characterizes those organizations that know what it means, practically, to honor vision and reality in equal measure. Such organizations do not shy away from facing difficult situations. Indeed, for them reality is an ally – telling the truth anchors them in the here-and-now without weighing them down. Such organizations operate predominantly in the creative orientation (versus the reactive orientation) because they see whatever happens as creating the conditions from which they must currently move in pursuit of their aspirations. In organizations in which structural tension dominates, structural conflicts still exist, but they too are seen as one more aspect of current reality, one more feature about which people must acknowledge the present in the service of creating the future.

Judging from citations of Senge and Fritz, those observations are familiar to communities concerned with organizational behaviour and change management, but are little known or valued by communities concerned with the ICT aspects of professional learning (e.g., ontologies, mapping competences, knowledge modelling and management).

2.4. Cultural barriers to Knowledge Sharing

According to Gorelick et al. ([31], p. 51):

> The nature of the unique organizational culture will make the implementation of Knowledge Management either easier or more difficult, depending on whether the culture is aligned or unaligned with the values of knowledge sharing. In an unaligned culture, KM will be a real struggle, while in the right culture it can be comparatively straightforward. Therefore, part of the challenge in implementing KM may be to change the culture. Paradoxically, KM itself may be one of the main tools for changing a culture. KM is by nature reflective because of the focus on learning and performance improvement. It can also lead to cultural improvements. If culture is a barrier to performance improvement, then KM efforts will inevitably raise the issue of necessary cultural changes. An example of a common barrier to KM implementation is a culture that sees knowledge as individual power and discourages knowledge sharing. […]
>
> A KM system needs a knowledge-aware culture, where people know that the knowledge they work with is not just their own personal knowledge, it is company knowledge. Employees know they need to manage knowledge, they need to look after it, and they need to not waste it. Changing the culture of the organization to become knowledge-aware will not be easy and it will not be quick. However, it is possible, as illustrated by the case of British Petroleum and others.

Many authors and practitioners emphasize that a major aim of Knowledge Management is to support the creation of a knowledge sharing culture within the organization ([15], [19], [31], [62]). Without a sense of the strategic importance of knowledge sharing for the overall performance of the organization, there is little use of introducing technological infrastructures and tools that enable knowledge sharing. The traditional strategy of "build it and they will come" has been proven wrong by experience, and a lot of companies have wasted a lot of money in learning this lesson. As described in [31], p. 51:

> Today, most organizations have access to the required processes and technologies, but most often employees do not yet understand the value of using them. Exceptions to this statement are informal

networks such as the grapevine, the gossip circle, and the rumor mill. These are highly effective knowledge-sharing mechanisms, which often work better than officially sanctioned practices for knowledge exchange. They work precisely because the rumor culture is alive and well in all organizations. If it were possible to develop a culture where individuals saw operational knowledge as being as important and interesting as rumor and gossip, Knowledge Management would be integrated into every action, interconnecting performance with learning.

Depending on whether an organization's specific culture is aligned or unaligned with the values of knowledge sharing, the implementation of KM within this organization will be easy or difficult. Therefore, part of the challenge in implementing KM may be to change the organizational culture. As discussed in [31], some of the main cultural barriers are embedded in the beliefs of individuals, teams, and the organization. People are attracted to organizations that support their beliefs and values, and managers tend to hire employees that share their own beliefs and values. This in itself is a significant barrier to changing the organizational culture and can also be a barrier to making effective use of individual and organizational competences. Below is a list of some other common barriers and suggested solutions[5]:

• *Knowledge is power*. This belief is prevalent in organizations with lots of internal competition, where knowledge is currently being managed by leaving it in the heads of experts as tacit knowledge. People need to see that sharing knowledge actually delivers greater power when it comes to competing against major competitors.
• *Drive to innovate*. Some organizational cultures are built so strongly around the principle of innovation that there is a strong cultural barrier towards reuse of knowledge. Employees need to realize that while invention is good, reinvention is a waste of time, i.e., reinvention that adds nothing new is inferior to reuse.
• *Individual work bias*. Cultures where employees work as individuals, with individual objectives and rewards are difficult places to successfully implement KM. KM will flourish in a culture where collaboration and cooperation are the norm and where employees work in teams and communities and are rewarded for collective performance.
• *Local focus*. In cultures where employees are focused purely on their own team or business unit, KM can be difficult. Introducing some form of cross-business unit structure, such as peer groupings or communities of practice, and providing tools for knowledge to flow in and out of the local teams or departments, is essential to generate more of a network focus.
• *Not invented here*. This is one of the biggest cultural barriers to knowledge sharing. Managers need to look for ways to bring individuals together and to build trust. Their goal should be to help build relationships and trust so that "invented in the community" is as trustworthy as "invented here".
• *It won't work here*. Employees may need to be convinced that knowledge can be managed in their own cultural and organizational context. This "showcasing" of success is very powerful for changing the culture by reinforcing a new mind-set of "it does work here".
• *Don't see the value*. This barrier is similar to "it won't work here", and can be overcome by similar counter-measures.
• *Making mistakes is wrong*. The "blame culture" is a powerful disincentive to honest and open knowledge sharing. Publicizing some high-profile knowledge capture from disastrous projects most easily breaks this barrier. In fact, the message from management needs to be that the really unforgivable crime is failing to learn from mistakes and thus causing mistakes to be repeated.
• *Information overload*. Employees often complain about being overwhelmed by information, and seem to think that KM will just add to this overload. The response to this is the reassurance that KM is not about bombarding employees with information but rather providing them with the tailored knowledge they need, at the time they need it.
• *Knowledge underload*. A barrier may occur at the start of a KM program, when employees start to look in the "knowledge bank" and find that there is nothing in there. There may be nothing for employees to go to, browse, and then learn from. A knowledge manager should start with the exchange of tacit knowledge, using a "connect" (personalization) rather than "collect" (codification) strategy, and at the same time, begin to put material in the bank.
• *No time to share*. The time barrier is a difficult one. Although KM will ultimately save time for the organization, it requires a time investment in the beginning. KM should start with knowledge processes that save time for the team in the short term.
• *Not paid to share*. KM needs to be embedded into other management processes, such as project management, so that it becomes part of the job rather than an add-on. When KM becomes part of the job, integrating learning and performance, it is no longer seen as an alternative to the job. As soon as KM is seen as "part of the job", it becomes part of the reward structure too.

[5] This list is a shortened version of the list appearing in [31], pp. 53-55.

3. FROM COURSES TO PERFORMANCE MANAGEMENT

3.1. The Increasing ubiquity of learning at the workplace

Today, learning at the workplace is becoming increasingly ubiquitous [31]. What used to be called "learning@work" is today more and more being thought of as "learning-is-work". This reflects a growing unwillingness by managers to send their employees to courses, and an increasing attitude of supporting the learning that goes on all the time when knowledge workers interact in the workplace, and harvesting it for the future so that similar situations can be handled more effectively and efficiently.

In parallel with this decreasing demand for explicit learning there is an increasing demand for *performance management*. For example the Ericsson corporation focuses on four different dimensions of performance management [25]:

- *Knowledge management*, whose main aim is to promote knowledge sharing within the corporation.
- *Resource management*, which aims to have the right person with the right competence at the right time in the right place at the right cost.
- *Competency management*, which tries to assert roles for new talents talents (and to develop people with talent: "talent management", instead of just filling vacancies and head counts.[6]
- *Responsibility management*, which involves all Ericsson employees, units and companies.

Within Ericsson, the individual capacities of each employee involves the three "competency dimensions" of *professional* competency, *human* competency and *business* competency. Job families are described in terms of the competencies that are required in order to carry out what should be done in a certain job/position. (Figure 1)

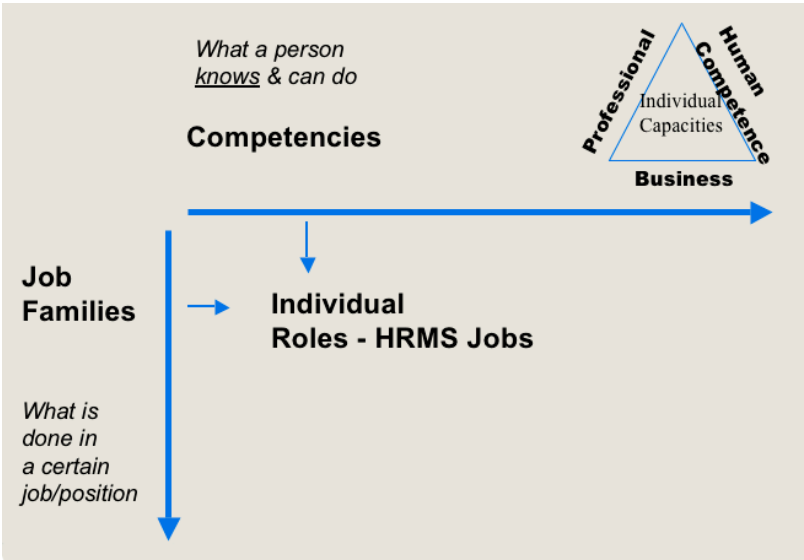

Figure 1. Matching job families and competencies at Ericsson

As seen in the spider diagram of Figure 2, Ericsson makes use of 4 different levels to assess the competency (knowledge and skills) of its employees. These levels are interpreted as: A = Basic, B = Good, C = Highly developed, and D = Exceptional.

[6] In this deliverable the words "competency" and "competence" are used as synonyms.

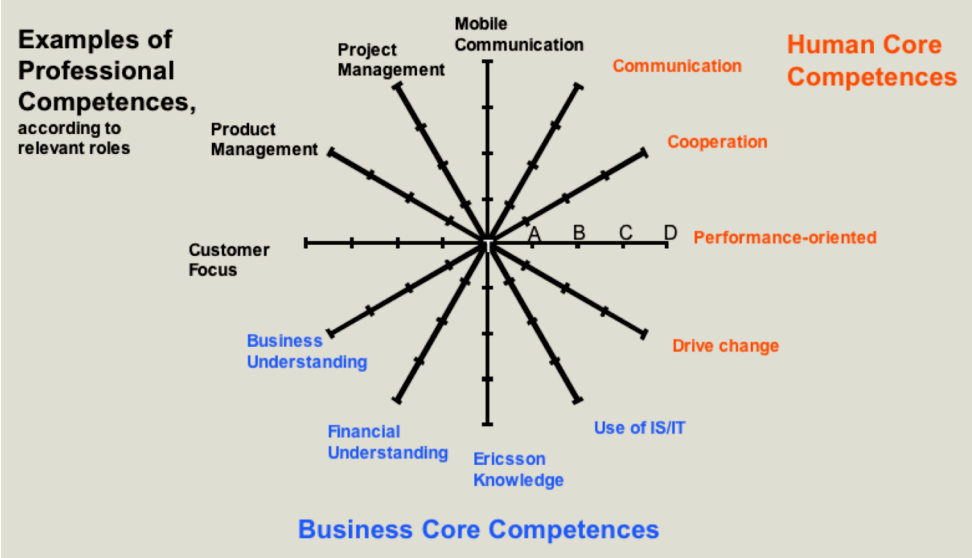

Figure 2. Spider diagram expressing some of the core competencies at Ericsson

Once a year, each Ericsson employee, together with her/his boss, assesses her/his present competency levels (along the relevant dimensions) as well as the competency levels (s)he aspires to gaining during the next year. This creates a competency gap (Figure 3) that becomes the basis for the learning of this employee during next year. A year later, this competency gap diagram is brought out and assessed in order to figure out the learning outcome. This assessment (performance appraisal) is in turn used as a basis for salary negotiations.

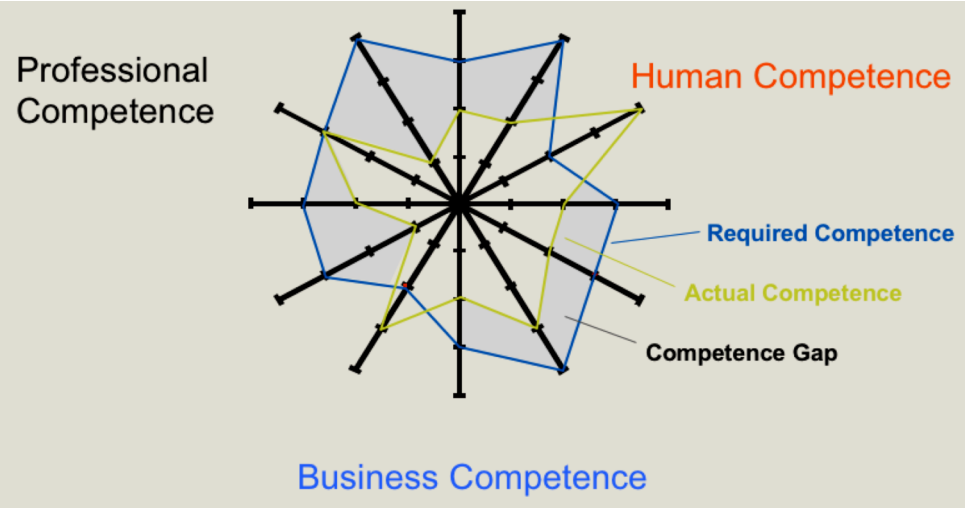

Figure 3. An Ericsson style competency gap chart

Within Ericsson, this type of competency gap analysis is performed not only at the level of the individual employee, but also at the level of development units and market/business units. In this way, visions, strategies and goals are formulated, and actions to achieve them are planned and later assessed in order to formulate lessons learned, reassess ambition levels, etc.

The Ericsson example is by no means unique. In fact, most corporations have some form of performance management process. For example, as described in [31], British Petroleum uses the model depicted in Figure 46 in order to improve its performance through knowledge and learning management.

4. LEARNING-PROCESS MODELLING AND COMPETENCY-GAP ANALYSIS

4.1. The Astrakan process modelling technique

In a service-oriented environment aiming for reusability of service components, the "process-object" – or process-module" is of vital importance. The basic ideas underlying the Astrakan™ process modelling technique[7], are depicted in Figure 4.

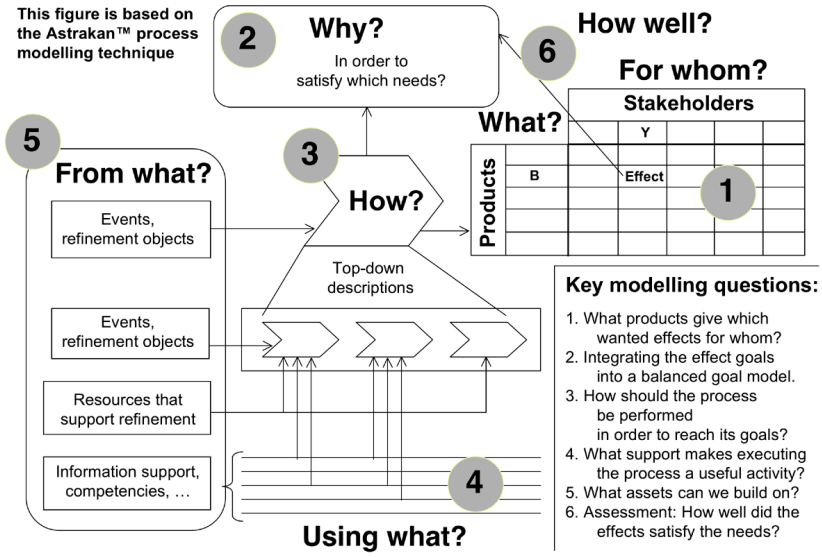

Figure 4. The Astrakan™ process modelling technique

A *Process Module* has certain *Process Goals*, produces *Output Resources* for different *Stakeholders*, refines *Input Resources* and makes use of *Supporting Resources* (Figure 5). The difference between an input- and a supporting resource is that the former is refined in the process, while the latter facilitates this refinement.

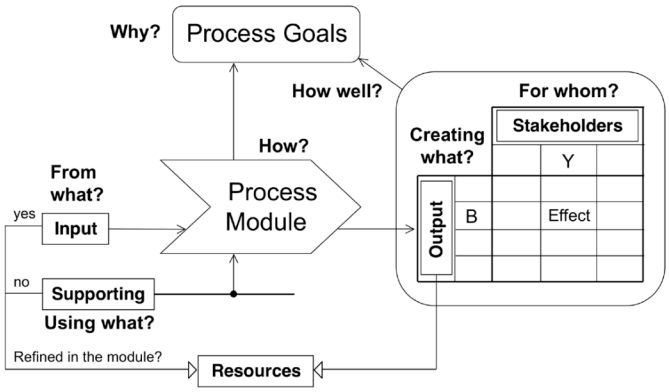

Figure 5. A Process Module with its Goals, and its Input-, Output-, and Supporting Resources

Figure 6 depicts a kind of (= subclass of) Process Module, called a *Learning Process Module* with its corresponding *Learning (Process) Goals*, and its *Input-, Output-, and Supporting Learning Resources*.

Observe that Figure 6 describes the crucial connections between Learning Resources (LRs) - which include so called Learning Objects (LOs) [8] - Learning Process Modules (LPMs), and Learning Goals (LGs). Hence it becomes possible to describe ***why*** we are using a certain LO in a certain LPM, i.e. what pedagogical aspects that we are trying to support and what LGs that we are trying to achieve.

[7] www.astrakan.se

[8] as well as other types of resources, such as human resources and physical resources (materials, tools, laboratories, etc.)

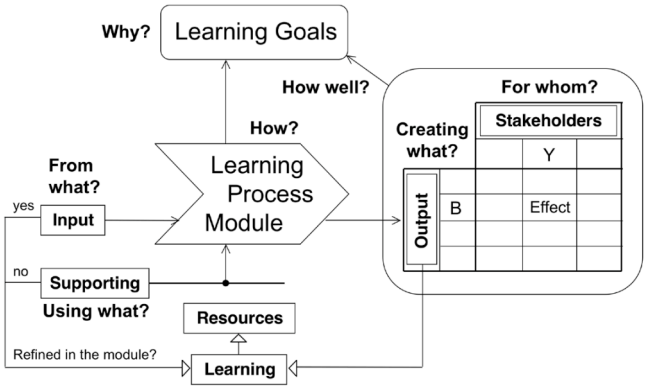

Figure 6. A Learning Process Module with its Learning Goals, and its Input-, Output-, and Supporting Learning Resources

Apart from the never-ending debate about their definition, a major criticism against Learning Objects is that they are too often considered in isolation from the learning context within which they are supposed to be used (see e.g., [27]). Hence it becomes difficult to connect LOs with the social and pedagogical dimensions of the learning process, and answer the crucial pedagogical/didactical questions of why LOs are being used, and what one is trying to achieve by using them. By applying the modelling techniques introduced in [57] and elaborated in [59], such questions can be answered in a satisfactory way. However, for practical use at an organizational level, it may be necessary to make provision in Learning Process Modules for Learning Goals that specifically address any cultural barriers to knowledge sharing (section 2.4).

4.2. Different types of competency gaps

Since individual competencies are refined and developed by learning, they can be considered as input and output data to learning processes. In fact, each Learning Process Module (LPM) can be considered as filling a *Real Competency Gap* (RCG), which is the difference between the *Input Competency* (IC), i.e., what the learner knows before entering the LPM, and the *Output Competency* (OC), i.e., what (s)he knows after having passed through it. The *Formal Competency Gap* (FCG) is the difference (as specified e.g., in a course manual) between the *Pre-Requisite Competency* (PreRC), which is required to enter the LPM, and the *Post-Requisite Competency* (PostRC), which is the competency that the LPM aims to provide for learners that possess its corresponding PreRC.

In Figure 7, the ICs and OCs are modelled as a kind of *Learning Resources*, while PreRCs and PostRCs are modeled as a kind of *Learning Goals*. *Pre-assessment* can be used to investigate whether there is a *Pre Competency Gap* (PreCG), i.e. whether there is a difference between what a learner knows when entering the LPM, and what (s)he should have known in order to enter it. Post-assessment can be used to investigate if the learner has actually acquired the aspired PostRC. If not, then there is a *Post Competence Gap* (PostCG), i.e., there is a difference between the PostRC and the actual OC for this learner. If there was no PreCG, then we can conclude that something went wrong in this LPM.[9]

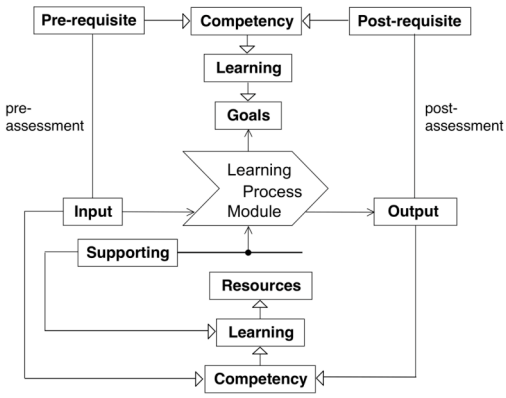

Figure 7. A Learning Process Module with a Formal and a Real Competency Gap.

[9] This is analogous to a software principle called "design-by-contract", where only data that satisfies the pre-conditions are allowed to enter a software module. If the post-conditions are not fulfilled, then we can conclude that something went wrong in this module.

A Learning Process (LP) can be modelled as a chain of successive LPMs, where the PostRC of the LPM_k is identified with the PreRC of the LPM_{k+1}. In this way, the larger learning goal of the entire LP can be broken down into a sequence of smaller learning sub-goals for each LPM. This maps well to the concepts of goals and sub-goals in WSMO[10], where there are gg-mediators, which can mediate between them.

4.3. Stakeholder matrices - connecting process modules into service networks

In the Astrakan™ modelling technique, stakeholder modelling is used for the output of processes, as illustrated in Figure 5 and Figure 6. In [59] this idea is expanded into making use of what is called *stakeholder matrices* in the description of every aspect of a process module, as shown in Figure 8. This means that we model not only who has an interest in the different output resources of a process module, but also who has an interest in its different goals, its input resources and its supporting resources.

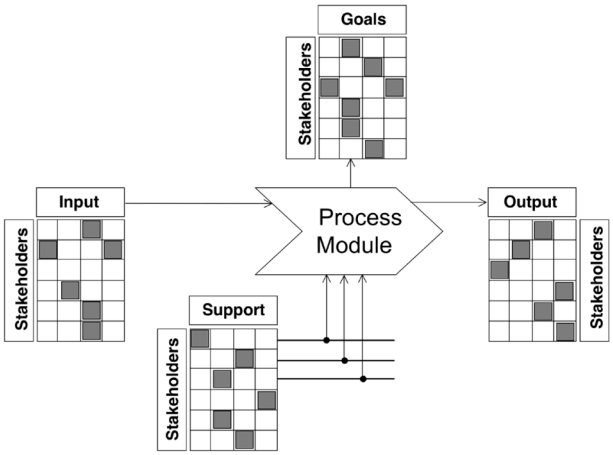

Figure 8. Process module with stakeholder matrices.

As mentioned above, the idea of modelling the stakeholders of each aspect of a process module provides a way to connect these modules into service networks. This is illustrated in Figure 9, where the output resources from the process module to the left function as input- and supporting resources to the two process modules to the right. The "interfacing questions" that must be answered in order to set up these connections can be summarized as follows:

- **Producing what?** - What output resources give which wanted effects for whom?
- **Why?** - Which needs for whom are being satisfied?
- **How?** - How should the process be performed in order to reach whose goals?
- **From what?** - Which input resources from whom should be refined in the process?
- **Using what?** - Which supporting resources from whom should support the process?
- **How well?** - How well did the output resources satisfy whose needs?

The modelling framework described provides a generic way to model organizational processes as linked to general goals, with a possible decomposition. Of course, the "goal stakeholder matrices" are connected as well (not shown in Figure 9) in a way that models how the different partial goals interconnect in order to support the overall goals of the service process network.

[10] *Web Services Modeling Ontology* (see www.wsmo.org).

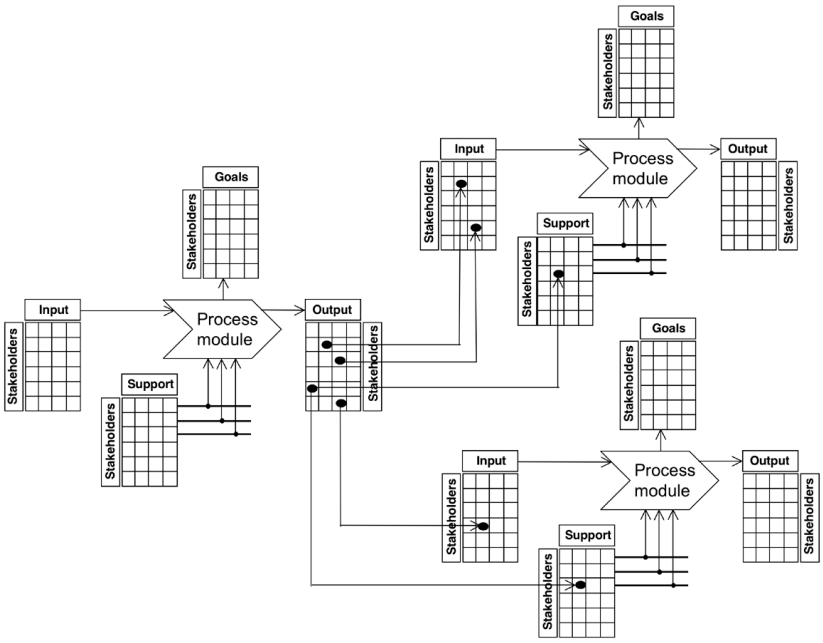

Figure 9. Service process network – connected through stakeholder matrices

4.4. Competence mapping and gap analysis in the TENCompetence project

In the TENCompetence project the aim is to assess relevant competences and define competence gaps within the consortium through the following procedure ([42]):

1. List all TENCompetence tasks,
2. Define competence profiles required in the consortium (competence map),
3. Staff uses the competence map for self-assessment,
4. Create and populate the Tasks x Competences Matrix,
5. Analyse the outcomes of 3 and 4 (gap analysis),
6. Prioritise competence development needs,
7. Identify expert facilitators within the consortium,
8. Establish competence networks for these topics.

An individual may exhibit competences at the following proficiency levels:

• 0 = none,
• 1 = can apply this with support in relatively simple and well organized situations,
• 2 = can apply this independently in relatively simple and well organized situations,
• 3 = can apply this independently in complex situations,
• 4 = can apply this flexibly in complex situations, can evaluate the competence and can support others.

The Competence Map comprises a temporary 'work version' within the project. Over time it is likely to change under the influence of lessons learned and new development in the TENCompetence environment. How to incorporate such changes in existing competence networks is one of the challenges to be addressed by the project. Several services will be supported by TENCompetence tools, including competence definition, positioning, navigation, and recommending. These integrated services will constitute the Personal Competence Manager (PCM), which will work with the Competence Map. See [42] for a detailed discussion of these issues.

4.5. Competency mapping and gap analysis in the LUISA project

Recent efforts in the area of learning technology have resulted in a considerable improvement in the interoperability of learning resources across different Learning Management Systems (LMS) and Learning Object Repositories (LOR). The central paradigm of such reuse-oriented technology is the notion of learning objects as digital reusable pieces of learning activities or contents. Semantic Web technology is able to provide

the required computational semantics for the automation of tasks related to learning objects as selection or composition.

Within the context described, the project **LUISA**[11] addresses the development of a reference semantic architecture for the major challenges in the search, interchange and delivery of learning objects in a service-oriented context. LUISA is a Specific Targeted Research Project (STREP) funded by the European Commission FP6 programme. The mission of LUISA is that of exploiting the advantages of a Semantic Web Service Architecture to make richer and more flexible the processes of query and specification of learning needs in the context of Learning Management Systems and Learning Object Repositories. This entails the technical description of the solution in terms of current SWS technology, and also the provision of the ontologies, facilities and components required to extend and enhance existing learning technology systems with the advanced capabilities provided by computational semantics.

The technology development objective of LUISA is put in a context of relevant learning scenarios – both academic and industrial – for evaluation and also to serve as a blueprint for technology adoption. The outcomes of LUISA are expected to make a significant contribution to the automation of learning technology systems beyond current standards, fostering the advancement of Web-based learning with an increase in the capacity to locate, search and negotiate learning resources mediated by semantic tools.

LUISA aims to match learning needs and learning objects (resources) through a competency-gap driven approach. By introducing *Learning Process Modules* (LPMs), which provide the "missing context" for learning resources, competency gaps can be mapped to pre- and post-requisite competency gaps. As discussed above, since individual competencies are refined and developed by learning, they can be considered as input- and output learning resources to different parts (= modules) of the learning processes (Figure 7).

4.6. The LUISA competency observatory

The LUISA project includes a competency observatory where different competency models can be compared and adapted to using the LUISA technology. The basic idea behind the LUISA competency observatory is to allow a community-specific, bottom-up approach to competency modelling, where each community of practice can formulate its own views on what it considers to be the most important aspects and characteristics of the competencies within its own field(s) of interest. On the industrial side, The LUISA competency observatory presently includes the top levels of the EADS/Airbus and Ericsson employee competency models.

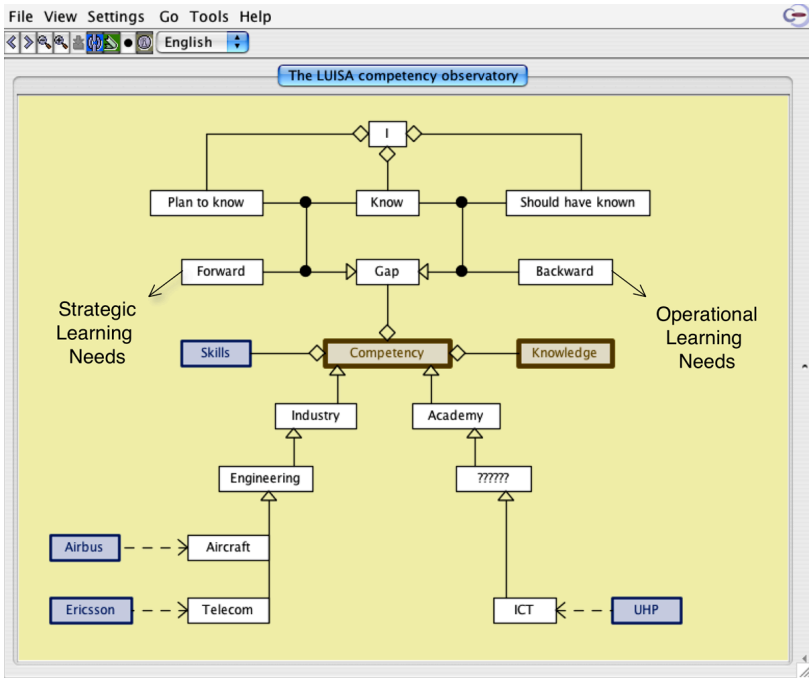

Figure 10. The top level of the LUISA competency observatory

[11] **L**earning Content Management System **U**sing **I**nnovative **S**emantic Web Services **A**rchitecture: www.luisa-project.eu

Figure 10 shows the top level of the LUISA competency observatory modelled in the Conzilla tool.[12] As seen in the figure, competency is described as consisting of Knowledge and Skills. Here knowledge is roughly identified with theory ("know what") and skills with practice ("know how"). Moreover, Competency has Gap, which can be of two different kinds. A *Forward Competency Gap* (FCG) is a difference between what the learner knows and what (s)he plans to know, while a *Backward Competency Gap* (BCG) is a difference between what the learner knows and what (s)he should have known. Hence, with respect to an LPM, a BCG is identical to a PreCG.

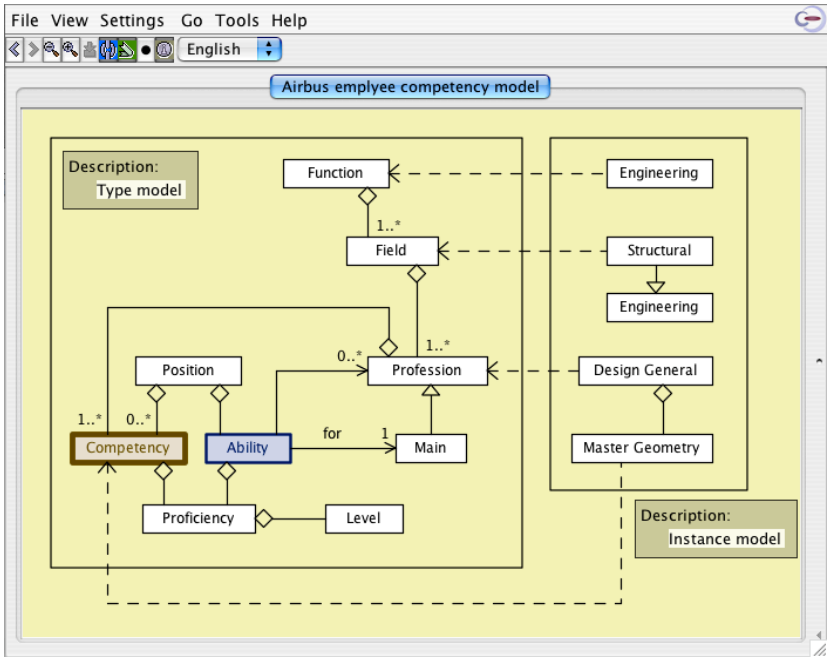

Figure 11. Part of the Airbus employee competency model (from the LUISA competency observatory)

In the EADS/Airbus use-case of LUISA, the difference between an employee's *Personal Profile* and her/his *Present Position Profile* corresponds to her/his BCG. The difference between the employee's *Personal Profile* and her/his *Desired Position Profile* corresponds to her/his FCG. The Airbus competency model is described further in [51].

4.7. Operational learning needs from a business perspective

The learning processes in the workplace can be divided into *operational* and *strategic*, which reflects the two different levels on which a company operates. The operational level deals with the short range of everyday activities of the company, while the strategic level is concerned with the long-range development of its future activities. Operational learning needs are mainly project-based ("what do we need to learn in order to handle the project that just got approved"), while strategic learning needs are mainly competency-based ("what do we need to learn in order to secure the approval of future projects"). "Project-based" here is understood as "planned" activities, with schedules, clear objectives and milestones, as opposed to *ad hoc* reactions.

[12] See section 11.1 or www.conzilla.org for a description of Conzilla.

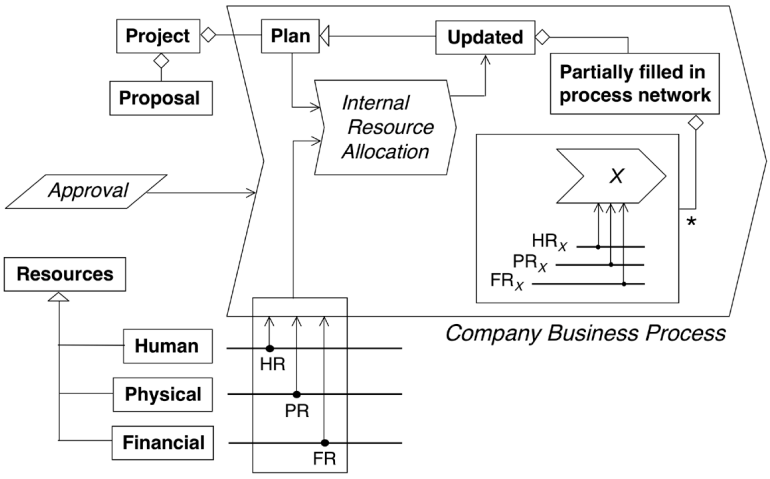

Figure 12. The origin of operational learning needs from a business perspective

In Figure 12 we illustrate how the project-based operational learning needs arise in the workplace from a business perspective. As shown in this figure, the overall *Company Business Process* is supported by *Human Resources* (HR), *Physical Resources* (PR), and *Financial Resources* (FR). In order to attract business, the company is involved in a *Project Proposal*, which involves the construction of a *Project Plan*. When the project gets approved, which is modelled by the occurrence of an *Approval* event, this triggers an *Internal Resource Allocation* (IRA) process, resulting in an *Updated Project Plan*, which contains a *Partially filled in process network* of the kind shown in Figure 6. In this IRA process, the available supporting resources (HR, PR, FR) of the company are distributed across the various process modules that describe the workflow of the project, and a suitable part of these resources (HR_X, PR_X, FR_X) are allocated to process module X. The operational learning needs arise from the "competency-gaps" in this process module network.

In general, forward competency gaps are more associated with *strategic learning needs* (what a company needs to learn in order to stay in business), while backward competency gaps are more associated with *operational learning needs* (what a company needs to know in order to deliver in its present undertakings). BCGs often appear because employees leave the company and have to be replaced by others who do not quite know what they (ideally) should have known in order to serve as good replacements. For example, during the internal resource allocation process described above, it might be discovered that Peter, who was the person that was planned to be in charge of a certain process module in the project plan, has left the company, and that Paul, who is the only employee that could possibly perform this task, does not quite possess all the competencies that are required for it. In this case Paul has a backward competency gap, a difference between what he knows and what he (ideally) should have known, a gap that needs to be filled ASAP in order for the project to work as planned.

4.8. Scenarios for competency-oriented learning design based on business processes

Using results from the PROLIX project, we can identify four major situations (scenarios) where companies have to offer learning processes to their employees in order to fulfil business needs ([87], p. 32). Each situation or scenario is an important trigger for corporate training, therefore leading to a competency gap analysis in order to design fitting learning processes.

Scenario 1 – optimizing business processes (Business Process Engineering BPE Scenario)

In a world of constant change, business strategies are continually fine-tuned, leading to changes in business processes. Introducing new business processes as well as adapting existing ones brings about new demands on employees responsible for these processes. Confronted with new task environments, employees are very likely to lack competencies and skills to perform these tasks effectively, i.e., they will have various backward competency gaps (as described above). Even in the case of unchanged but inefficient business processes, one important factor to optimize process performance is to improve competencies of the personnel allocated to the business process. The respective competency gaps shall be closed through personalized learning processes.

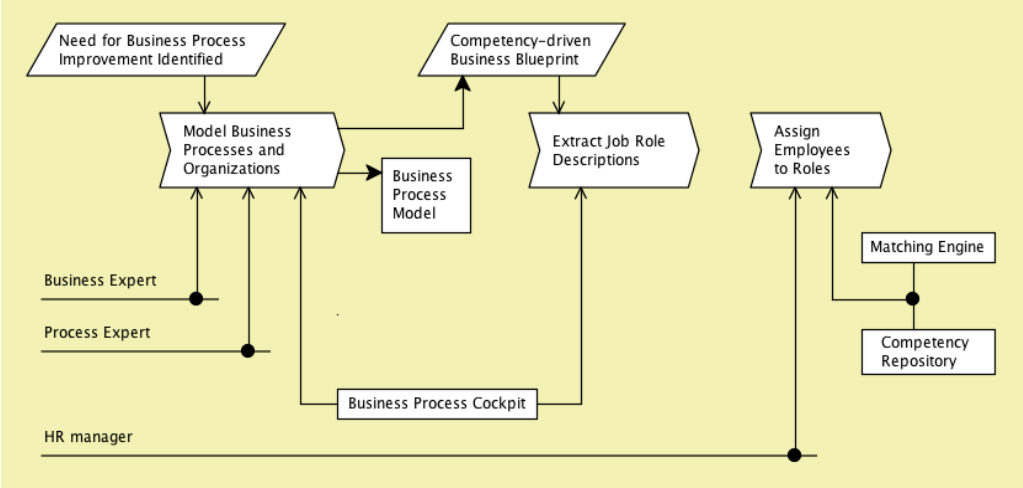

Figure 13. Business Process Engineering Scenario

Scenario 2 - Recruiting & Staffing (R&S)

Another trigger for designing and executing learning processes arises from a job vacancy that needs to be filled either internally or externally. In this event the job role as well as the required competencies (the person specification) must be described by the HR Manager and Business Expert before HR starts to look for suitable candidates (Recruiting). The vacancy is filled by the recruitment of the candidate whose competencies best match the requirements of the job. Remaining competency gaps have to be closed by designing learning processes.

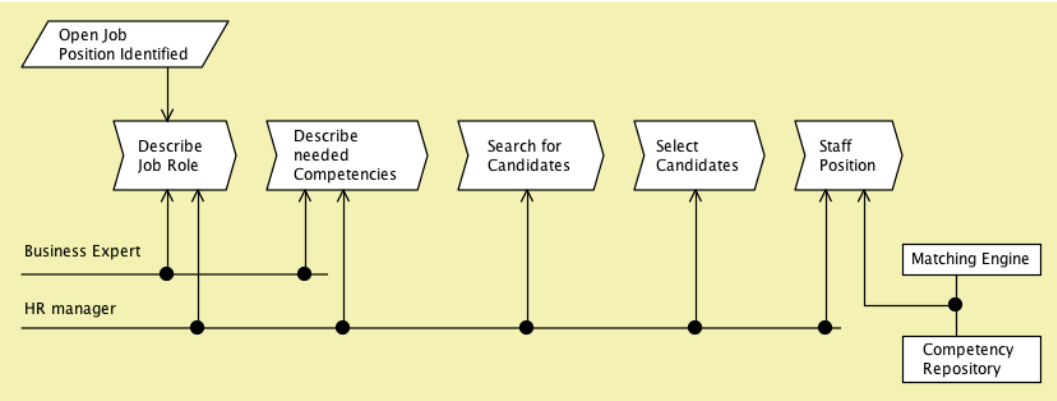

Figure 14. Recruiting & Staffing

Scenario 3 - Personal Competency Development (PCD)

The need for developing personal competencies towards a specific professional goal may not only be set off by organizational strategy (as in scenario 1 and 2) but also by personal ambition to climb the job ladder, self-actualisation and desire for further education or training. This is addressed by scenario 3. The important difference compared with the second scenario lies in the individual employees' self-determination and striving for professional progression both within and outside their current organization. Here, the competency gaps tend to be of the forward type, and stem from personal development objectives identified in annual personnel interviews or performance appraisals, but they could also be identified by external career counsellors. Individual employee initiatives should therefore be seen as possible triggers for personal competency development. To fill such competency gaps, training should be designed according to competency needs.

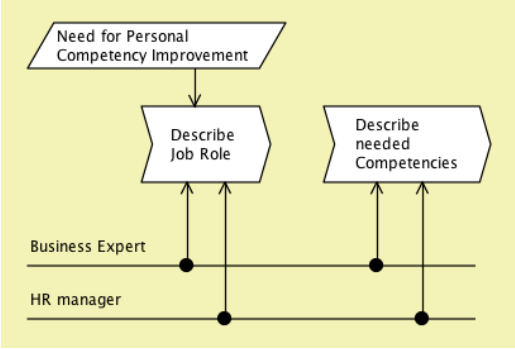

Figure 15. Personal Competency Development

Scenario 4 – Compliance

A fourth trigger can be the need for personalized learning processes according to compliance regulations. Regulation is already pervasive in banking, financial services and health and social care, with recent corporate scandals (e.g. the Enron Case in 2001) highlighting the urgent need for stronger compliance regulations in publicly listed companies. From a managerial point of view, the act of adhering to and demonstrating adherence to, a standard or regulation is covered by the term 'compliance'. Thus, regulatory compliance refers to systems or departments at corporations and public service agencies to ensure that personnel are aware of and takes steps to comply with relevant laws and regulations. Most cited examples for both compliance deficiencies and effective counteractive measures are to be found in the financial sector (insider dealing, money laundering). Other instances affecting compliance across industries are driven by the wide adoption of ICT, e.g. data protection and information security.

Another field of compliance occurs in cases where job roles ask for official certification - as in the social care sector[13], where matching existing competencies of employees and required competency profiles is indispensable. Usually, official competency requirements are already defined and only need to be translated into a format that can be matched to employees' profiles. This very special case totally shifts the focus from business processes to pure standardized job roles that trigger learning in an organization. More generic cases such as First Aid courses, which everybody working in the organization has to go through, also belong to the group of compliance-triggered learning needs but are less formalized. In any case, to fill competency gaps resulting from a compliance regulation is a very important reason to design learning processes according to the SECI framework.

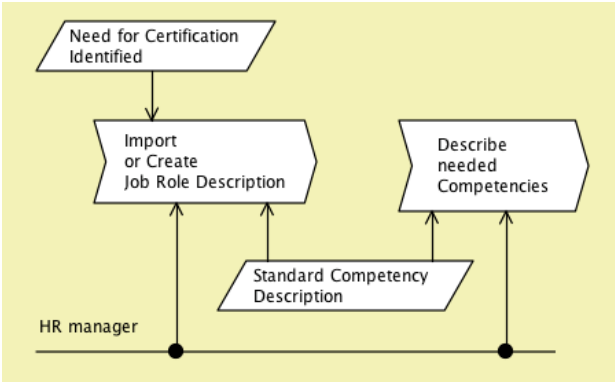

Figure 16. Compliance Scenario

In 80 to 90 percent of the cases in enterprises, these four scenarios might provide the reasons to start designing learning processes. Even though every scenario expresses a specific business need for training, which results in a "competency-oriented role description" and "role assignment", they all together lead to a process of formal or informal learning of tacit or implicit knowledge.

[13] The particular context in England is that social care businesses are driven in large part by regulatory compliance – whether in terms of e.g. Health and Safety at Work or by mandatory levels of staff qualification, expressed in terms of National Vocational Qualifications or to meet inspection standards from the Commission for Social Care Inspection.

Whereas the first scenario views a business process as the context of a rising training need, the other scenarios are related to business processes. According to "a process is a process is a process", staffing, recruiting, competency development as well as compliance measures are business processes in themselves. In contrast to the first scenario, these business processes no longer serve as the trigger for training needs but rather include the corporate training process as a major activity. Thus, all four scenarios can be considered process-oriented whereas only the first one may truly be said to be process-driven.

5. ROLES WITHIN THE BUSINESS AND LEARNING PROCESSES

When talking about competency-oriented design of learning processes based on business needs, we have to analyze who is involved from the business side in organizations and integrate this into a role-concept of SECI based learning framework. A role concept answers the question of "who" will be the users of the different technologies involved in the process from business need over learning design to learning process management and performance measurement. In this section, we define a role concept without addressing deeper questions about whether the roles are appropriate for the long-term survival of the organization that the learning processes are designed for (see section 2.3, Robert Fritz [29] on how to redesign an organization for success).

A role is defined as an organizational concept detached from departments, organizational units, jobs or specific employees. Neither is a role defined by the experiences, competencies and skills needed to undertake it at the outset. In principle, a role is defined by the goal it has to reach. The goal itself is not defined within the role description, but rather the processes to reach this goal. In a second step, the role is expressed in terms of the competencies an employee or department needs to execute it. Only now is a role related to an individual, an organizational unit or a department. There is an n-to-m relationship between roles and employees: An employee can have one or multiple roles, a role can be assigned to one or multiple employees up to entire departments.

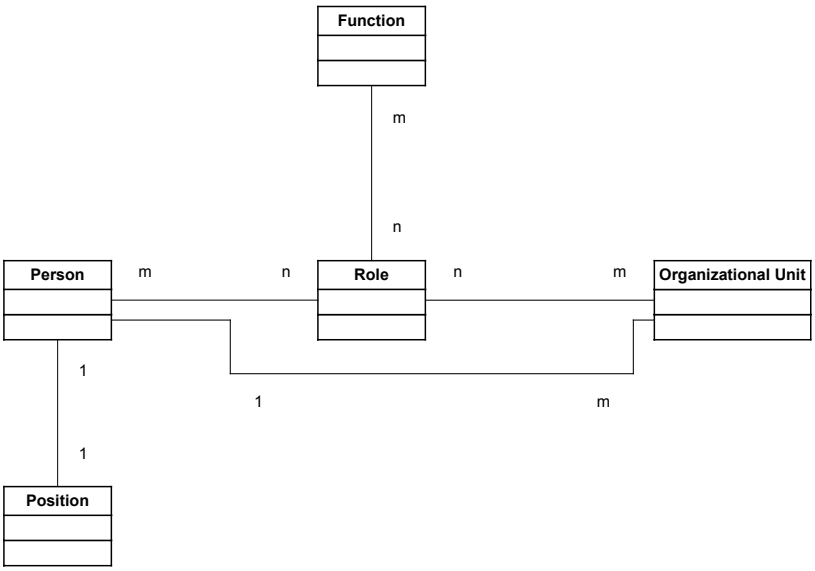

Figure 17. The meta model of a role concept

An employee, organizational unit or department occupies one or several roles. According to the roles attributed, the employee or department is provided with certain software rights. Thus, the role concept presented below may serve as a basis for the software architecture design to define user classes that group access rights to functions and data.

Based on the roles defined, the viewpoints of each player can be visualized in the form of a use case diagram. Each viewpoint is represented by a separate diagram. The diagram shows the relations between the various roles and the functions executed by the role.

5.1. Business Analyst

The business analyst is responsible for any decisions that are based on or related to financial figures and business strategy in general. In the event of a business process improvement initiative triggering a learning process, the

business analyst identifies the need for an adjustment of the business process (based on financial figures, strategic guidelines, new product/service offers etc.).

The business analyst is involved in prioritizing competency gaps by simulating the business process or manual decision-making on the most relevant competency gaps. After completion of the learning process, the analyst again takes action monitoring business process performance and analyzing the business value. The last step informs decisions on necessary business or learning process updates. The business analyst is most likely to cooperate with the process expert and the business expert.

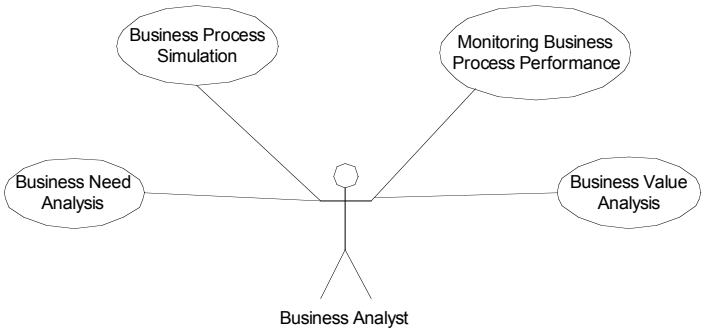

Figure 18. The major activities of the Business Analyst

5.2. Process Expert

During the business need analysis the process expert is responsible for setting up new business processes and organizational models (business blueprint) and for documenting changes in existing business process models. The process expert defines modelling conventions (e.g. definition of object types to use) and develops process management standards (e.g. standardization of business process functions) for the company.

In addition, the process expert is responsible for monitoring business process performance. As the ultimate decision-maker in business process design, the expert assists in simulating the business process and administering the business process repository. The process expert is also involved in assigning competencies to functions, adding attributes for simulation purposes, adding attribute values, and assigning roles to functions in conjunction with the business expert. The process expert is most likely to cooperate with the business analyst and the business expert.

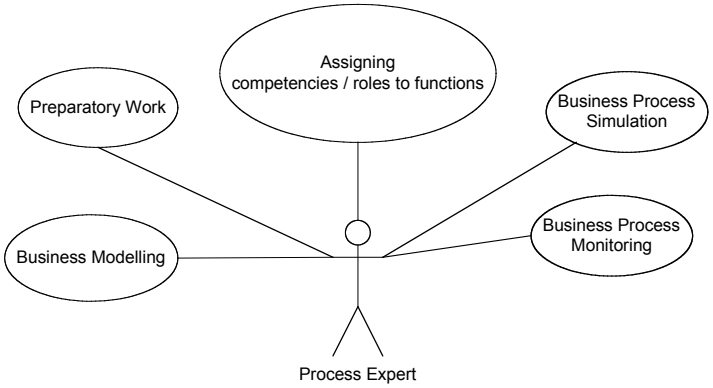

Figure 19. The major activities of the Process Expert

5.3. Business Expert

A business expert usually represents a specific department or subdivision and provides expert, day-to-day business knowledge on functions, tasks, and business requirements. (S)he is responsible for the description of job roles by assigning relevant functions and competencies to them. Therefore the business expert needs to define these competencies with the support of the human resources manager. As for the business process modelling, the business expert is also responsible for assigning competencies to functions, adding attributes for simulation purposes and assigning roles to functions. The business expert is also involved in prioritizing

competency gaps. Assisting the production of learning resources, the business expert delivers content, media material, and necessary business knowledge to the author. Other functions include: examining existing learning resources for relevance, adequateness and correctness of content and possibly assisting the instructional designer in assigning resources to learning templates. The business expert is most likely to cooperate with the business analyst, the process expert and the human resource manager as well as with the training specialist and the author.

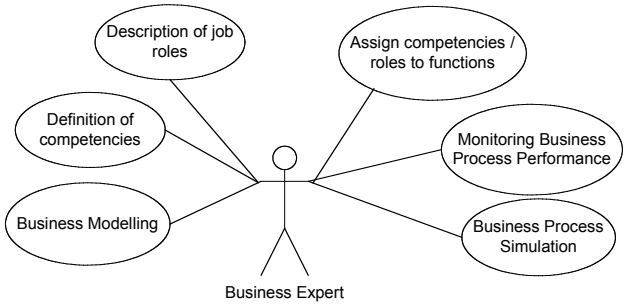

Figure 20. The major activities of the Business Expert

5.4. Human Resource Manager

The human resource manager is generally responsible for the personnel. Ranked higher than the training specialist, the HR manager's field of activity has more to do with the coordination of personnel than the ongoing servicing of various learning employees. [14]

The human resource manager is involved in the initial definition of job roles consisting of a set of functions and competences. Here, the HR manager must also support the business expert defining relevant competences. The roles are based on the required business tasks or functions that will be executed by an employee assigned to a particular job. Due to the close linkage between roles and business functions, which are organized in a timely and logical order as business processes, the human resource manager and the business expert must combine their efforts in role definition. Furthermore, employees have to be assigned to roles. This is a core functionality of human resource management closely related to internal and external staffing. In the Recruiting & Staffing (R&S) scenario described earlier, the search for suitable candidates includes external job advertisements and interviews as well as the selection of the right candidate. If training is required by compliance regulations, the HR manager is responsible for importing certified job role descriptions and required competencies.

The human resource manager manages employee master data and administers competency profiles. Other functions include the calculation of competency gaps and assistance in prioritizing them according to business needs, the search and selection of employees requiring training, and the execution of the learning process including booking employees onto courses. After completion of a learning process the HR manager updates the competency profiles of the learning employees. The HR manager is likely to cooperate closely with ALL of the other roles.

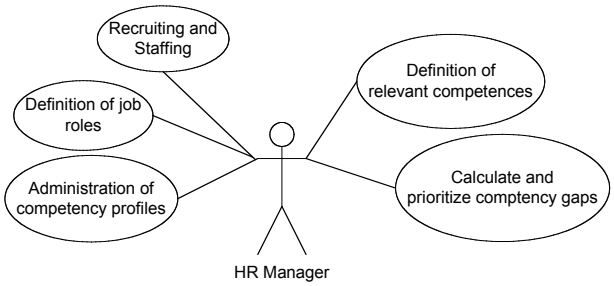

Figure 21. The major activities of the HR Manager

[14] Historically, line managers addressed performance and measured results, while learning was the domain of a dedicated training department. Today, HR professionals are increasingly involved in ensuring alignment between corporate and HR strategies by supporting line managers in moving from a short-term productivity focus to longer-term and cross-organizational issues.

5.5. Instructional Designer

The instructional designer is responsible for the design of learning scenarios to fill the prioritized competency gap and will:

- Define, create, and edit Learning Design templates and Learning Designs (IMS-LD),
- Store Learning Design templates and Learning Designs in a repository,
- Discover and retrieve Learning Design templates and Learning Designs from the repository (reuse of previous LDs),
- Examine, modify, and adapt already existing Learning Design templates and Learning Designs.

The instructional designer creates and provides Learning Design templates acting as exemplars of particular models expressed in Learning Design, as well as Learning Designs tailored for very specific needs (based on competency gaps).

The instructional designer is responsible for the design of the learning process to fill the competency gap. Functions include the examination of existing learning resources and templates for validity of content as well as for didactical aspects and choosing appropriate learning templates in IMS LD. The instructional designer will most likely cooperate with the training specialist, and sometimes maybe with the author.

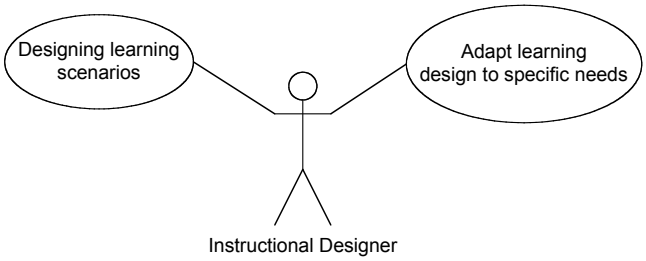

Figure 22. The major activities of the Instructional Designer

In practice, the instructional designer might also be involved in the assignment of learning courses and in their preparation. This means working closely with Authors and Training Specialists (see below) or even sometimes taking over their tasks. This extension of the instructional designer's role is based on experiences of Giunti Interactive Labs who have found that many of their clients do not distinguish clearly between the three theoretical roles described above.

5.6. Training Specialist

The training specialist mainly identifies the need for training, and plans and conducts training sessions. To generate an individual learning process, the competency deficiency (competency gap) of individual learning employees with respect to their business functions has to be calculated. Therefore the training specialist must first assess and create a consistent competency profile for each employee, based on the competency taxonomy that was defined in cooperation with the business expert and the HR manager. In addition, the competency profile for each role has to be created.

The comparison between the 'as-is' competency profile of the employee and the 'to-be' competency-profile required by the business process is mainly done by a Matching Engine, e.g., of the semantic web services type developed within the LUISA project.[15] However, the insight of the training specialist may be necessary. At the end, when the competency gaps are to be prioritized, the training specialist must provide information about training feasibility in terms of time and complexity. Since the determination of the most relevant competency gaps is based on the business process simulation, the training specialist will participate in these simulation activities led by the process expert.

The training specialist takes the Learning Designs from the instructional designer and assigns resources to them. Should no appropriate learning templates/resources be available, the training specialist creates new learning templates in IMS LD and produces learning resources, supported by the business expert and the author. The training specialist also delivers the packaged IMS Learning Design.

[15] www.luisa-project.eu

The training specialist directly supervises and supports the execution of the entire learning process, starting with its instantiation. Should the learning process need adaptation to the individual learner, the training specialist gives instructions to the instructional designer. After finishing the learning process, the training specialist calculates competency improvements based on assessment results. The learner's process performance is monitored with the aid of surveys and conclusions drawn for the learning process based on these monitoring results. As this task will also refer to business performance, the specialist will cooperate with the business analyst. This collaboration will be especially relevant for drawing conclusions from the monitoring results and for deciding on updates of learning or business processes. The training specialist will most likely cooperate with the instructional designer and the author.

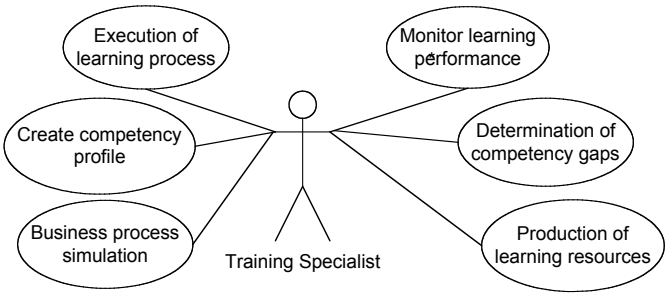

Figure 23. The major activities of the Training Specialist

5.7. Author

The author is responsible for examining existing learning resources (in cooperation with the training specialist) and for developing new learning resources, which then need to be stored in the repository. Taking input from the business experts the author edits it to fully fledged learning resources. The learning resources will be created and managed separately from the Learning Design (LD) and then need to be inserted into the LD at appropriate points. Learning resources also need to be stored in a repository. The author is assisted by the business expert, the training specialist, and by the instructional designer.

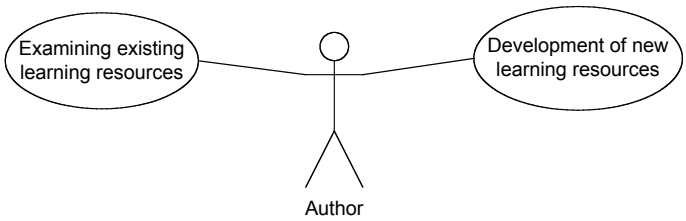

Figure 24. The major activities of the Author

5.8. Tutor

The tutor (= training provider) is only involved in the execution of the learning process (taking classroom sessions, conducting face to face training sessions, providing training material for self-study and supervising examinations). In most cases the tutor will be external. Furthermore, instead of producing new learning resources, the company may want to introduce external training material into the pool of resources to be examined by the business expert, the instructional designer, and the author. Therefore, an external training provider – providing training material - may also be involved in the examination and assignment of learning resources. The tutor will cooperate with the training specialist.

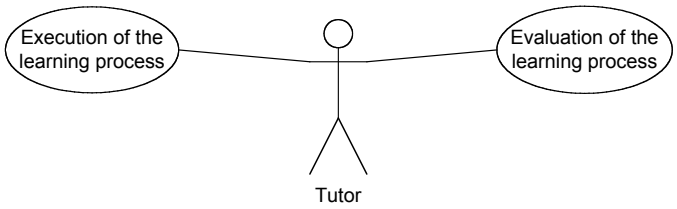

Figure 25. The major activities of the Tutor

5.9. Learner/Employee

First of all, one or more learners might book themselves onto a learning process or be booked by the HR manager. In this case the individual learning employees take centre stage for the execution of the learning process they are booked onto in order to close one or more of their competency gaps. The learner has to take tests to show how far learning has been successful, i.e. to what extent the competency gap has been closed. After the learning process is executed, the learning employee will contribute to performance monitoring by providing feedback in the form of a survey. Depending on the way their initial competency profile is assessed, individual employees may be involved in a kind of assessment centre.

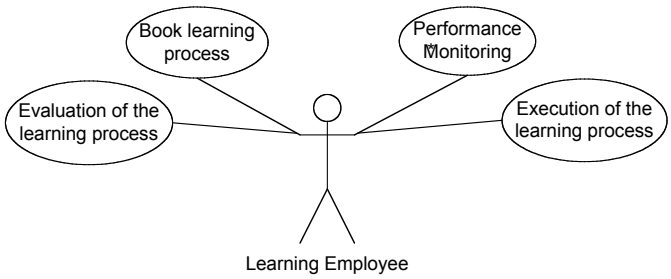

Figure 26. The major activities of the Learner/Employee

5.10. The Business Roles Ontology

The major activities of the business roles described above have been collected into a Conzilla model, which is available from the Conzilla model of the Generic Professional Learning Process Framework described in section 11. The activities of each business role is described in pop-up information on the corresponding concept, and the associations between the different business roles carry pop-up information on their common activities, as shown by the screenshot in Figure 27.

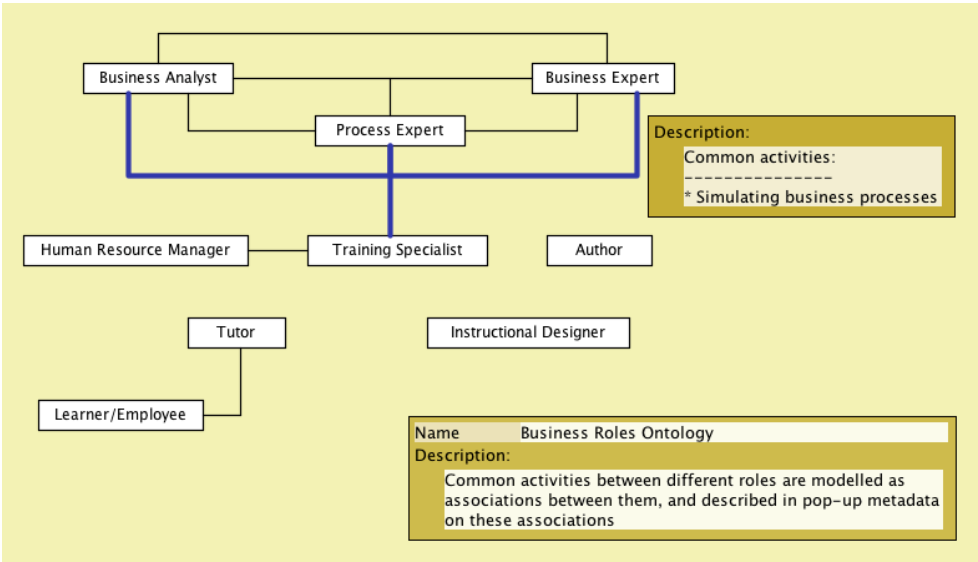

Figure 27. Business Roles Ontology (represented in Conzilla)

6. TACIT AND EXPLICIT MENTAL MODELS

6.1. What is a mental model?

According to Wikipedia, "a *mental model* is an explanation in someone's thought process for how something works in the real world. It is a kind of internal symbol or representation of external reality, hypothesized to play a major part in cognition".[16] According to the Mental Models Website [36]:

> Mental models are representations in the mind of real or imaginary situations. Scientists sometimes use the term "mental model" as a synonym for "mental representation", but it has a narrower referent in the case of the theory of thinking and reasoning. Mental models can be constructed from perception, imagination, or the comprehension of discourse. They underlie visual images, but they can also be abstract, representing situations that cannot be visualised. Each mental model represents a possibility. Mental models are akin to architects' models or to physicists' diagrams in that their structure is analogous to the structure of the situation that they represent, unlike, say, the structure of logical forms used in formal rule theories. In this respect they are a little like pictures in the "picture" theory of language described by Ludwig Wittgenstein in [86].
>
> Cognitive scientists have explored mental models and the mind generally. They have carried out an extensive programme of study on how models engender thoughts and inferences. They have studied how children develop such models, how a model of one domain may serve as an analogy for another domain, how mental models engender emotions, and how to design computer systems for which it is easy to acquire a model.
>
> Many reasoning researchers world-wide have studied the model theory of deductive reasoning. They have published more than 350 papers on mental models in reasoning. Many of these articles present experimental evidence that corroborates the predictions of the model theory of deduction, and others suggest revisions and modifications to some of the theory's tenets to accommodate new data. Critics of the model theory include proponents of alternative theories of deduction based on inference rules. The model theory is an alternative to the view that deduction depends on formal rules of inference akin to those of a logical calculus. The distinction between the two sorts of theories parallels the one in logic between proof-theoretic methods based on formal rules and model-theoretic methods based, say, on truth tables. Which psychological theory provides a better account of naive human reasoning is controversial.
>
> The controversy about whether people reason by relying on models or on inference rules has been long but fruitful: it has led to better experiments, to explicit theories implemented in computer programs, and to developments of the mental model theory of thinking and reasoning in novel domains.

6.2. The efficiency of mental models

In his remarkable book "Märk Världen" ("Notice the World") [64] Tor Nørretranders describes a number of scientific discoveries that question traditional ideas about the nature of human consciousness. The essence of his observations is that the conception of the conscious mind as the central governing unit of our thoughts and actions can no longer be upheld. The reason for this is basically that conscious information processing, which takes place in what Nørretranders calls "the I", has much too narrow bandwidth (16-30 bits per second) in order to deal with the more than 5 million bits per second of information that is constantly entering the human body through its different sense organs. In order to be "processable" by the I, this information has to be heavily compressed through pre-processing "in the background", which is performed by something Nørretranders calls "the Me". According to Nørretranders, most human activities – such as dancing and playing soccer or music - are most efficiently practiced when one is non-conscious of what one is doing, i.e., when "the I" is not interfering with the operations of "the Me". In fact, this is precisely the aim of the repetitious training of the sportsman and the musician: to internalize the corresponding skills to the point where (s)he experiences that "it is not I that am doing this – it is being done in me".[17]

Figure 28 presents a model of how we use mental models that has been taken from [54]. We are constantly creating simplified representations of the phenomena that surround us, in the form of mental models. These models enable coarse but effective predictions of the behaviour of the modelled phenomena. For example, let us

[16] The idea is believed to have originated with Kenneth Craik in his 1943 book *The Nature of Explanation* [16].

[17] According to Nørretranders, the last words of the famous Scottish mathematician and physicist James Clerk Maxwell were: "What I have thought I have not thought – it has been thought in me".

assume that you see a man coming towards you on the street. Your mental model of this phenomenon leads to a number of different expectations, such as e.g., that the man will pass you on your right side. At the same time as you are registering the man's movements through your sense impressions, you check the expectations of your model. As long as the man is moving according to your expectations, this process can iterate (loop) in the back(ground) of your mind where it is controlled by "your Me".

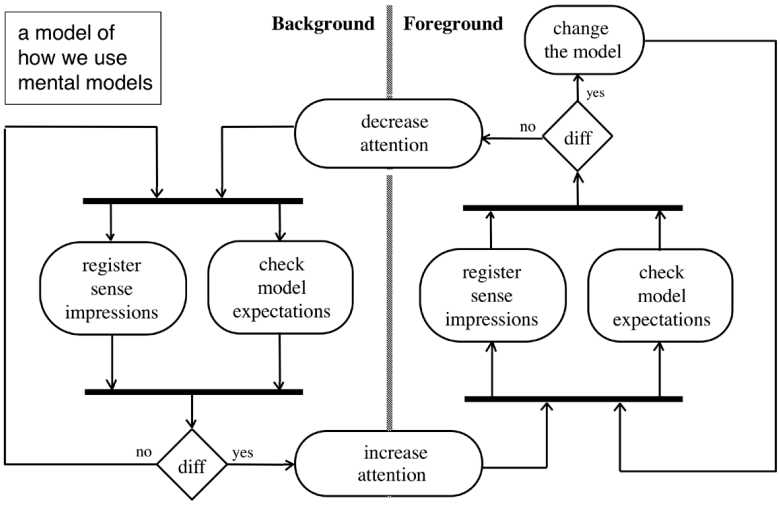

Figure 28. A model of how we use mental models (Source [54])

However, if you experience a difference (diff) between your sense impressions and your model expectations, then you are forced to increase your attention, externalize the model, and carry out the control in the foreground of your mind, under the control of "your I". Now, if it turns out that it was a case of "false alarm", then you can decrease your attention again, and let the control of the process return to "your Me". But if the difference survives your conscious comparison process, then you must update your mental model of how the man is moving, in order to avoid a collision. And finally, when your sense impressions coincide with the expectations of your updated model of the man's motion, then "your I" can release control of the comparison process and delegate it to "your Me", where it does not require so much bandwidth. The new model has been learned and integrated into your subconscious assumptions.

6.3. Tacit and Explicit Mental Models

In this deliverable we will adopt Polanyi's terminology [69] and introduce the difference between *tacit* and *explicit* mental models. By *explicit mental models* we mean mental models that have been explicitly formulated in such a way that they can be communicated to others, e.g., in words or diagrams. By *tacit mental models* we mean mental models that are so taken for granted that they have become ingrained and embedded in our "mental background" and hence are invisible on the conscious (explicit) level. In the foreground/background example of the last section, we can regard the "foreground mental model" as explicit and the "background mental model" as tacit. As the example illustrates, our tacit mental models help us to filter the multitude of impressions that bombard our senses and focus on what is essential by disregarding what is unessential. The power of thinking lies in knowing what not to think about, and tacit mental models help us to know this without even having to think about it.

Mental models, as described in section 6.1 would be classified as tacit. Peter Senge [74] also uses mental models in the tacit sense when he describes them as "deeply ingrained assumptions, generalizations, or even pictures or images that influence how we understand the world and how we take action". According to Senge:

> The discipline of working with mental models starts with turning the mirror inward; learning to unearth our internal pictures of the world, to bring them to the surface and hold them rigorously to scrutiny. It also includes the ability to carry on "learningful" conversations that balance inquiry and advocacy, where people expose their own thinking effectively and make that thinking open to the influence of others.

As discussed below in section 8.4, what Chris Argyris defines as "double-loop learning", involves transforming tacit mental models to explicit mental models by externalizing them, updating the externalized models according to the "lessons-to-be-learned", and finally internalizing the updated models in order to handle the bandwidth problem of the conscious thinking process.

7. SECI-BASED WORK PROCESSES

7.1. The SECI Process Framework of PROLEARN D5.3

In PROLEARN Deliverable 5.3 ([58]) we combined learning-process modelling with the SECI theory of knowledge creation ([60], [61], [62], [63]) and created a *SECI process framework* (*abstract model*) for the description and classification of knowledge-creating learning processes. That deliverable also discussed the use within SECI of the Japanese philosophical concept of *Ba*, a construct that relates to various elements of "place" or perhaps "context". In Figure 29 we see the four different kinds of ba, as well as their corresponding tools of support. *Socialization* occurs in *originating ba*, where *experiencing* and *empathizing* activities are supported by *community building tools*. *Externalization* occurs in *dialoguing ba*, where *articulating* and *conceptualizing* activities are promoted by *discussion supporting tools*. *Combination* occurs in *systemizing ba*, where *connecting* and *deducing* activities are supported by *conceptual modelling tools*. *Internalization* occurs in *exercising ba*, where *reflecting* and *embodying* activities are supported by *reflective analysis tools*.

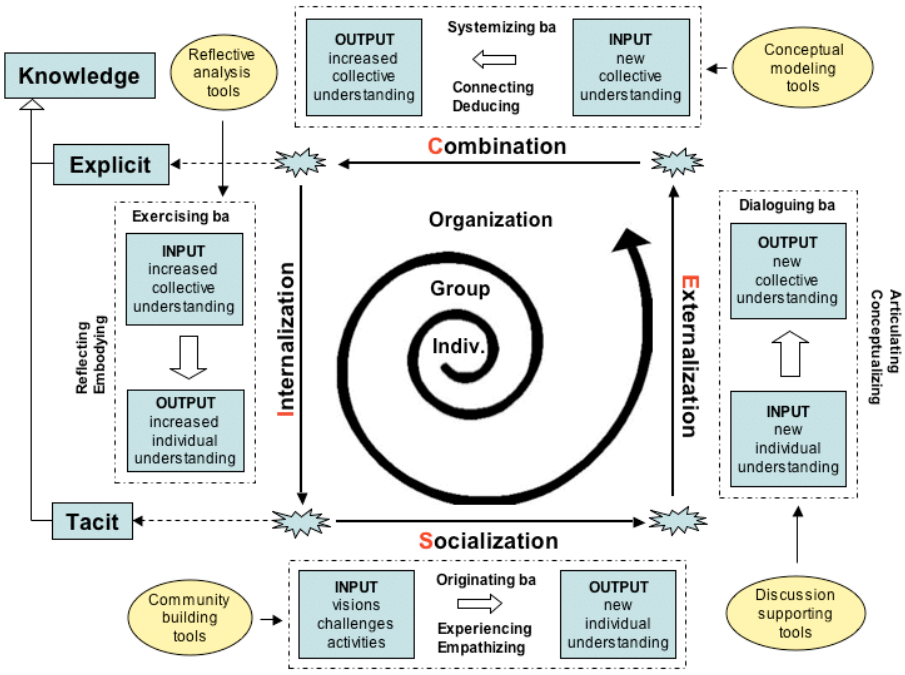

Figure 29. The SECI process framework: increasing understanding through experiencing, articulating, deducing and reflecting. (Source: PROLEARN D5.3)

In each of the four SECI knowledge conversion stages a learning process takes place. As shown in Figure 29, sharing experiences in the socialization process, with input from *visions*, *challenges* and *activities*, produces *new individual understanding* of the issues at stake. This new individual understanding is then externalized and articulated into *new collective understanding* of the same issues. Then the combination process deductively produces *increased collective understanding*, which is then internalized by reflection and embodied into *increased individual understanding*.

As described in D5.3, our original intention for this deliverable (D1.10) was to use this SECI process framework as a basis for describing and categorizing knowledge-creating processes in the workplace. However, during the work with doing this, we have run into two basic problems:

1) The division between knowledge creating and knowledge transmitting processes described in D5.3 is not a fixed division. Instead it represents two different “execution states” that a work process can be in. Other such execution states are described in Figure 30.

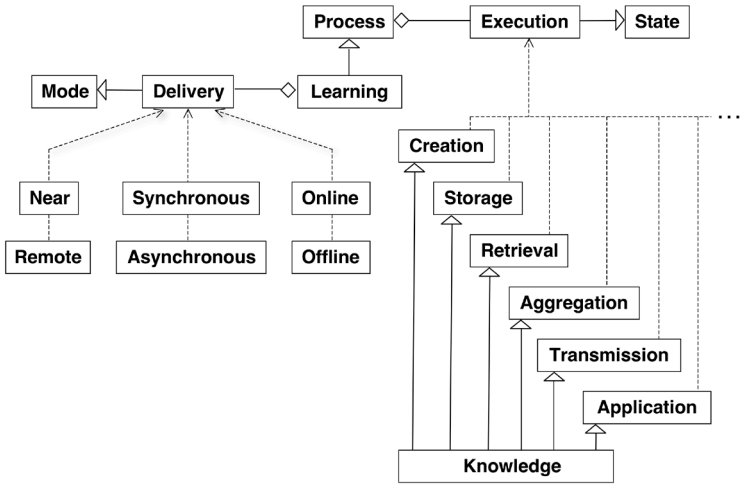

Figure 30. Different execution states and delivery modes of a learning process

2) The linearity of the SECI model is not well adjusted to describing what is actually going on in knowledge creation. Nonaka, Toyama and Konno [63] acknowledge this problem when they describe the knowledge creating process as a collection of intertwined SECI spirals of various sizes that interact with each other. Figure 31 (taken from [63]) shows the way they depict the SECI-based interaction between the individual and the group level.

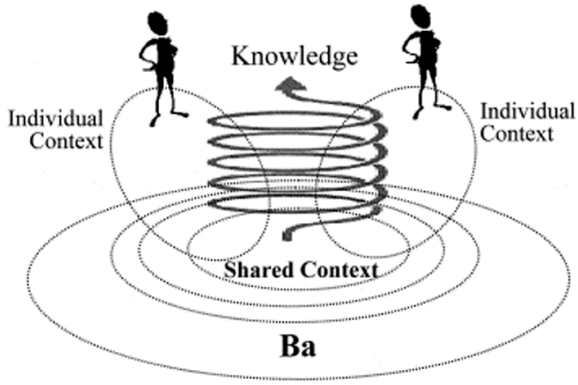

Figure 31. The interaction of SECI spirals at different levels according to Nonaka, Toyama and Konno [63]: Original caption: "Ba as shared context in motion" (Figure 5 in [63]).

In this deliverable, we will deal mainly with the second problem. We will focus on a SECI-based description of work processes and introduce some semantics that models the input, output, aims, controls, support and effects of these work processes at the individual/group/organizational level. It is important to emphasize that this will be done in a completely "learning neutral" way. Then we will introduce a "learning lens" by applying the Schön-Argyris framework of single and double loop learning [6] - as described by Kim in [38] - to these work processes.

7.2. A SECI-based recursive model of organizational inter-intra action

Figure 32 shows a different SECI-based way to model the communication process at two different organizational levels, called *intra* and *inter*. An important aspect of this model is that it applies to communication across any boundary level of an organization, as well as between different organizations. For example, the intra-level could refer to two individuals communicating at the inter-individual (= group) level, or two groups communicating at the inter-group (= department- or organizational) level, etc.

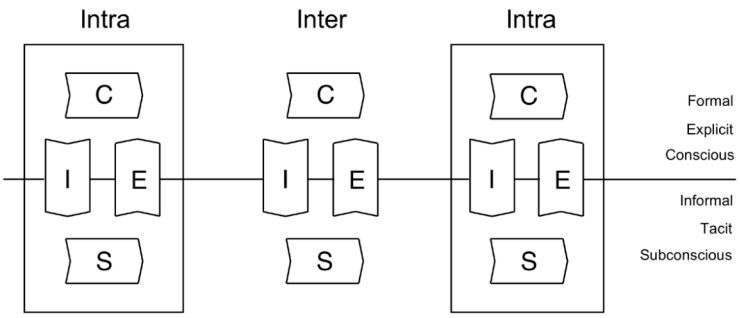

Figure 32. SECI-based inter- and intra-action processes

Note that the SECI spiral has been modified in such a way that the S- and C-parts (Socialization and Communication) are going on *in parallel*, while the I- and E-parts (Internalization and Externalization) are feeding information back and forth between the explicit (= formal = conscious) and tacit (= informal = subconscious) knowledge levels. Moreover, the intended semantics of the model is that also the I- and E-parts are considered to be going on in parallel. This is shown more clearly by the notation, which is introduced in Figure 33.

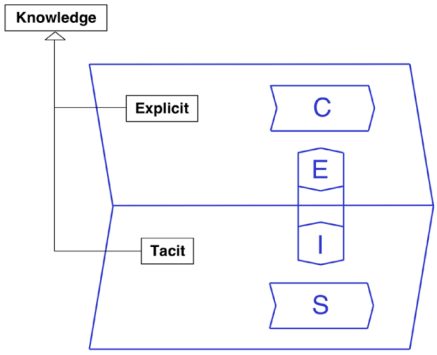

Figure 33. In the modified SECI model, Combination and Socialization correspond to the explicit-tacit / formal-informal / conscious-subconscious parts of a process. The C- and S- parts run in parallel, and so do the I- and E-parts.

In Figure 34 we make use of the Astrakan process modelling semantics (Figure 5) in order to model the interaction between two groups within the same organization. The vertical (dotted) lines refer to the *environmental interfaces* of the groups / organization, while the horizontal lines refer to the *cultures* (= meaning and memory) of the groups respectively the organization. These cultures represent the shared mental models ("world view") and routines ("the way we do things") within the organization respectively within the groups ([31], [74]). As described below (Figure 37), the filled dots refer to major (= responsible) stakeholders, while the unfilled dots refer to minor (= non-responsible) stakeholders.[18]

Hence the interpretation of the model of Figure 34 is that the group to the left is driven mainly by some overall organizational goals and to a lesser extent by its own group-specific goals, while the opposite is true for the group to the right. Also, the left group is drawing its main support for its actions from the organizational culture, while the right group is drawing its main support from within its own group culture. Hence, the model implies that the left group is acting more for the overall benefit of the organization, while the right group is acting more in its own self-interest.

[18] This represents an extension of the Astrakan™ process modelling semantics introduced by Naeve in [57].

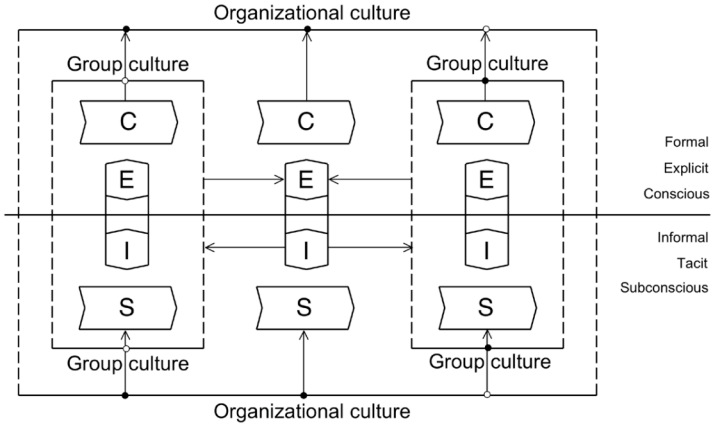

Figure 34. A modified SECI model of an "unselfish" and a "selfish" group interacting within the same organization.

There is an aspect of this model that requires some clarification. Although only individuals are capable of internalization and externalization, these processes can take place in different contexts (at different levels). The E- and I-parts in the centre of Figure 34 represent what is externalized and internalized (by individuals) at the inter-group level, e.g., in a meeting between the two groups. The left and right E- and I-parts represent what is externalized and internalized at the intra-group level (by individuals) in meetings within each separate group. The horizontal arrows between the E-parts indicate that what is externalized at the meeting depends on what has been externalized by each separate group before the meeting, i.e., what each group has discussed in advance and decided to express at the meeting. The horizontal arrows at the I-level indicate that although some internalization goes on at the meeting, each group also brings back "something to think about" from the meeting.

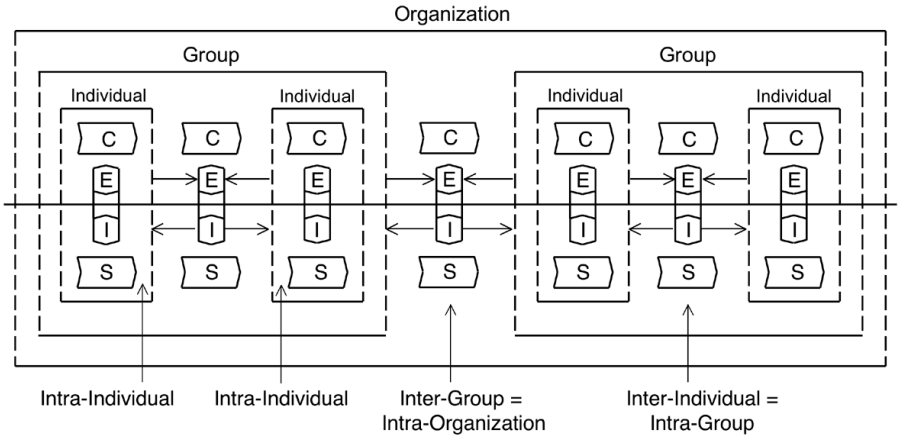

Figure 35. Individual , Group, and Organizational level of the de-linearized SECI model

As mentioned above, a great merit of the de-linearized SECI model is that it applies recursively to intra- and inter-actions at any level. In Figure 35 we have expressed these actions at three different levels, the individual level, the group level and the organizational level.

7.3. Simplifying the notation of the modified SECI model

It is also important to note that the model allows for socialization and combination to go on within a single individual. This makes it easier to handle refinement of ideas that take place in solitude.

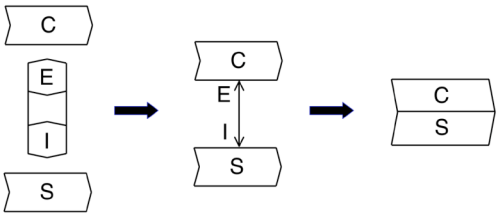

Figure 36. Simplified notation for the modified SECI model

Having established a precise notation for the modified SECI-model, a simplification will now be introduced in order to allow us to concentrate on the elements of interest. It is often desirable to suppress the E- and I-parts of a process and focus on the C- and S-parts. In a work process there is always a formal part, which represents the production of some product or service, and an informal part, which represents the supporting context within which the formal production process takes place.

Figure 36 displays this simplified notation. The basic idea is to divide the traditional "process fish" into two parts, and let the upper (C) part represent the formal (explicit) part of the process and the lower (S) part represent its supporting informal (tacit) part. The E- and I-parts are assumed to go on during the entire C/S process and to transform knowledge between the tacit and explicit levels whenever this is needed.

Combining this notation with that of the Astrakan process modelling technique (Figure 4), we arrive at the notation displayed in Figure 37. Here there are six different types of arrows, connected with each of the two process levels, making a total of 12 different possible "arrow semantics".

• Formal/informal *aim* (= *goal*) arrows that point *from the top* of the formal/informal part of the process fish.
• Formal/informal *control* arrows that point *to the top* of the formal/informal part of the process fish.
• Formal/informal *support* arrows that point *to the bottom* of the formal/informal part of the process fish.
• Formal/informal *effect* arrows that point *from the bottom* of the formal/informal part of the process fish.
• Formal/informal *input* arrows that point *into the tail* of the formal/informal part of the process fish.
• Formal/informal *output* arrows that point *from the head* of the formal/informal part of the process fish.

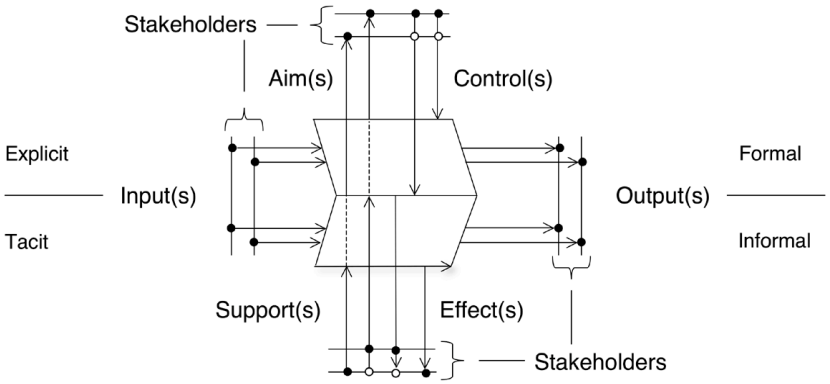

Figure 37. Input/Output, Aims/Controls and Support/Effects of the Formal/Informal part of a Process. The filled dots refer to major (= responsible) stakeholders, while the unfilled dots refer to minor (= non-responsible) stakeholders.

The stakeholders are represented by line segments and connected to their corresponding "stake-items" (= items of interest) by filled and unfilled dots respectively. As remarked above, a filled dot indicates *responsibility* (= the main stake) while an unfilled dot indicates a *shared interest* (= a co-stake).

7.4. The conferencing process as an example of formal/informal process modelling

In order to demonstrate the semantic power of this type of modelling, let us consider a model of the conferencing process, the top level of which is displayed in Figure 38. On this level, the model involves three different stakeholders: the conference organizer, the venue provider, and the academic institutions to which the participants are affiliated.[19] The model shows that the conference organizer is responsible for the (conference) program, which supports the formal part of the conferencing process, while the venue provider is responsible for the space and the food, which supports the informal part of the conferencing process. All these supports have goals, which are connected to the corresponding supports by dotted lines.

[19] At more detailed levels, the academic institutions would of course be split up and modelled individually.

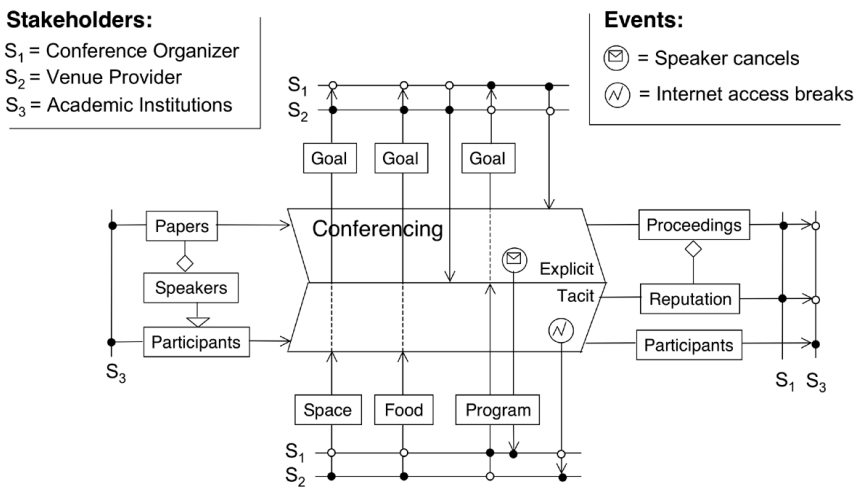

Figure 38. The formal and informal part of the conferencing process

Participants – affiliated with academic institutions - are modelled as input and output to the informal part of the conferencing process, which means that they are considered to be refined during the process (see Figure 5). Some of the participants are speakers, which have papers. These papers are modelled as input to the formal part of the conferencing process, where they are refined and output in the form of (conference) proceedings. Moreover, the proceedings have a reputation, which is modelled as an output of the informal part of the conferencing process.

In Figure 38 two kinds of events are modelled in standard BPMN (Business Process Modelling Notation). The message-driven event "speaker cancels" has an effect on the program, which has to be changed. This is the responsibility of the conference organizer. Note that the venue provider does not care about this, although there is probably going to be one person less for lunch and/or dinner. This reflects the granularity level of the model. The interruption event "internet connection breaks" affects the venue provider, who is responsible for the functionality of the conference space. Note that the conference provider has an interest in fixing this problem, since if it remains unfixed, this will reflect badly on the reputation of the conference.[20]

7.5. A process model of the inter-intra-actions at the group level

The model presented in Figure 34 does not include a temporal dimension of the inter-intra-actions within an organization. If it is desirable to focus on the temporal flow of inter-intra-actions, different forms of dynamic modelling can be used.

In Figure 39 we present an Astrakan-style process model of how an inter-intra-action at the group level could actually take place. The group to the left (G1) has been entrusted with carrying out some task on behalf of the organization. As shown by the filled dots on the goal-, and control-arrow from/to the *Act* process, the group goals and agendas of G1 are strongly synchronized with the corresponding organizational goals and agendas, which means that G1 is committed to the overall organizational goals and has the formal means to carry them out in an effective manner. The G1 action process produces a *Result*, which is input to *React* processes from other groups in the organization. The output of these React processes is a *Response* from each reacting group, and the Result together with its Responses serve as input to a *Reflect* process carried out by G1, supported by strongly aligned (mutually reinforcing) group and organizational cultural values.

The output of this Reflect process is an *Updated Result*, which is then critically examined to find out if it is *Good enough*. If the answer is "no", then the Act, React, Reflect loop is repeated until the answer is "yes". Then the group G1 decides whether or not to *Export* the Updated Result to the rest of the organization. If the answer is "no, then the Updated Result is stored in the G1 group culture, and if the answer is "yes" – which it would be in this case, since the initial request for the task came from the higher (organizational) level – the Updated Result is "externalized" (i.e., it passes the *G1 environmental interface*) and becomes the input of a *Dissemination* process, which is supported by the other groups, and results in (outputs) a "strong update" (filled dot) of the organizational culture.

[20] Note that the last statement is not explicitly modelled in the figure.

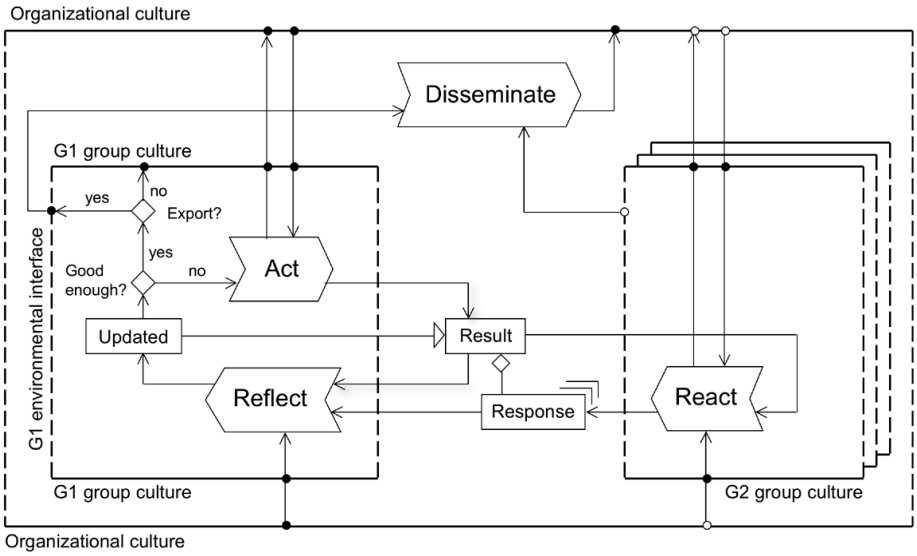

Figure 39. A process model of some inter-intra-actions at the group level

Note that the support of the G2 group is weak (unfilled externalization dot), which is consistent with the fact that G2 is modelled as an autonomous (and possibly rebellious) group, which pursues its own selfish goals, is controlled by its own independent agendas and is supported by its own independent group culture.

8. LEARNING@WORK - APPLYING THE LEARNING LENS TO THE WORK PROCESSES

8.1. The Wheel of Learning

In his book "The Age of Unreason" [34], Charles Handy introduces a theory of experiential learning, based on ideas from Dewey, Kolb, Revans, Illich, and others. In Handy's own words ([34], pp. 46-48):

> It is best, I realized, to think of learning as a wheel divided into four parts
>
> QUESTION ----- > THEORY ------- > TEST ------- > REFLECTION ---- > QUESTION --- > …
>
> I draw a wheel to emphasize that it is meant to go round and round. One set of questions, duly answered and tested and reflected upon, leads on to another. It is life's special treadmill. Step off it and you ossify, and become a bore to others. The trouble is that for most of us for much of the time the wheel does not go round. It gets stuck or blocked.
>
> Mankind, I am sure, is born to learn. One has only to look at little children to see that wheel turning furiously. Why, we must wonder, does it slow down for most of us as we grow older? If we knew more about that we would know more about our reluctance to change and the consequent need for crisis and calamity to budge us into action.
>
> Logically, the wheel starts with a *question*, a problem to be solved, a dilemma to be resolved, a challenge to meet. If it doesn't start there, and if it is not our question, we shall not push the wheel around to the stage of Reflection. It won't become part of us.
>
> Questions need possible answers. The next stage provides them. *Theories* is too grand a term. I use it only to emphasize that this stage is investigating *possible* ideas. It is a stage of speculation, of free-thinking, of re-framing, of looking for clues.
>
> Ideas and Theories can never be enough. At this stage of the wheel all is still fancy. "Dreams" as my children used to remind me, "give wings to fools". The theories have to be *tested* in reality, the next stage of the wheel. Some will work, some won't. […]
>
> Until I know why, which is the stage of *Reflection*, the final stage, I will not have learnt. Change only sticks when we understand why it happened. Too often have I invited chief executives to explain their philosophy only to listen to a bare record of their achievements, with no interpretation, no theory to

explain them, no philosophy expounded. Such men have not changed and will not change. They have learnt nothing from their success which makes it unlikely that they will be able to repeat it.

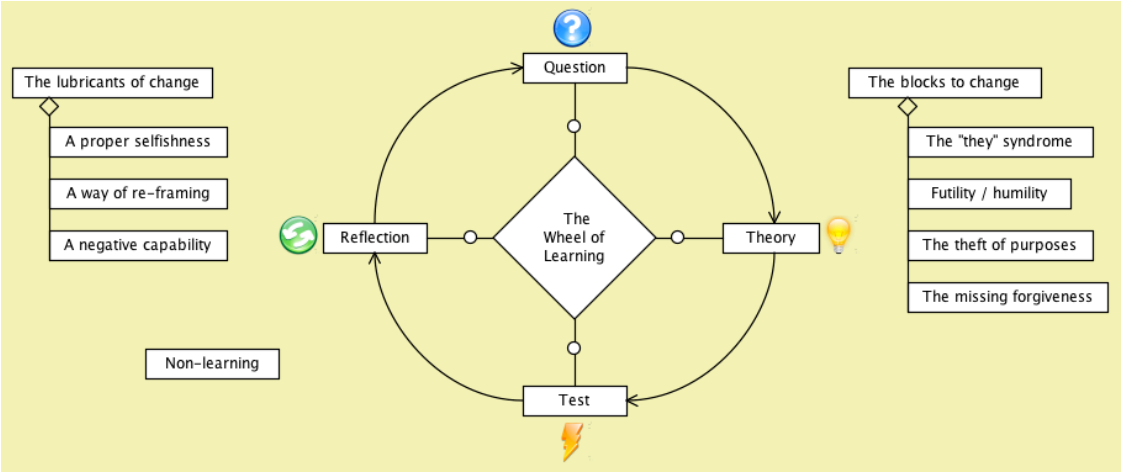

Figure 40. A Conzilla map of Handy's theory of learning

Figure 40 shows a Conzilla map that summarizes Handy's theory of learning. Under the titles of "Lubricants of Change", and "Blocks to Change, he discusses which structures that most often stop (or block) the wheel of learning, and what can be done (lubricants) in order to get it moving again.

To Handy, learning is experiential and synonymous with personal change. In order to differentiate his use of the term learning from more traditional uses, he explicitly lists what learning (in his sense) is not ([34], p. 50):

> Most of the time, most of us do not go through all the four segments of this wheel. I describe it here to emphasize how difficult true learning is and why the sort of deliberate change that goes on with learning is so rare. This sort of learning, the one from experience and life, is the one that matters if we are to change. It is not to be confused with more trivial definitions of learning:
>
> • Learning is *not* just knowing the answers. That is Mastermind learning at its best, rote learning at its most boring and conditioned response at its most basic. It does not help you to change or to grow, it does not move the wheel.
>
> • Learning is *not* the same as study, nor the same as training. It is bigger than both. It is a cast of mind, a habit of life, a way of thinking about things, a way of growing.
>
> • Learning is *not* measured by examinations, which usually only test the Theory stage, but only by a growing experience, an experience understood and tested.
>
> • Learning is *not* automatic, it requires energy, thought, courage and support. It is easy to give up on it, to relax and to rest on one's experience, but that is to cease to grow.
>
> • Learning is *not* only for the intellectuals, who often shine at the thinking stage, but are incurious and unadventurous and therefore add little to their experience as they go through life.
>
> • Learning is *not* finding out what other people already know, but is solving our own problems for our own purposes, by questioning, thinking and testing until the solution is a new part of our life.

8.2. The Learning Organization

Today there is wide consensus about the strategic necessity for "organizational learning" in order to adapt and survive in the rapidly changing and evolving markets. In his award-winning book "The Fifth Discipline" [74], Peter Senge describes five different disciplines that must be cultivated in order to effectively build a learning organization. They are (1) personal mastery, (2) mental modelling, (3) building shared vision, (4) team learning, and (5) systems thinking.

• *Personal mastery* is concerned with learning how to cultivate the creative tension between vision and reality.
• *Mental modelling* aims at developing awareness of the attitudes and perceptions that influence our thoughts and interactions.

• *Building shared vision* focuses on creating mutual purpose by nourishing a sense of commitment in a group or organization and by developing shared images of the desired future.
• *Team learning* helps to transform a team's collective thinking, and mobilize its energies and abilities into something greater than the sum of the individual members' talents.
• *Systems thinking* focuses on complex interdependencies and changes in order to deal more effectively with the forces that shape the consequences of our actions.

According to Senge, an individual's actions are supported by his/her personal mental models, which consist of conscious and subconscious assumptions, attitudes, and perceptions. Senge emphasizes the importance of mental modelling, which aims at surfacing the subconscious parts of these structures in order to make them amenable for change.

Within the knowledge management field it is widely recognized that the same is true for organizations ([19], [31], [77], [79]). As discussed in section 2, the collective behaviour of an organization is heavily influenced by its "organizational culture", which encompasses the shared mental models of the organization and codifies "the way we do things around here". The organizational culture contains both explicit and implicit parts, ranging from war stories to dress codes and knowledge about what is discussable or not in different contexts.

8.3. The Caring Organization

Learning organizations want everyone to learn always, and bend over backwards to make that obvious. According to Charles Handy [34], one of the principal blocks to effective learning is the lack of forgiveness, which is linked to the lack of care for the individual that is predominant in most organizations. In the words of Handy ([34], p. 184):

> Care is not a word to be found in many organizational textbooks, or in books on learning theory, but it should be. Forgiveness is not easy without that unconditional positive regard of the the sort we feel for our children, no matter how much we disapprove of their behavior. People do not take risks with those they do not trust or genuinely care for. […] A culture of exitement, of question and experiment, of exploitation and adventure cannot survive under a reign of fear. That kind of culture cannot be imposed, it can only be encouraged by demonstrations of warmth for all that is good, by celebration, by investment in individuals beyond the bounds of prudence. That kind of encouragement is only possible if one genuinely cares for the people being encouraged.

The blocks to change can be quite effective. Organizations know them well and make efficient use of them. Rosabeth Moss Kanter studied a range of large American corporations and reported her findings in the book *The Change Masters* [53]. She came up with the following ten commonly applied rules to stifle initiative:[21]

Rule 1: Regard any new idea from below with suspicion - because it is new and because it is from below.
Rule 2: Insist that people who need your approval to act first go through several other levels of management to get their signatures.
Rule 3: Ask departments or individuals to challenge and criticize each other's proposals.
Rule 4: Express your criticisms freely and withhold your praise. That keeps people on their toes. Let them know they can be fired at any time.
Rule 5: Treat problems as a sign of failure.
Rule 6: Control everything carefully. Count anything that can be counted.
Rule 7: Make decisions to reorganize or change policies in secret and spring them on people unexpectedly (that also keeps them on their toes).
Rule 8: Make sure that any request for information is fully justified and that it isn't distributed too freely (you don't want data to fall into the wrong hands).
Rule 9: Assign to lower-level managers, in the name of delegation and participation, responsibility for figuring out how to cut back, lay off or move people around.
Rule 10: Above all, never forget that you, the higher-ups, already know everything important about this business.

[21] See also [7] and [21] for interesting discussions on related subjects.

8.4. Single- and double-loop learning

The terms *single-loop learning* and *double-loop learning* were introduced by Chris Argyris ([5], [6]) in order to deal with the difference between learning that does not change the underlying mental models of the learner but merely revises their application scenarios (single-loop), and learning which does affect such changes (double-loop). In his excellent article "Teaching Smart People How to Learn" ([4]), Argyris argues that most people define learning too narrowly as mere "problem solving", so they focus on identifying and correcting errors in the external environment. This is what Argyris calls single-loop learning. But, in the words of Argyris:

> If learning is to persist, managers and employees must also look inward. They need to reflect critically on their own behavior, identify the ways they often inadvertently contribute to the organization's problems, and then change how they act. In particular, they must learn how the very way in which they go about defining and solving problems can be a source of problems in its own right.

This deeper form of learning is what Argyris' terms "double-loop learning". In [4], Argyris claims that highly skilled professionals are frequently very good at single-loop learning:

> After all, they have spent much of their lives acquiring academic credentials, mastering one or a number of intellectual disciplines, and applying those disciplines to solve real world problems. But, ironically, this very fact helps explain why professionals are often so bad at double-loop learning. Put simply, because many professionals are almost always successful in what they do, they rarely experience failure. And because they have rarely failed, they have never learned how to learn from failure. So whenever their single-loop learning strategies go wrong, they become defensive, screen out criticism, and put the blame on anyone and everyone but themselves. In short, their ability to learn shuts down precisely at the moment they need it the most.

Since organizations consist of professionals, Argyris has pinpointed a major problem in organizational learning. Moreover, this problem is reinforced by the prevailing reward structure of the "expert culture", which not only encourages single-loop learning, but also actively discourages double-loop learning, since the latter involves admitting mistakes.

8.5. Learning Categories and Learning Strategies

The initial point of Peter Senge's approach to organizational learning (as described in section 8.2) is the need of organizations to adapt in evolving environments. From this need he derives disciplines that have to be cultivated to effectively build a learning organization. In this section a somewhat different approach to organizational learning will be taken. Here, learning will be looked at from the point of view of cognitive psychology, and then conclusions for learning processes at work will be drawn.

Learning Categories

Since the middle of the last century, psychologists have developed cognitive classifications of learning processes and methods to successfully apply learning processes in different learning settings. One of the most applied approaches in this domain is Bloom's Taxonomy [9] that was originally published in 1956, and which has since been established as a standard.

Bloom's Taxonomy provides a hierarchical classification of learning processes in the following six categories: Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation. Bloom's taxonomy has been revisited by Lorin Anderson [1] to adapt it to the development of pedagogy and to the requirements of learning in a knowledge-based society. As the main categories Anderson proposed Remembering, Understanding, Applying, Analyzing, Evaluating and Creating. The change from nouns to verbs reflects that learning and thinking should be regarded as activities. Furthermore, the "knowledge" category was renamed, because knowledge is a product of thinking and therefore is not suitable to describe a category of thinking. Thus, "knowledge" was replaced with "remembering".

As Anderson's changes to Bloom's taxonomy are widely accepted in educational research and practice, we will make use of Anderson's set of categories in this deliverable. To illustrate the pedagogical value of Anderson's categories, they will be described in detail, giving exemplary activities for each category.

Category	Keywords	Examples
Remembering (Can the learner RECALL information?)	Recognising, listing, describing, retrieving, naming, finding, memorising, reproducing.	Recite a policy. Quote prices from memory to a customer. Name the safety rules.
Understanding (Can the learner EXPLAIN ideas or concepts?)	Interpreting, summarising, paraphrasing, classifying, explaining, generalizing, exemplifying.	Explain in one's own words the actions of a character in a story. Devise examples for quadratic equations that have no real solutions.
Applying (Can the learner USE information in another familiar situation?)	Implementing, carrying out, using, executing.	Use a manual to calculate an employee's vacation time. Apply laws of statistics to evaluate the reliability of a written test.
Analysing (Can the learner DIFFERENTIATE between constituent parts?)	Comparing, organising, deconstructing, attributing, outlining, finding, structuring, integrating.	Classify the actions of the characters in a story. Compare the graphical and the analytical representation of quadratic equations.
Evaluating (Can the learner JUSTIFY a decision or course of action?)	Checking, hypothesizing, critiquing, justifying, experimenting, judging, testing, detecting, monitoring, contrasting.	Evaluate a character's actions in a story. Select and justify the most effective solution. Judge the qualification of the candidates.
Creating (Can the learner GENERATE new ideas, products, or ways of viewing things?)	Designing, constructing, planning, producing, inventing, devising, making.	Write about your feelings about a character's actions in a story. Design a machine to perform a specific task.

As the categories and the keywords describing them are generic, the taxonomy can be applied to most learning settings and can be helpful for authors of learning materials, for teachers and for learners themselves, in order to create awareness of the desired categories of learning.

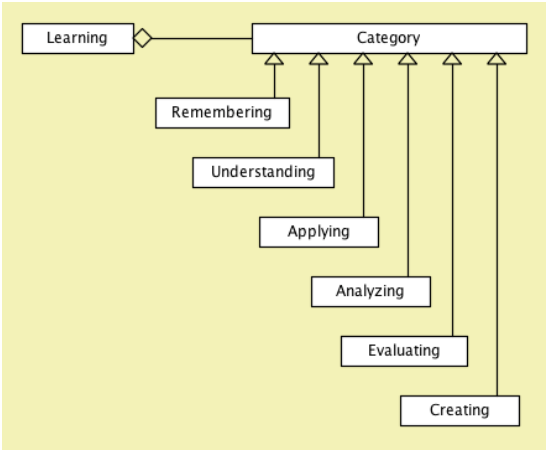

Figure 41. Anderson's Learning Categories

Learning Strategies
Weinstein and Mayer [84] and McKeachie [50] proposed a taxonomy that encompasses the cognitive, meta-cognitive and resource management strategies for successful learning. This taxonomy has since been prevalently used in various domains; e.g. for teaching learners how to learn or for evaluating the learning capability of persons. An overview of the learning strategies according to McKeachie is given in the following table.

Cognitive Strategies (Strategies that help learners to actively process information and structure this information into memory)	Rehearsal Strategies. Elaboration Strategies. Organizational Strategies.
Meta-cognitive Strategies (Strategies that help learners to self-regulate their learning)	Planning Strategies. Monitoring Strategies. Regulating Strategies.
Resource Management Strategies (Strategies that concern the quality and quantity of the task involvement)	Time Management. Study Environment Management. Effort Management. Support from others.

A UML model of these learning strategies is shown in Figure 42.

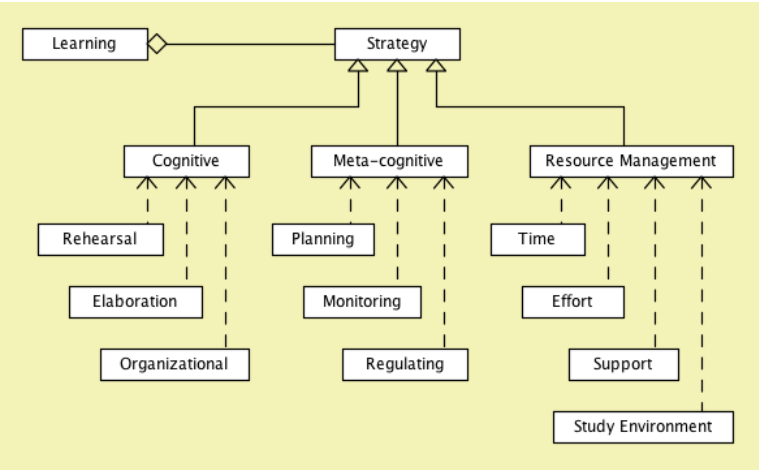

Figure 42. McKeachie's Learning Strategies

To completely elaborate and evaluate the whole set of learning strategies is beyond the scope of this deliverable. Instead, a short description and some examples are provided in the table below.

Explanation of the strategies	**Examples**
Rehearsal Strategies Help the learner to remember material using repetition.	Repeating the material aloud. Copying material. Underlining. Mnemonic hooks.
Elaboration Strategies Help the learner to connect what is currently being learned and previous knowledge.	Paraphrasing. Summarizing. Finding examples. Creating analogies. Generalizing.
Organizational Strategies Support the learner in organizing the information she learns.	Selecting the main idea. Diagramming the information. Classifying

Planning Strategies Help the learner to set goals and to structure their learning.	Setting goals. Skimming material. Generating questions.
Monitoring and Regulating Strategies Help the learner to check themselves for knowledge or skills.	Checking attention-focus. Employing test-taking tactics. Adjusting reading rate. Re-reading.
Time Management Helps the learners to organize their learning with respect to time.	Scheduling (daily ritual, weekly pattern).
Study-environment Management Helps the learners to develop a setting that is conducive to learning.	Designing a quiet and organized study-environment.
Effort Management Helps the learner to control the effort for learning.	Persisting. Self-motivating with incentives. Self-reinforcing.
Support from others Helps the learner to seek support from peer learners or from instructors.	Establishing a learning group. Maintaining a learning group. Contact the instructor regularly.

Several studies have confirmed that the use of learning strategies enhances the effectiveness and efficiency of learning, though in different degrees.[22]

Usability Guidelines for Individual and Organizational Learning
The relations between learning categories, learning strategies and Peter Senge's concept of personal mastery can be described as *effectiveness, efficiency* and *satisfaction*. This will now be elaborated in detail.

The learning categories are a valuable instrument for measuring and improving the *effectiveness* of learning. For example, new knowledge that has only been remembered and understood (the first two categories) is worthless for organizational learning. What's missing is at least applying the new knowledge. Without such application, this knowledge is almost non-existent from the viewpoint of the organization and will soon be forgotten again by the individual learner. Hence, for the learning of new knowledge to be *effective,* it should ideally be assimilated in all the six categories described above.

The learning strategies are helpful for improving the *efficiency* of learning. Applying the cognitive, meta-cognitive and resource management strategies can greatly increase the rate and profundity of learning. Of course, every learner has an implicit set of learning strategies that (s)he consciously or unconsciously employs. However, without raising the issue of learning strategies to the explicit (conscious) organizational level and explicitly training them, the learning strategies of the individual will remain more or less deficient. Here, organizations can greatly improve the efficiency of individual learning by teaching their members "how to learn" and by supporting the whole set of learning strategies by an appropriate set of organizational measures and supportive technologies.

Peter Senge's approach to organizational learning provides a complement for learning categories and learning strategies. While arguing for the need of personal mastery, Senge stresses that learning for the individual and for the organization should lead to *satisfaction*: "Learning in this context does not mean acquiring more information, but expanding the ability to produce the results we truly want in life".[23] Thus, his approach shows ways to integrate the needs of organizational learning with personal fulfilment in learning.

In summary, it can be argued that learning categories, learning strategies and Peter Senge's concept of personal mastery provide "usability guidelines" for learning, by improving effectiveness, efficiency and satisfaction at the individual and the organizational levels.

[22] E.g., Pilcher [67], Bernt and Bugbee [8], McKeachie et al. [50].
[23] Senge [74], p. 132.

Conclusions for Learning at Work
Learning categories are widely used for learning needs analysis, for learner assessment and for the improvement of learning at work. Though the basic ideas of learning categories can be easily understood, they are often disregarded in the everyday practice of workplace learning. For example, in almost all organizations the categories of remembering, understanding and applying are indispensable to make learning valuable for the organization. Nevertheless, it is common knowledge that advanced trainings in companies and organizations often do not sufficiently endorse the application of newly acquired knowledge, let alone result in the high level of performance without conscious attention that is described in section 6.2 - the performance "in me" discussed by Tor Nørretranders ([64]).

According to the goals of an organization and according to the task of the individual learner (or learning group), the higher learning categories of analyzing, evaluating and creating may be required. Here the organization can use the learning categories to map them to learners and to tasks with the goal to tailor the learning process according to needs and to resources.

For organizations there are several ways of implementing and improving learning strategies at the workplace. The efficient use of the higher level learning strategies clearly depends on the conditions the organization sets for learning. For example an organization can actively support the time management, the study environment management, the effort management and the support of others - both by supportive corporate culture and suitable regulations, and by providing supportive technologies. Moreover, an organization can actively support its members in acquiring and improving a suitable set of learning strategies.

8.6. Connections with PROLEARN D1.11 and IMS Learning Design

In PROLEARN D1.11 “Integration of adaptive learning processes with IMS Learning Design considering corporate requirements” there is an important section where we follow up several categories and strategies out of all those in the listed taxonomies and research how they can be modelled with e-Learning specifications, notations and systems (i.e., Laos, IMS Content Packaging, SCORM, Moodle…) [12], [17]. For this purpose, we mainly work with IMS Learning Design (IMS LD) that allows for using several pedagogies in a flexible way. IMS LD and the other specifications are focused on the development of courses and units of learning for single and multiple learners and other staff. The main challenge points out a) to develop a conceptual model that could cope with as many as possible of the categories and strategies described, and b) to match this model to specific solutions provided by the e-Learning set, so that it could be implemented somehow.

IMS LD can represent and encode learning structures for both, single and multiple learners, grouped by roles, like “learner” or “stuff” [13], [40]. A lesson plan can be modelled in IMS LD, defining roles, learning activities, services and several other elements, making a Unit of Learning (UoL). Later, this modelled lesson plan (or UoL) is packaged with the nested resources in a compressed ZIP file and it is published and run in a player. The player coordinates the teachers, the students, the activities as well as their respective learning processes. A user will then take a role to play with and will carry out the related activities in order to complete a satisfactory Unit of Learning. All together, the Unit of Learning structure, the roles taken and the activities taken build the learning scenario that must be run in an IMS LD compliant system.

IMS LD does not offer a particular pedagogic model or models, but can rather be used to define a practically unlimited range of scenarios and pedagogic models. Because of this it is often referred to as a pedagogic meta-model. Some previous e-learning initiatives have claimed to be pedagogically neutral. IMS LD does not aim for pedagogic neutrality, but seeks to enable pedagogically aware e-learning.

It was developed with a focus on e-Learning and virtual classrooms, although face-to-face lessons can be carried out and integrated in a structure created with this specification, as learning activities or support activities. As long as the final aim of IMS LD is to create full-rich Units of Learning with supportive content pursuing to fulfil learning objectives in order to get the best learning experience, face-to-face meetings or any other possible learning resource are permitted, such as videoconference, collaborative blackboards or any field-work.

For instance, if we take the categories listed in Anderson´s taxonomy, we could match “Remembering” and “Understanding” to the conceptual map behind IMS Learning Design (or any other) that allows for modelling them, and also providing some specific example that prove it. Another example is when talking about McKeachie´s strategies, we will model “Planning strategies” generating questions for a survey or we will model “Effort management strategies” when we improve the self-motivation with incentives.

A practical example could be focused on adaptive learning, taking the user's performance as a possible input out of a general quiz on Geography with five questions and multiple answers [14]. The user produces some measures, like a score, an average and an accuracy level. The subsequent activity to be studied by the student depends on these results, and it is taken from four possible activities, including the repetition of the task if a certain threshold is not reached.

In doing so, a continuation of the theoretical background in this deliverable (D1.10) has been established between both deliverables connecting the research on learning@work with the ontologies and conceptual mapping with actual e-Learning technologies. On the other hand, the deliverable D1.10 provides some needed theory to support the more practical approach of D1.11 that presents specific examples of development.

8.7. Connections with PROLEARN D6.7

Most learning today is informal. According to [18], formal learning is the source of only 10% to 20% of what we learn at work. We discover how to carry out our jobs through informal learning, e.g., by observing others, by asking the person in the next cubicle, by calling the help desk, by applying trial-and-error, or simply by working with people that already know. Today, informal learning can be effectively supported by evolved Web 2.0 technologies that have shown great opportunities to overcome many of the failings of traditional e-Learning solutions as they provide more support for collaboration and networking. Recognizing these facts, in D6.7 "Business process-oriented learning – Part II", the authors argue that the SECI-model presented in D5.3 and D1.10 with a focus on the difference between formal and informal learning processes, can serve as a theoretical basis for an approach to orchestrate and interlink learning processes in general and informal learning processes in particular with supporting learning technologies. D6.7 shows how the phases of the SECI-model, enhanced by essential aspects of business process theory, could be supported by Web 2.0 applications in order to support informal learning processes in organizations. The focus of D6.7 is on how to incorporate the new Web trends into the learning process and how to harness and apply Web 2.0 concepts to create new and more effective learning experiences.

9. KIM'S INTEGRATED MODEL OF ORGANIZATIONAL LEARNING

In [38] Daniel Kim constructs an integrated model of organizational learning, which describes the link between individual and organizational learning. In this section we present a sort of "executive summary" of Kim's model, which contains several concepts that are highly relevant to the SECI-based Professional Learning Process Framework that is presented in section 11.

9.1. The experiential learning cycle

According to Kim ([38], p. 30) "a dictionary definition of learning states that learning is "the acquiring of knowledge or skill". Thus learning encompasses two meanings: (1) the acquisition of skill or know-how, which implies the physical ability to produce some action, and (2) the acquisition of know-why, which implies the ability to articulate a conceptual understanding of an experience. A number of theorists make the connection between thought and action. Argyris and Schön argue that learning takes place only when new knowledge is translated into different behaviour that is replicable [5]. For Piaget ([66]), the key to learning lies in the mutual interaction of *accommodation* (adapting our mental concepts based on our experience in the world) and *assimilation* (integrating our experience into existing mental concepts). As Kolb states ([39], p. 38): "Learning is the process whereby knowledge is created through the transformation of experience".

Both parts of the definition are important: what people learn (know-how) and how they understand and apply that learning (know-why). Learning can thus be defined as increasing one's capacity to take effective action.

An important distinction in Kim's model is to think about the two facets as *operational* and *conceptual* learning. According to Kim, experiential learning theory is the school of thought that best accommodates these two aspects of learning.[24] One of the theorists associated with this school is Lewin[25], whose experiential learning model is based on the following cycle: A person continually goes through the process of having a (1) *Concrete experience*, which is subjected to (2) *Observations and reflections*, which are followed by the (3) *Formation of*

[24] Other schools include behavioural and rationalist learning theory. See Kolb [39], p. 38.
[25] *Ibid*, p.21.

abstract concepts, which leads to (4) *Testing the implications in a new situation*, which generates another (1), etc.

This basic cycle has appeared in a variety of settings. As we have seen in section 8.1, Handy describes it as "the wheel of learning", consisting of the stages *question – theory – test – reflection*. In the total quality management (TQM) literature, it shows up as the Deming cycle of *plan – do – check - act* ([35], p. 59). Deming himself refers to it as the Shewhart cycle of *plan – do – study - act* [20]. In organizational development, Schein calls his version the cycle of *observation - emotional reaction – judgment – intervention* ([72], p. 64). Argyris and Schön refer to a *discovery – invention – production - generalization* cycle of learning ([5], p. 141).

Kim's model of individual learning is based on Kofman's version of the experiential learning cycle, which Kim calls OADI (*Observe – Assess – Design - Implement*). In Kim's model, the assess–design phase of the cycle corresponds to conceptual learning, and the implement-observe phase corresponds to operational learning (see Figure 43).

9.2. Shared mental models: the basis of organizational memory and meaning

As stated by Kim, various theories of organizational learning have been based on theories of individual learning. However, if a distinction between organization and individual is not made explicit, a model of organizational learning will either obscure the actual learning process by ignoring the role of the individual (and anthropomorphizing organizations) or become a simplistic extension of individual learning by glossing over organizational complexities. According to Kim ([38], p. 41):

> Organizational learning is dependent on individuals improving their mental models; making those mental models explicit is crucial to developing new, shared mental models. Why put so much emphasis on mental models? Because the mental models in individual's heads are where a vast majority of an organization's knowledge (both know-how and know-why) lies. […]
>
> The intangible and often invisible assets of an organization reside in individual mental models. The shared mental models are what make the rest of the organizational memory usable. Without these mental models, which include all the subtle interconnections that have been developed among the various members, an organization will be incapacitated in both learning and action. […]
>
> Mental models do not merely form a repository of sensory data. They are active in that they build theories about sensory experience. Each mental model is a clustering or an aggregation of data that prescribes a viewpoint or a course of action. Conceptual learning creates changes in frameworks, which lead to new ways of looking at the world. Operational learning produces new or revised routines that are executed in lieu of old ones. […]
>
> Individual frameworks become embedded in the organization's "weltanschauung" (= world view). The organization's view of the world slowly evolves to encompass the current thinking of the individuals within. In similar fashion, individual routines that are proved to be sound over time become standard operating procedures. Like an individual driving a car, the routines become the organization's autopilot reflexes. The strength of the link between individual mental models and shared mental models is a function of the amount of influence exerted by a particular individual or group of individuals. CEOs and upper management are influential because of the power inherent in their positions.

9.3. The OADI-SMM model of organizational learning

Kim's integrated model of organizational learning organizes all of the elements described so far into a cohesive framework, which he calls the OADI-SMM model (Observe, Assess, Design, Implement – Shared Mental Models). An UML-style version of the OADI-SMM model is presented in Figure 43.

The OADI-SMM model incorporates Argyris's and Schön's concept of single-loop and double-loop learning on both the individual and the organizational levels. As described earlier, double-loop learning involves surfacing and challenging deep-rooted assumptions and norms of an organization that have previously been inaccessible, either because they were unknown or known but undiscussable. Individual double-loop learning is traced out in Figure 43 as the process through which individual learning affects individual mental models, which in turn affect future learning.

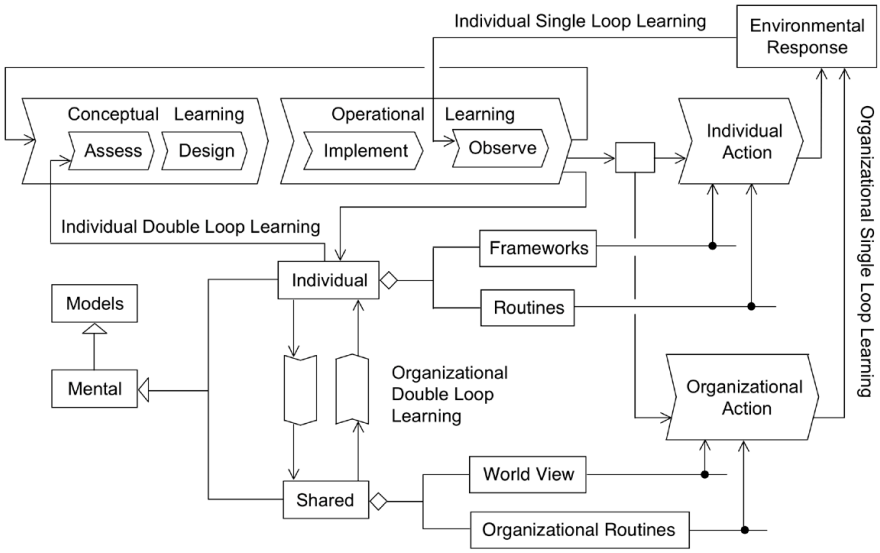

Figure 43. A UML-style process model of Kim's OADI-SMM model (Modelled from [38], Figure 2.7).

Organizational double-loop learning occurs when changes in individual mental models become incorporated into the organization through shared mental models, which can then affect organizational action. In both cases, double-loop learning provides opportunities for discontinuous steps of improvement where reframing a problem can bring about radically different potential solutions. In the formulation of Kim ([38], p. 48):

> as mental models are made explicit and actively shared, the base of shared meaning in an organization expands, and the organization's capacity for effective coordinated action increases.

9.4. Incomplete learning cycles

Kim also discusses different ways in which the learning cycle can become incomplete. He builds on the work of March and Olsen [49], who make a distinction between individual and organizational action in their model of organizational learning. They identify four different kinds of broken links in the learning cycle (Figure 44).

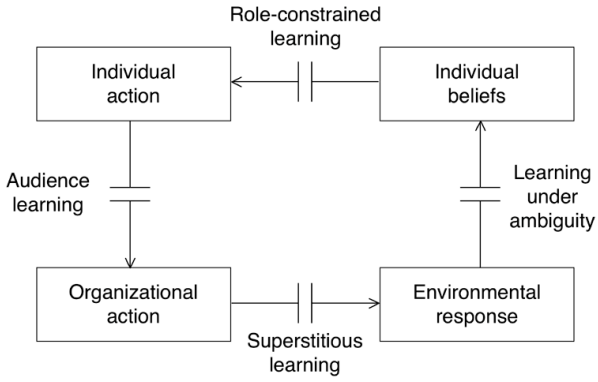

Figure 44. March and Olsen's model of organizational learning

• *Role-constrained learning* occurs when individual learning has no effect on individual action because the circle is broken by constraints on the individual's role.

• *Audience learning* occurs when the individual affects organizational action in an ambiguous way.

• *Superstitious learning* occurs when the link between organizational action and environmental response is severed. Thus, actions are taken, responses are observed, inferences are drawn, and learning takes place, but there is no real basis for the connections made between organizational action and environmental response.

• *Learning under ambiguity* occurs when the individual affects organizational action, which affects the environment, but the causal connections among the events are not clear. Hence, operational learning takes place, but conceptual learning does not. Effective organizational learning requires a balance between conceptual and operational learning.

Kim identifies three additional types of incomplete learning cycles that affect organizational learning: *situational*, *fragmented* and *opportunistic* learning ([38], p. 43):

• *Situational learning* occurs when the individual forgets or does not codify the learning for later use: The link between individual learning and individual mental models is severed. Regardless of whether the learning occurs at the conceptual or operational level, it does not change the person's mental models and therefore has no long-term impact – the learning is situation-specific. Crisis management is an example of situational learning. Each problem is solved, but no learning is carried over to the next case.

• *Fragmented learning* occurs when the link between individual mental models and shared mental models is broken. Individuals learn but the organization as a whole does not. In such a case loss of individuals mean loss of the learning as well. Universities are a classic example of fragmented learning. Professors within each department may be the worlds leading expert on management, finance, operations, and marketing, but the university as an institution cannot apply that expertise to the running of its own affairs.

• *Opportunistic learning* occurs when organizational actions are taken based on an individual's (or a small group of individuals') actions and not on the organization's widely shared mental models (values, culture, myths, or standard operating procedures). The use of "skunk working" to develop the IBM personal computer or the Ericsson mobile phone are two good examples. In both cases the companies bypassed their normal bureaucratic structures and created entirely separate, dedicated teams, which were able to deliver in record time.

10. KNOWLEDGE MANAGEMENT TO SUPPORT PERFORMANCE THROUGH LEARNING

10.1. Knowledge Management and Organizational Learning

As discussed earlier, "Knowledge Management" is a term that has been surrounded by a lot of controversy and confusion ever since its introduction in the early 1990s. The interest in KM as a discipline has been driven by the realization that KM methods and tools can be instrumental in increasing organizational performance. KM builds on and integrates several business and management disciplines: organizational learning, business management, anthropology, sociology, intellectual capital, virtual teams, and communities of practice. Snowden [76] summarizes the history of KM during the 1990s as three phases, and Gorelick et al. ([31], p. 10) claim that a fourth phase is in progress. Phase 1 emphasized technology, and phase 2 moved the focus to the distinction between tacit and explicit knowledge introduced by Nonaka [61]. Phase 3 recognized the need to move beyond codified information by using stories in the form of narrative representation. Phase 4, which is the claimed present trend, integrates the previous three phases by using a systems approach to KM for the purpose of increasing organizational performance through learning.

The foundation of Knowledge Management is the integration of people, process, and technology within the organizational culture. As described in [31], p. 35:

> In traditional organizations, individuals and departments usually specialize in one of three functions: People issues are addressed in human resources departments, process is often related to quality, business process reengineering, and/or project management, and technology resides in the information systems department. Often staff specialists within these functions are highly capable and competent within their discipline. The challenge to business in general and the opportunity provided for Knowledge Management practitioners, is to integrate people, process, and technology functions to support continuous learning for the purpose of increasing organizational performance. Knowledge management tools that contribute to organizational learning take advantage of the unique culture, resources, and capabilities of the organization.

This quote highlights the ongoing convergence between Knowledge and Learning Management, which is being accelerated by rapidly emerging "semantic technologies" - such as Semantic Web – and social software approaches – such as Web 2.0. See e.g., [46], [47], and [48] for more information on this subject.

10.2. An Integrated Knowledge Management Framework

KM is not a single thing, process, or a management slogan. Different authors and theorists define and explain KM differently. As a framework, KM can be seen as a collection of elements that work together in varying combinations to accomplish the goal of leveraging an organization's knowledge capital. Choo [15] bases his definition of KM on the framework approach:

> Knowledge Management is a framework for designing an organization's goals, structures, and processes so that the organization can use what it knows to learn and to create value for its customers and community.

Here we will present the integrated KM framework of Gorelick, Milton, and April. Their framework expands on Choo's definition by recognizing that, ultimately, the KM strategy drives the accomplishment of organizational goals by increasing performance through learning. Hence, KM needs to drive organizational learning in order to continuously add value. Their definition ([31], p. 18) states that:

> Knowledge Management is a framework for applying structures and processes at the individual, group, team, and organizational levels so that the organization can learn from what it knows (and acquire new knowledge if required) to create value for its customers and communities. The Knowledge Management framework integrates people, processes, and technology to ensure performance and learning for sustainable growth.

As described in [31], chapter 7, the Knowledge Management Architecture shown in Figure 45 was developed by the British Petroleum's Knowledge Management team over a period of ten years. It has proven to be an effective framework for implementing KM in several organizations besides British Petroleum, e.g., Shell, Tearfund, De Beers, and Old Mutual. To increase organizational performance, the goal is to systematically capture and re-use knowledge. Sometimes this knowledge can be transferred face-to-face, and thereby kept in tacit form. Often, however, it needs to be published and stored in order to be available for future users. It also needs to be "packaged" in a form, which makes it easily usable and understandable by the knowledge re-user. This packaged and stored knowledge is labelled a "Knowledge Asset".

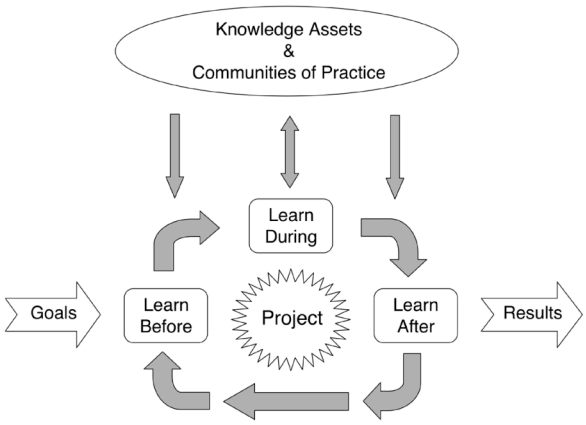

Figure 45. The BP Knowledge Management Architecture: Learn Before, during and after a project (Source: [31], p. 48)

The framework assumes that business units and teams work on specific projects with associated goals. Processes to learn before, during, and after a project aim to capture and apply knowledge in order to increase performance. Once the project is defined and the project team has been assembled, a "Learn Before" process should take place. The objective is to identify knowledge from people, documents, and Knowledge Assets, which can improve the way the project will be delivered. During the "Learn Before" stage, knowledge is acquired so that the project team can begin their work better prepared than they would otherwise have been.

Figure 46 shows a Conzilla[26] model of the Knowledge Management process applied by British Petroleum. As shown in the figure, a typical "Learn Before" method used by BP is the "Peer Assist", where a project team presents the plans, objectives, issues, opportunities, and challenges of the project to a number of invited people with relevant knowledge and experience from similar projects in order to receive their feedback in the form of recommendations, options, issues, and guidance.

[26] For a detailed description of Conzilla, see [68] or www.conzilla.org.

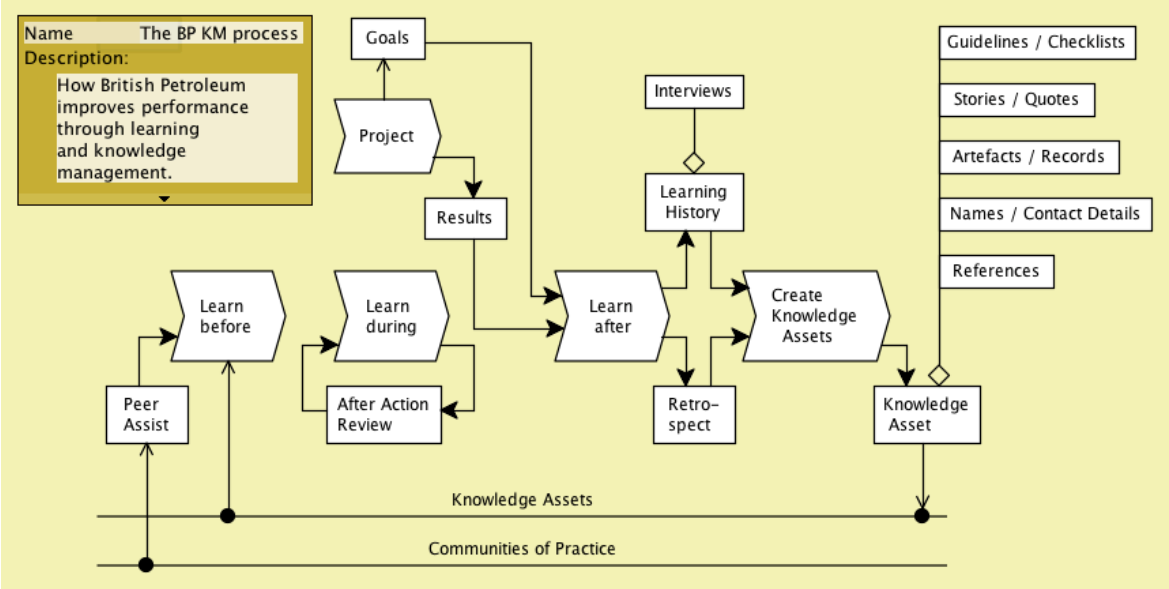

Figure 46. A Conzilla model of the BP knowledge management process

During the project, methods and tools are available to ensure that the team will "Learn During" the project. An example is the "After Action Review", where the team assesses its results against its plans at the end of a shift, (or day, or week), in order to identify and make explicit any learning points that can be applied during the next shift (or day, or week). When the project is complete, the goals of the project are compared to the results and a process kicks in for "Learning After" the project. This ensures that any knowledge that could be useful to future teams working on similar projects is identified and captured. At BP this knowledge capture takes place by creating Retrospects and Learning Histories.

A Retrospect is a face-to-face or a videoconference meeting that takes place as soon as possible after a project is completed. It can take from 30 minutes to an hour for a short, simple project, to two days for a project, which represents an alliance between several departments or companies. A Learning History is compiled through individual interviews with the people involved. It would be used when the team of knowledge sources is too big or too busy to schedule a group knowledge capture session, such as a Retrospect.

Finally, in a "Create Knowledge Assets" process, the experience thus gained is packaged into a Knowledge Asset, which should contain Guidelines and Checklists, Stories and Quotes, Artefacts and Records, Names and Contact Details (of the people involved) and References to relevant background information.

A Knowledge Asset is ideally owned by a group of people who share professional interests and responsibilities. Such a group is often referred to as a "Community of Practice". According to [85], CoPs refer to "groups of people in an organization who share a concern, a set of problems, or a passion about a topic, and who deepen their understanding and knowledge of this area by interacting on an ongoing basis".

11. A SECI-BASED FRAMEWORK FOR PROFESSIONAL LEARNING PROCESSES

In this section we will make use of several of the ideas discussed earlier in order to assemble a *Professional Learning Process Framework* (PLPF), apply it from different perspectives, and connect it with various ontologies and process models related to learning. These models include the ontologies for business roles (section 5), the learning categories and learning strategies (section 8.5), the laws of organizational structure (section 2.3), the cultural barriers to knowledge sharing (section 2.4), the rules for stifling initiative (8.3), the blocks and lubricants of change (section 8.1), and the learning organization (section 8.2). The PLPF will be based on the modified SECI-based work processes discussed in section 7, the wheel of learning discussed in section 8.1, and the BP knowledge management process discussed in section 10.2. The PLPF is really a "live" Conzilla model, and all the pictures presented in this section are screenshots of the corresponding Conzilla maps - most of which consist of several layers that can be switched on and off independently of each other. The complexity of the Conzilla-based PLPF model implies a serious presentation problem, since this non-linear model has to be mapped onto a linear presentation medium.

11.1. Some semantic perspectives on web-based collaborative learning

In [90], Yli-Luoma & Naeve present a semantic perspective on web-based learning theory using a modelling approach based on the SECI process framework (Figure 29) developed in PROLEARN D5.3 ([57]). The authors explore some pedagogical aspects of the SECI knowledge conversion phases, and show how they can be supported by different tools for community-building (S), discussion support (E), conceptual modelling (C) and reflective analysis (I).

A powerful tool for "collaborative combination" is the *Conzilla* concept browser mentioned above ([56], [68]) with the newly released collaboration service *Collaborilla* ([22], [23]). By using Conzilla/Collaborilla, members of a community of practice can collectively build, publish and connect human-semantic graphical representations – such as concept maps, dialogue maps, etc., where different maps are published by different sources. This kind of 'conceptual web' represents a development beyond wikis, where everyone is editing the same information. In fact, as described in [57], Conzilla/Collaborilla can be used for distributed discourse management within a community, using a conceptual calibration technique where agreements and disagreements can be explicitly modelled without consensus having to be reached. Such a conceptual web – centred on different aspects of Technology Enhanced Professional Learning - is presently being constructed by some of the students of the PROLEARN Summer School 2007 with the purpose of finding cross-disciplinary areas for research collaboration. This effort will be reported within the PROLEARN Academy (month 48).

11.2. Assembling a Generic Professional Learning Process Framework

As discussed in PROLEARN D7.7, all types of organizationally condoned learning within an organization are intended essentially to serve the same goal, which is to improve the operational effectiveness and excellence of the organization. As we have discussed earlier (section 4.7), learning@work takes place on two levels: operational and strategic. What unites these levels is that they are both concerned with various projects. The operational level deals with the projects of today, which the company is involved with, and the strategic level deals with the projects of tomorrow, which the company needs to get involved with in order to survive.

As illustrated by the BP knowledge management process (Figure 46), project-based learning can naturally be divided into three stages, learning *before*, *during*, and *after* the project. Integrating this classification with the SECI model leads to the project-oriented learning process framework presented in Figure 47.

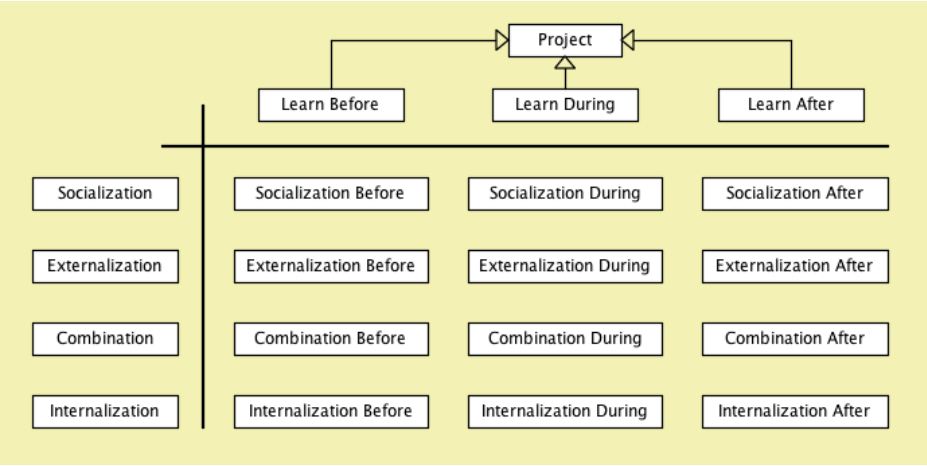

Figure 47. SECI-based, project-oriented learning process framework

This ontology could become the basis for the empirical data that will be collected in the user-clinics run by IMC and presented in the final version of D7.7. However, in order to present the questions in a language that is closer to the one normally used by people involved in learning@work, we will use the modified version of this learning process ontology presented in Figure 48. The connections with D7.7 are discussed below in section 11.4.

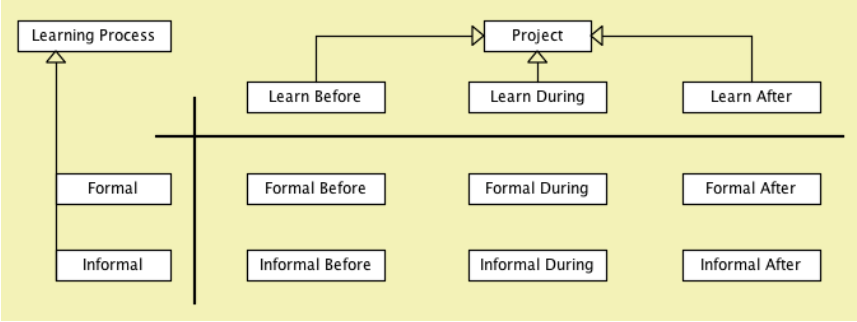

Figure 48. Formal/Informal project-oriented learning process framework

By combining the framework of Figure 48 with the modified SECI-based work process model discussed in section 7.1, and especially the formal/informal process model of Figure 37, we arrive at the *Modified SECI-based Professional Learning Process Framework* (PLPF) presented in Figure 49. From now on this framework will be referred to as *the Generic PLPF*.[27]

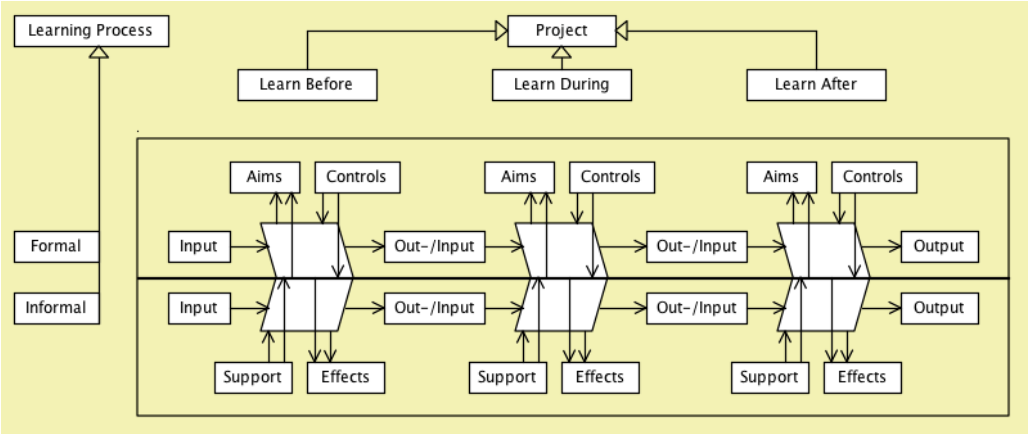

Figure 49. The Generic PLPF (with only the top layer switched on)

There is an aspect of this framework that needs further clarification. Each Out-/Input box represents two separate concepts (Output and Input), because there will normally be additional Input for the next part of the learning process - apart form the Output of the previous one – both at the formal and the informal level. However, in order to save space, the separate Output and Input concepts have been modelled as a "combo box". The reason for this space saving will become clear below.

As mentioned above, the "live" version of the Generic PLPF is in fact a multi-layered Conzilla context map to which extensions can be added and published from different sources using the collaboration service Collaborilla.[28] In order not to make the text in the screenshots too small, the layers involved are shown separately by screenshots of the Conzilla layer manager. For example, the screenshot shown in Figure 49 corresponds to the screenshot of the layer manager shown in Figure 50.

[27] The Generic PLPF is a muli-layered model, the dynamics of which is impossible to convey on paper. It is available by launching Conzilla from www.conzilla.org (Click on "Download" and then on "Launch") and then entering the following address into the Context-Map URI window of Conzilla: http://www.conzilla.org/projects/roadmapping/presentation/CM#689e12113fcda8a0f

[28] More about how this works is presented in the next section.

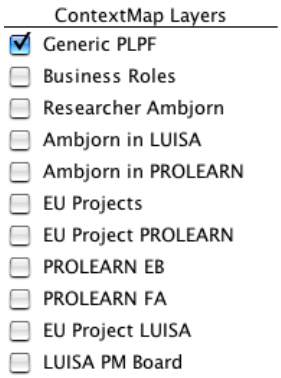

Figure 50. Only the top layer of the PLPF is switched on, which produces the picture shown in Figure 49.

The Generic PLPF can be applied from several perspectives. Below we will demonstrate this by applying the PLPF from the two different perspectives of "Business Roles" and "EU-projects". Other perspectives can be introduced in an analogous way.

11.3. The Generic PLPF from the Business Roles perspective

Switching on the second layer (Business Roles) shown in Figure 50 produces *the Generic PLPF with Business Roles* shown in Figure 51. Here we connect the Generic PLPF to the different business- and learning process roles discussed in section 5.

It is important to observe that the Business Roles are generic – appearing in many different contexts, while the particulars (context-specific parts) of the learning process for each Business Role can be represented on the association between the corresponding Business Role and the frame surrounding the learning process. We will see this representational pattern reappearing in many places below.

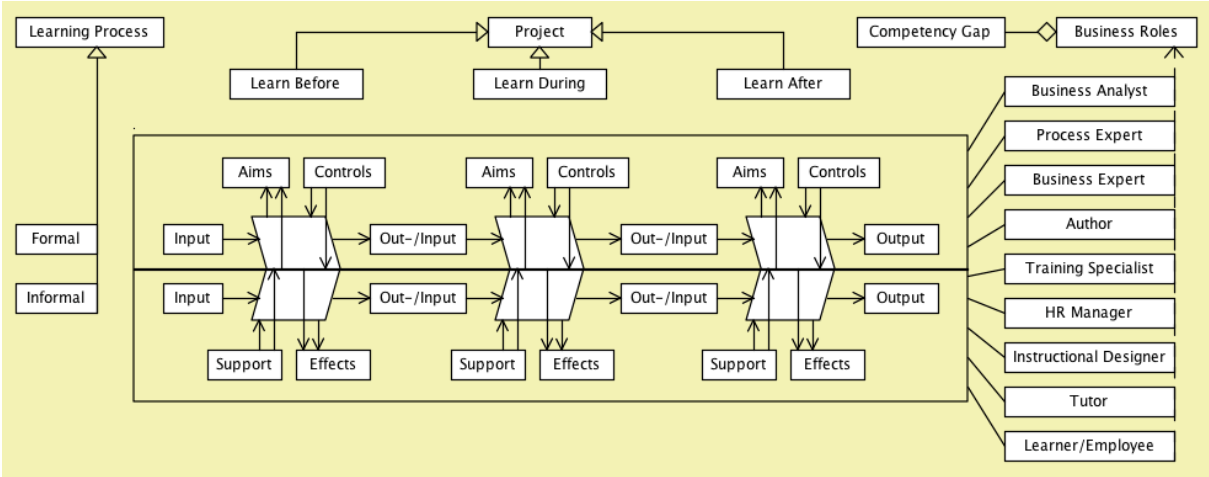

Figure 51. Generic PLPF with Business Roles

A major advantage of the Generic PLPF with Business Roles is that it supports learning not only for the intended "learner/employee" but also for the various "experts" that provide the different aspects of the learning experience. This is the essence of double-loop learning (section 8.4), which is often so hard to achieve for experts, who – by definition – are supposed to know more or less everything within their own professional field.[29]

[29] This problem has been brilliantly addressed by Chris Argyris in his article "Teaching smart people how to learn" [4].

11.4. Connections with PROLEARN D7.7

The Generic PLPF with Business Roles will be used as the basis for empirical data collection through questions that will be addressed to members of the professional learning community through the user clinics performed by the PROLEARN core partner IMC. The results of this empirical study will be presented in the final version of PROLEARN D7.7, which is due month 48. The focus will be on the role of Learners/Employee, which will be sub-classed according to the professional profiles of the interviewees, but the learning of members of other business roles will be documented when appropriate. This information will be made available as Business Role specific content in the Conzilla model of the Generic PLPF, in a fashion that is analogous to the Conzilla-based model of the PROLEARN Roadmapping Process.

The questions asked in the user-clinics will be of the following type:

> Think of a specific project that you have been involved in. What was your role in this project? How was the formal/informal learning process supported before, during, and after the project? What were the aims (= goals) of these learning processes? What formal/informal input was given at each stage? What was the formal/informal outcome (= output) at each stage? What formal/informal (side-)effects did you observe? What controlled the formal/informal learning process at each stage?

The purpose with presenting the results of the empirical study in the form of a "live" Conzilla model is that this study can be continued and expanded beyond the end of the PROLEARN project.[30] As further empirical studies are carried out, their results can be added to the model, and cross-linked in various ways that can highlight existing learning patterns for different business roles in different types of projects. In this way, a coherent picture of the strengths and weaknesses of these patterns can be expected to emerge over time – a picture that can provide valuable information for companies about to engage in similar projects. This is part of the strategy for PROLEARN sustainability, and will be elaborated on in D10.10 (the PROLEARN Sustainability Review).[31]

11.5. Applying the Generic PLPF from the Business Roles perspective

We will now describe how the Generic PLPF with Business Roles can be applied to support the professional learning process of an individual that belongs to a specific business role and who is involved in a specific project. The Generic PLPF will be contextualized with various "learning frames" that are specific to the individual and the project in question.

In Figure 53 "Researcher" is introduced as a specific sub-type of the "Learner/Employee" Business Role, and "Ambjorn" is introduced as a specific instance of type "Researcher" Moreover, the specific Projects "PROLEARN" and "LUISA" are introduced, with respect to each of which Ambjorn has a specific "Competency Gap". Figure 52 shows the context-specific layers that have been switched on in order to produce the picture shown in Figure 53.

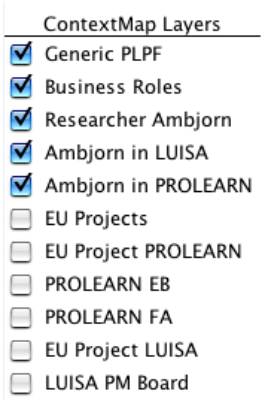

Figure 52. Switching on the layers of the PLPF shown here produces the picture shown in Figure 53

[30] For more about "Learning after PROLEARN" see below.

[31] See also section 12.3 for some preliminary ideas on the subject of PROLEARN sustainability.

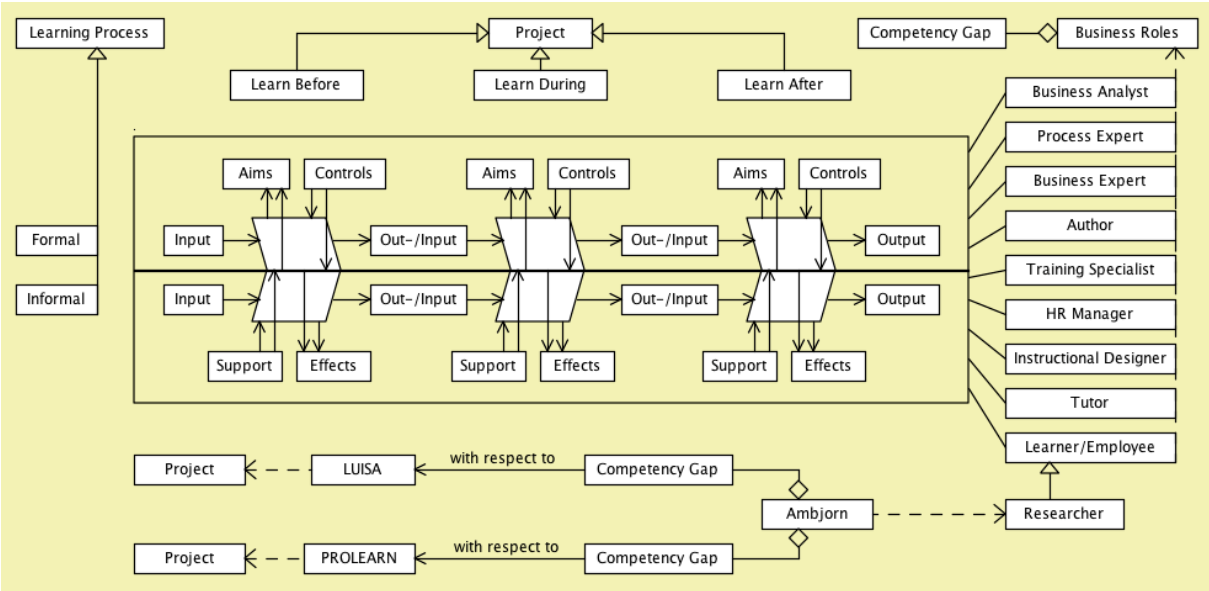

Figure 53. Additional layers of the Generic PLPF introduces Researcher Ambjorn with Competency Gaps with respect to the Projects PROLEARN and LUISA

Let us concentrate on the PLPF for Ambjorn with respect to PROLEARN. In the Conzilla model of Figure 53, it is represented as a detailed map on the Competency Gap of Ambjorn with respect to PROLEARN, and it can be accessed by double-clicking on this Competency Gap. This opens the map shown in Figure 54, where only the top layer (Ambjorn's PLPF in PROLEARN) has been switched on. [32]

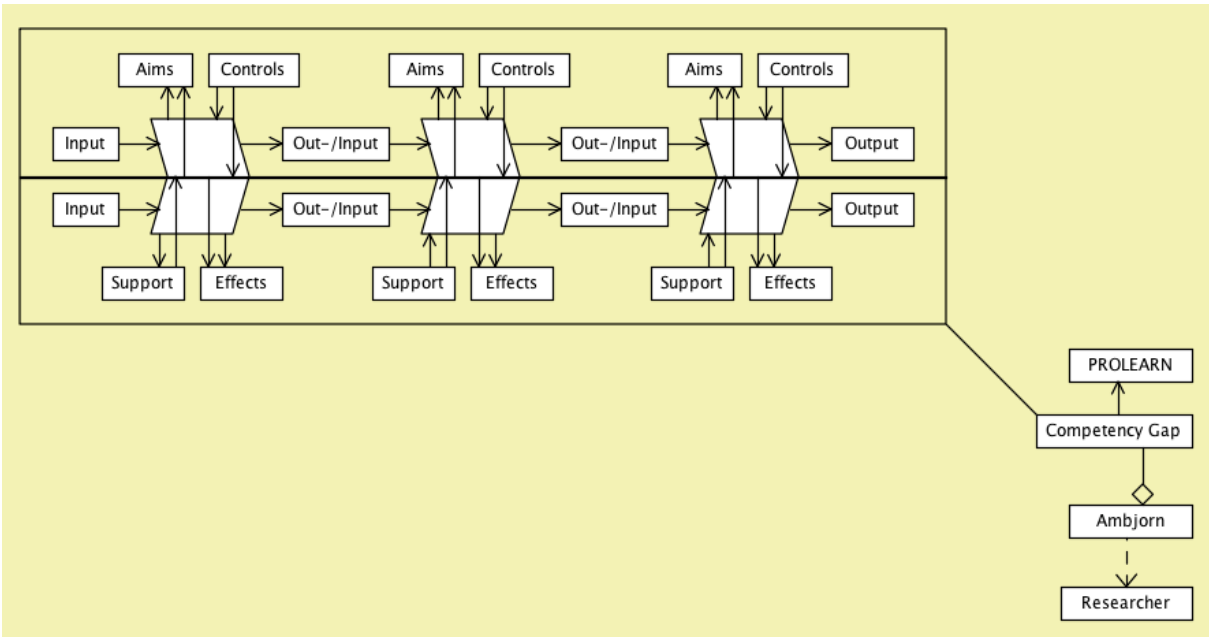

Figure 54. Ambjorn's PLPF in PROLEARN

[32] In this map, the "process data boxes" within the frame (Process-fishes, Input, Output, Aims, Controls, Support, Effects) can either be made generic, or specific for the PROLEARN context, or even specific for the Ambjorn/PROLEARN context. Moreover, independently of the "degree of context specificity" of these concepts, the content of each concept can be made specific to each map where it appears. For instance, if the "Aims" before the PROLEARN Project is made context-specific to the PROLEARN project, each learner related to PROLEARN can take part of other learners' reflections on this concept by switching (surfing) to the corresponding context and opening up the content. This supports collaborative learning between the participants of PROLEARN. On the other hand, if a learner wishes to keep her/his reflections private, (s)he only has to make the corresponding concepts specific to her/his own private PROLEARN context (e.g., the Ambjorn/PROLEARN context discussed above). This will become easier to do when Conzilla becomes equipped with a full-fledged access control model.

The Competency Gap of Ambjorn with respect to PROLEARN is represented as a set of questions, the discussion of which are supported by various ontologies and connections to the relevant parts of the PLPF. Each question is associated with a *Learning Frame*, which surrounds the inner frame of the Generic PLPF as shown in Figure 56.

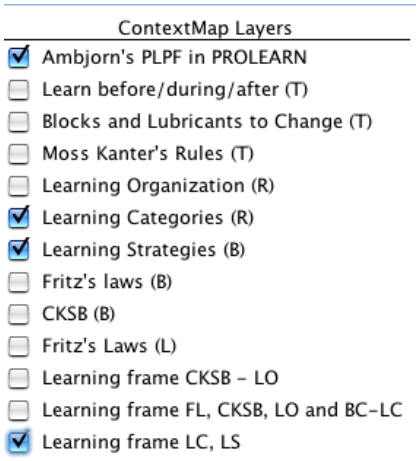

Figure 55. Switching on the layers of Ambjorn's PLPF in PROLEARN shown here produces the picture shown in Figure 56

The Learning Frame shown in Figure 56 corresponds to the question "*How do I find out what parts of which other deliverables that are relevant to the ones that I am involved in producing*?" This question is represented as pop-up metadata on the question-mark symbol in the lower right hand corner of the Learning Frame (as shown in Figure 57). Since the question is related to learning during the PROLEARN project, only the concepts of the middle part of "Ambjorn's PLPF in PROLEARN" have been associated with this frame. Moreover, as seen in Figure 56, the frame presently involves the concepts "Applying" and "Creating" from the Learning Categories ontology (Figure 41) and the concepts "Organizational Strategy", Planning Strategy", "Time management Strategy", and "Support management Strategy" from the Learning Strategies ontology (Figure 42).

As seen in Figure 55, in the Conzilla layer manager the learning frame in question is called "Learning frame LC, LS". This is to remind the user that in order to interact properly with the information contained in the frame, the layers presenting the ontologies for "Learning Categories" (LC) and "Learning Strategies" (LS) have to be switched on. [33]

The symbols shown on the corners of the Learning Frame of Figure 55 correspond to the four different stages (Question, Theory, Test, Reflection) of Handy's wheel of learning (Figure 40), which was discussed in section 8.1. In the Conzilla model, the information about the corresponding concepts is represented as pop-up metadata, as shown in Figure 57.

[33] In a future release of Conzilla, we will introduce logical dependencies between layers, so that when the user activates the "Learning frame LC, LS" layer, then the "Learning Categories" and "Learning Strategies" layers will be switched on automatically. In the present version (Conzilla 2.1), the layers have to be named (or meta-tagged) in such a way as to make this dependency apparent to the user.

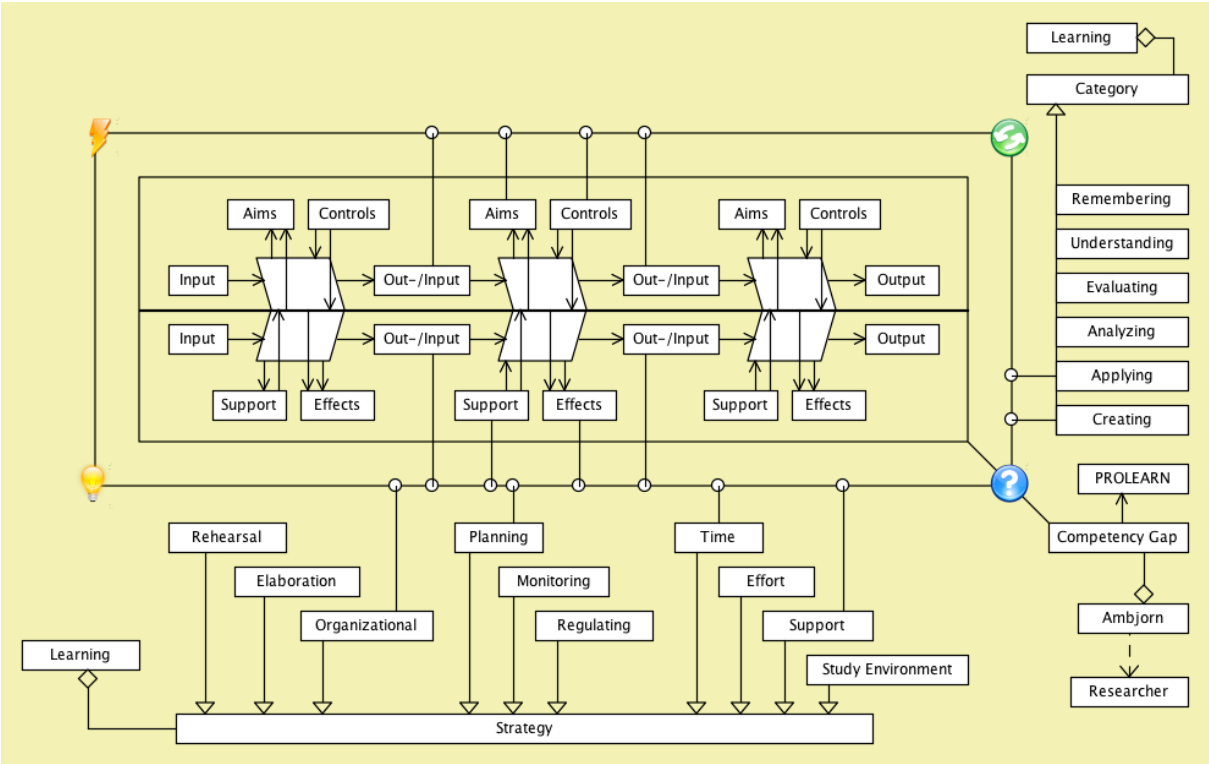

Figure 56. Learning frame (and supporting ontologies) for Ambjorn's PLPF in PROLEARN related to the question "How do I find out what parts of which other deliverables that are relevant to the ones that I am involved in producing?"

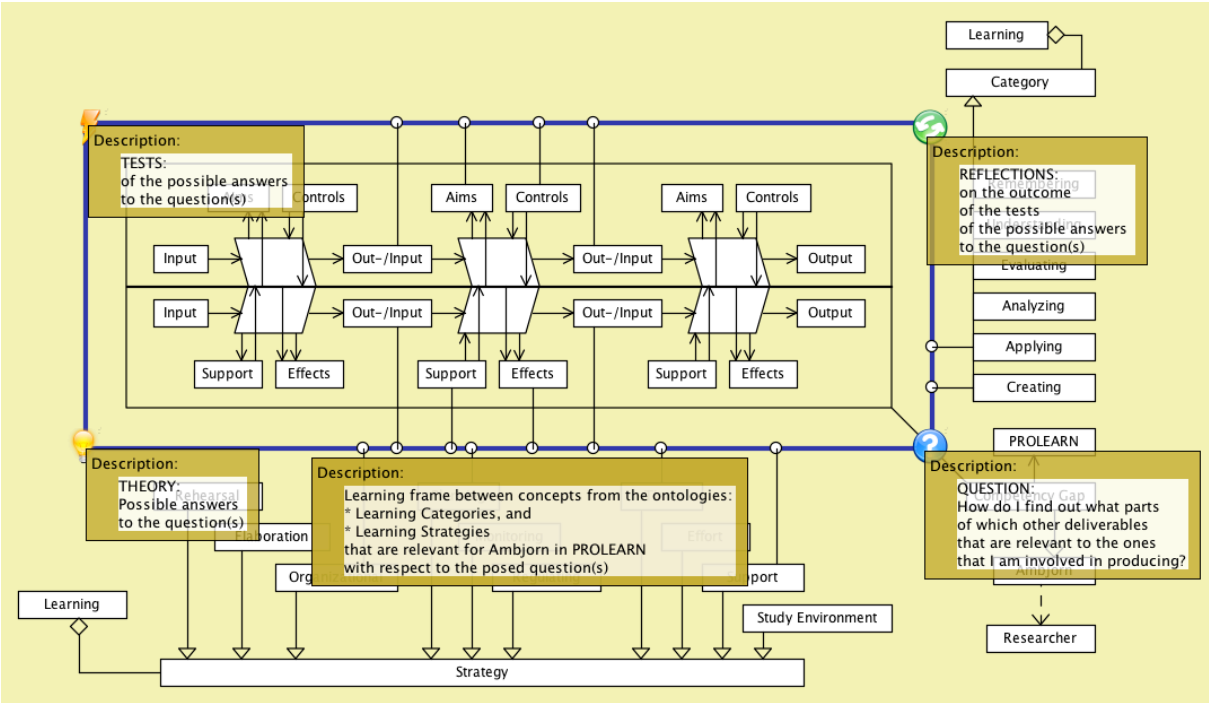

Figure 57. The same learning frame as in Figure 56 with some of its pop-up metadata exposed

In each Conzilla map of the PLPF, each learning frame that appears is connected to the Conzilla map of Handy Wheel of Learning (Figure 40), where more in-depth explanations of his theory of learning can be found. Single-clicking on the learning frame itself, brings out an icon of this Learning Wheel map (as shown in Figure 58), and double-clicking on the learning frame switches the context to this map.

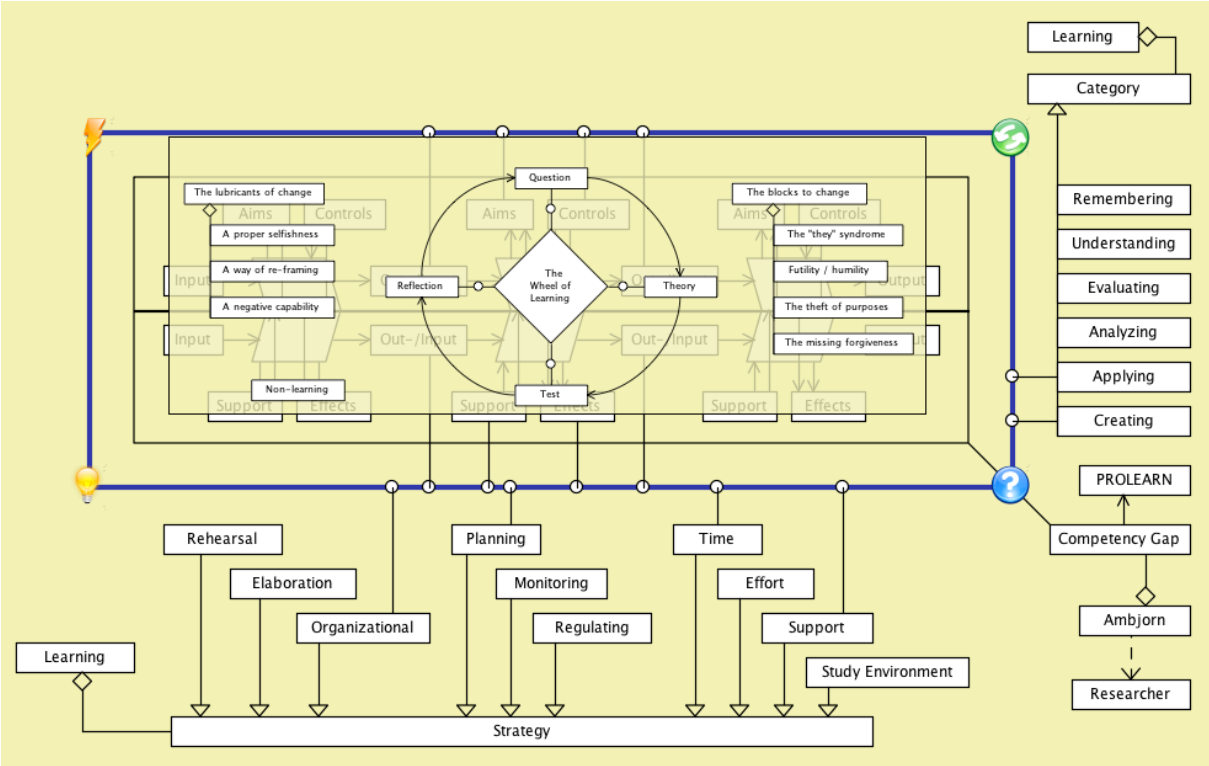

Figure 58. **Single-clicking on the learning frame exposes an icon of a Conzilla map of Handy's Learning Theory. Double-clicking on the learning frame opens this map.**

Before leaving this example, we will look at a second learning frame that involves another question (competency gap) related to the Ambjorn/PROLEARN context. The posed question (shown in Figure 61) is the following: "*What happens when an idea from one community is introduced into another community*?" In particular: "*What happened when the SECI idea from the KM community was introduced into the TEL community via PROLEARN D5.3*?"

The posed question involves various concepts from the four different ontologies: "Blocks and Lubricants to Change" (Top), "Learning Organization" (Right), "Cultural Knowledge Sharing Barriers" (Bottom) and "Fritz's Laws of organizational structure" (Left). Figure 59 shows the learning frame layer ("Learning frame FL, CKSB, LO and BC-LC") and the four corresponding ontological layers that support it. The picture produced by switching on these layers is shown in Figure 60.

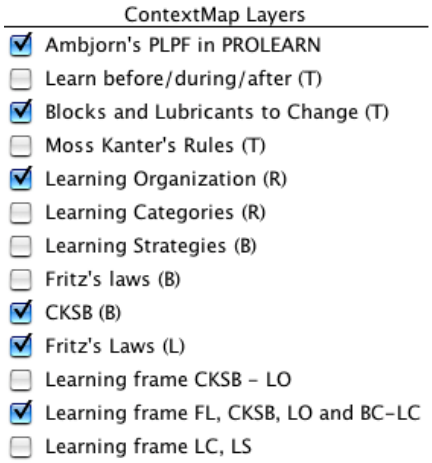

Figure 59. **Switching on the layers shown here produces the picture shown in Figure 60**

Moreover, since the posed question relates to both "learning during" and "learning after" the PROLEARN project, the corresponding frame is connected with the concepts of both the middle (= learn during) part and the right (= learn after) part of the PLPF.

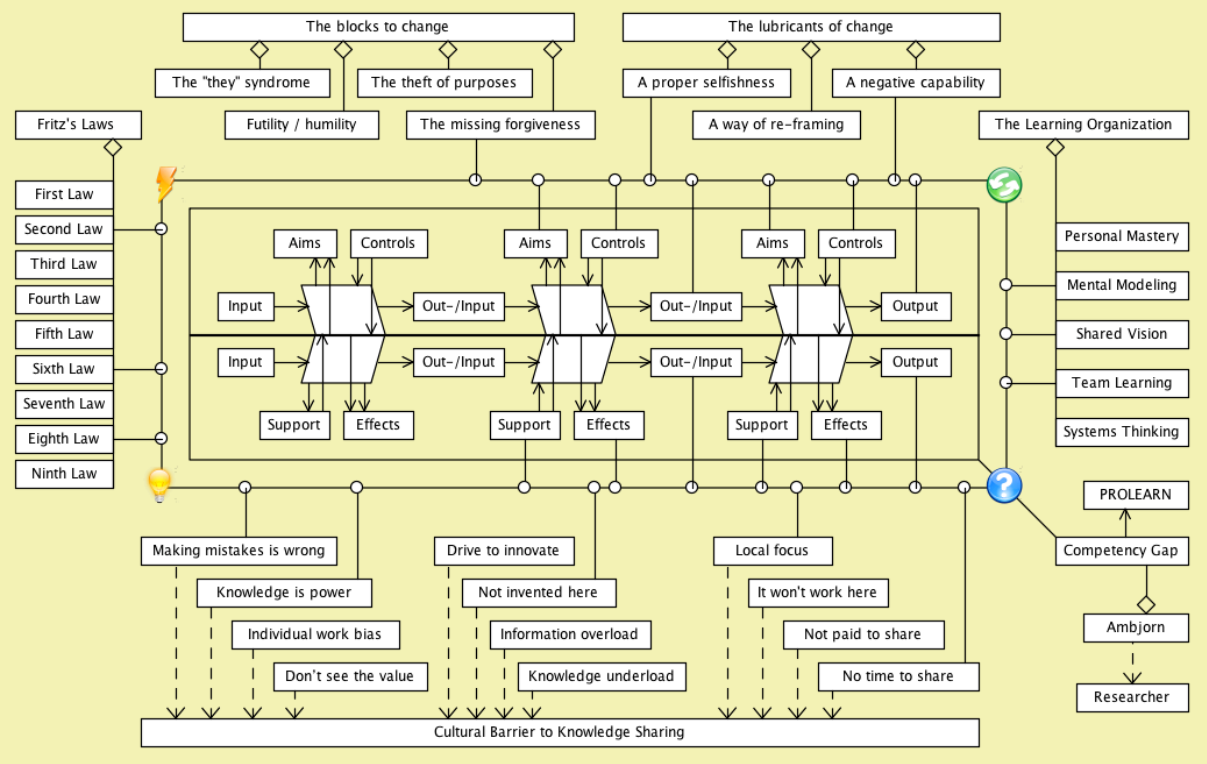

Figure 60. Learning frame for Ambjorn's PLPF in PROLEARN with respect to concepts from the ontologies "Blocks and Lubricants to Change", Learning Organization", Cultural Barriers to Knowledge Sharing, and Fritz's Laws

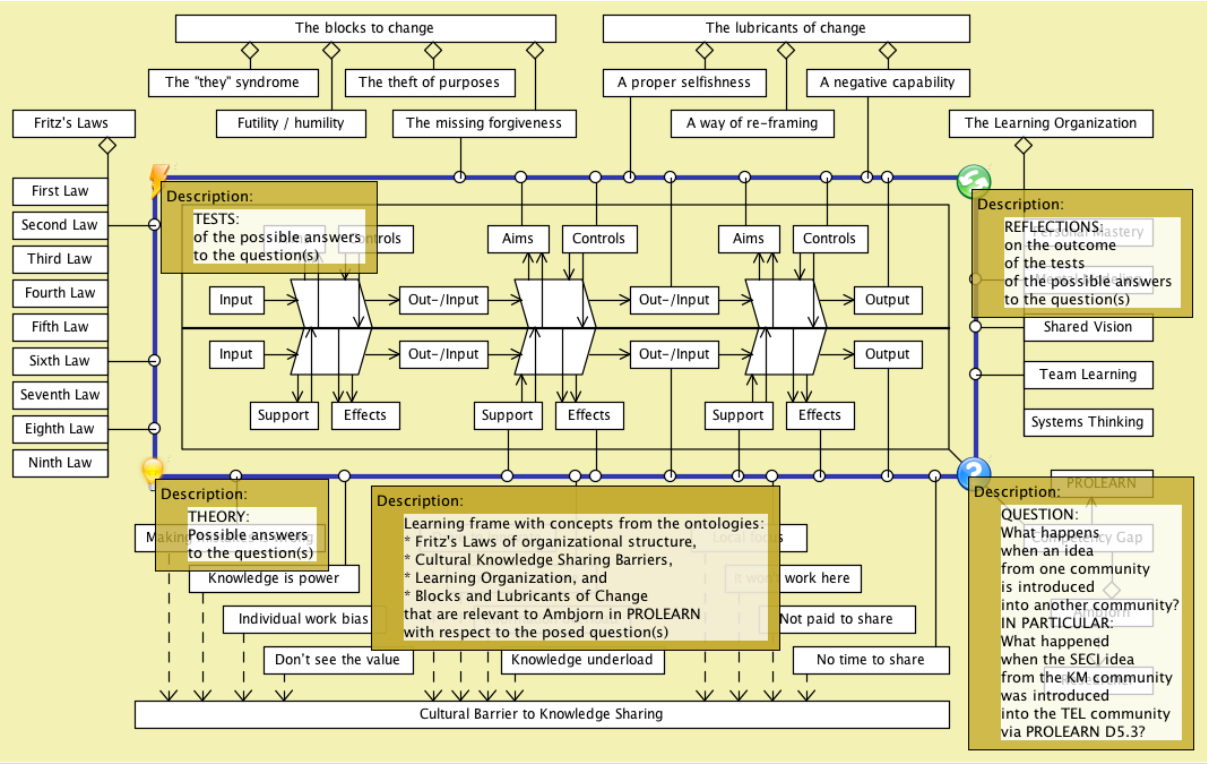

Figure 61. The same learning frame as in Figure 60 with some of its pop-up metadata exposed.

11.6. Applying the Generic PLPF from the EU-projects perspective

As promised at the end of section 11.2, we will now show how the Generic PLPF can be applied from another perspective, namely the perspective of EU projects. Although the last example involved the EU projects PROLEARN and LUISA, these projects were introduced as subordinate to a person (Ambjorn) with the specific business role "Researcher", which was considered as a sub-type of the business role "Learner/Employee". Hence, the PLPF of Ambjorn was being modelled from the perspective of an individual researcher employed by an organization. Here we will start from the perspective of EU projects, which corresponds to the "EU Projects ontology" shown in Figure 63. In this screenshot we are back in the Conzilla map of the Generic PLPF (introduced in Figure 49) with the layers shown in Figure 62 switched on.

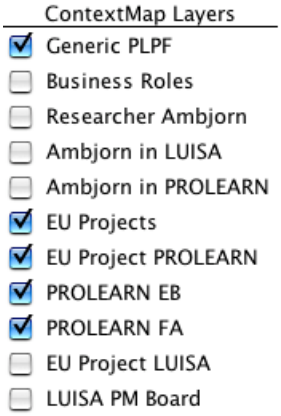

Figure 62. Switching on the layers of the Generic PLPF shown here produces the picture shown in Figure 63

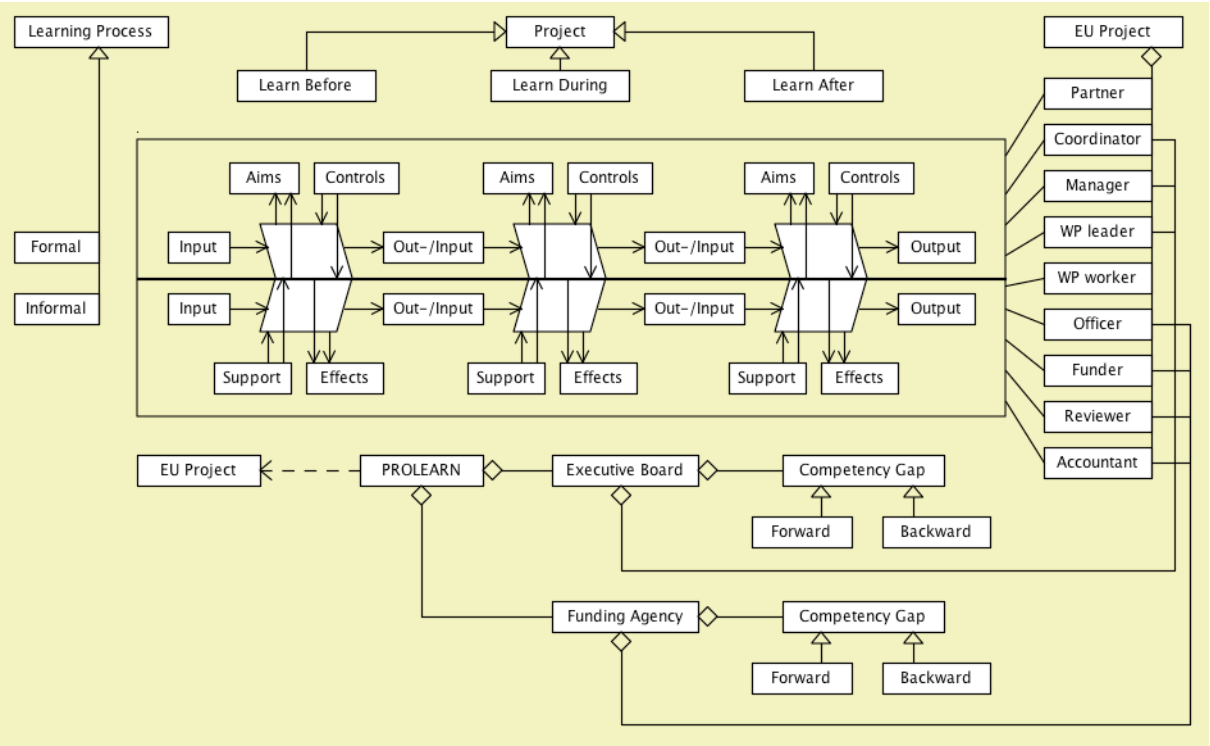

Figure 63. Generic PLPF from an EU-Project perspective with layers for the PROLEARN Executive Board and the PROLEARN Funding Agency switched on

In Figure 63, the "EU Project" ontology has been introduced (in a somewhat simplified form) and PROLEARN has been introduced as an instance of type "EU Project". Moreover, the two groups "Executive Board" and "Funding Agency" have been introduced as part of PROLEARN, each one with a (collective) Competency Gap with respect to the PROLEARN project. Moreover, as an extra option, the distinction between Forward and Backward Competency Gaps (discussed in section4.6) has been introduced, to enable the option to focus on the one or the other of these types of competency gaps.

Double-clicking on the Competency Gap of the PROLEARN Executive Board with respect to the PROLEARN project opens the Conzilla map shown in Figure 64, which is the PLPF for the PROLEARN Executive Board with respect to the PROLEARN Project. By adding different learning frames to this PLPF, different questions of interest to the PROLEARN Executive Board can be studied. A great advantage of the Conzilla model of the PLPF is that this study can involve knowledge sharing between the entire EB – by publishing learning frames from different members – but does not need to do so. Each member of the EB can contribute to the collectively available PLPF by adding a different learning frame (= layer) and publishing it through the Collaborilla service. However, if some members wish to study some issues in private, they can just add the corresponding learning frames without publishing them. This reflects a practical work situation, where some issues are OK to talk about, while others are too sensitive to discuss openly.[34]

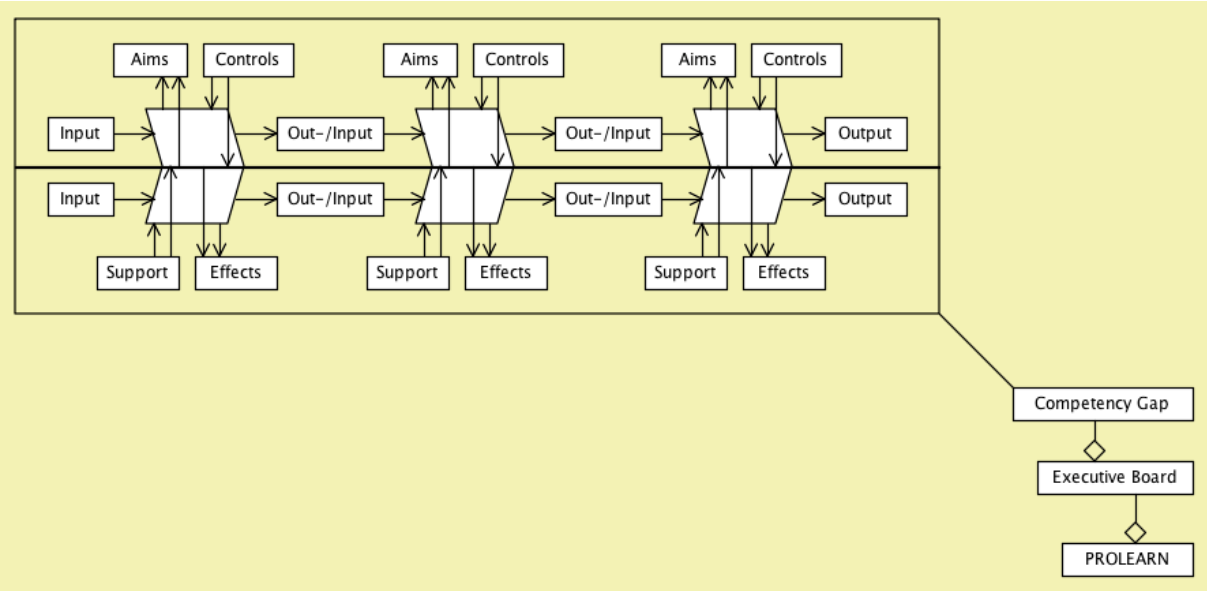

Figure 64. The PLPF for the PROLEARN Executive Board (with only the top layer switched on)

The example question for the PROLEARN EB that corresponds to the learning frame shown in Figure 66 is the following: "*How do we deal with partners that do not deliver in accordance with the work plan*?" The related ontological layers that support this learning frame are shown in Figure 65.

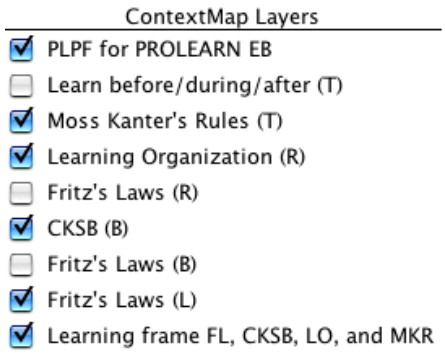

Figure 65. Switching on the layers of the PLPF for the PROLEARN EB shown here produces the picture of Figure 66

The learning frame relates this issue to concepts from the ontologies "Fritz's Laws" (of organizational structure), "Cultural Knowledge Sharing Barriers", "Learning Organization", and "Moss Kanter's Rules" (to stifle initiative). These ontologies have all been introduced elsewhere in this deliverable.

[34] In the current version of Conzilla (2.1) there is no selective access control to the maps. Hence, the only option at present is to share your Conzilla maps with everyone or with no one. In a future Conzilla release we plan to add a full-fledged access control model – possibly using the open source based Shibboleth middleware (http://shibboleth.internet2.edu).

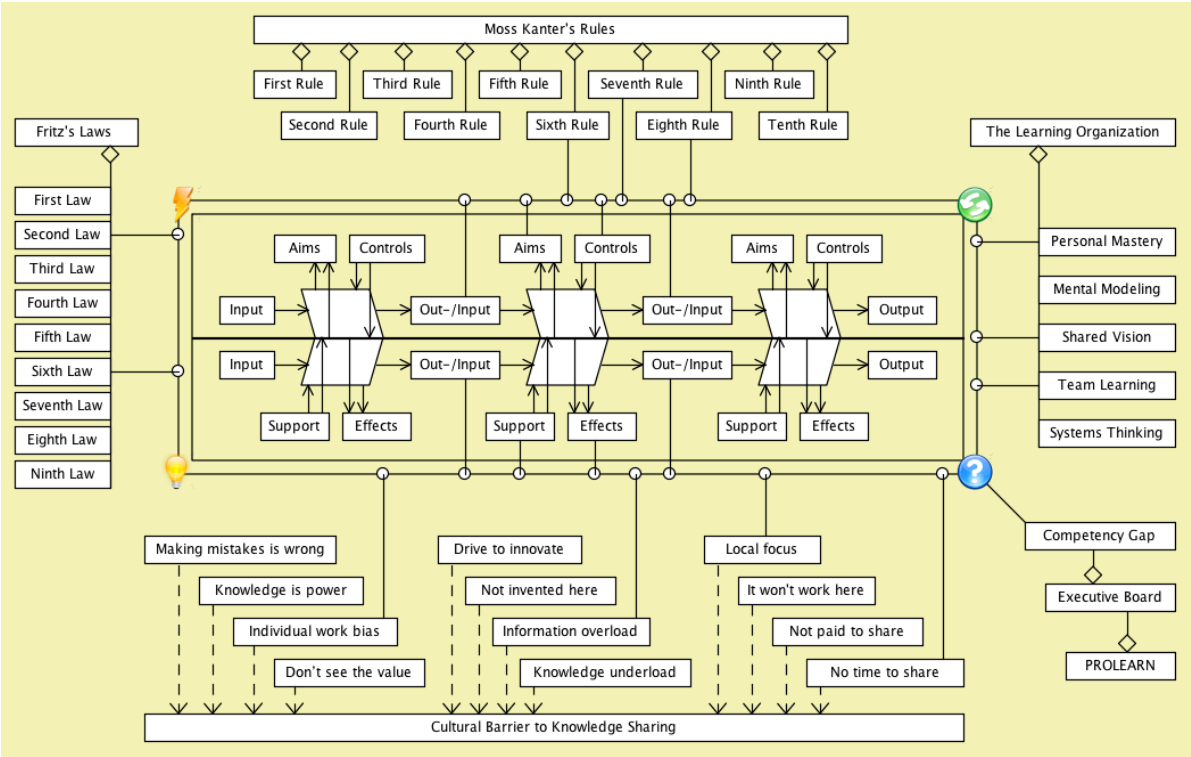

Figure 66. **Learning frame for the PROLEARN Executive Board with respect to the question "How do we deal with partners that do not deliver in accordance with the work plan?"**

Moreover, since the question relates to "Learning during PROLEARN" the learning frame is shown connected to the middle (= learning during) concepts of the PLPF for the PROLEARN EB. On the corresponding white dots it is possible to store information on how the corresponding PLPF concepts are connected with this specific question. On the icons shown in the corner of the learning frame, the progress in turning Handy's wheel of learning can be recorded. Figure 67 shows the learning frame with some of its pop-up information exposed.

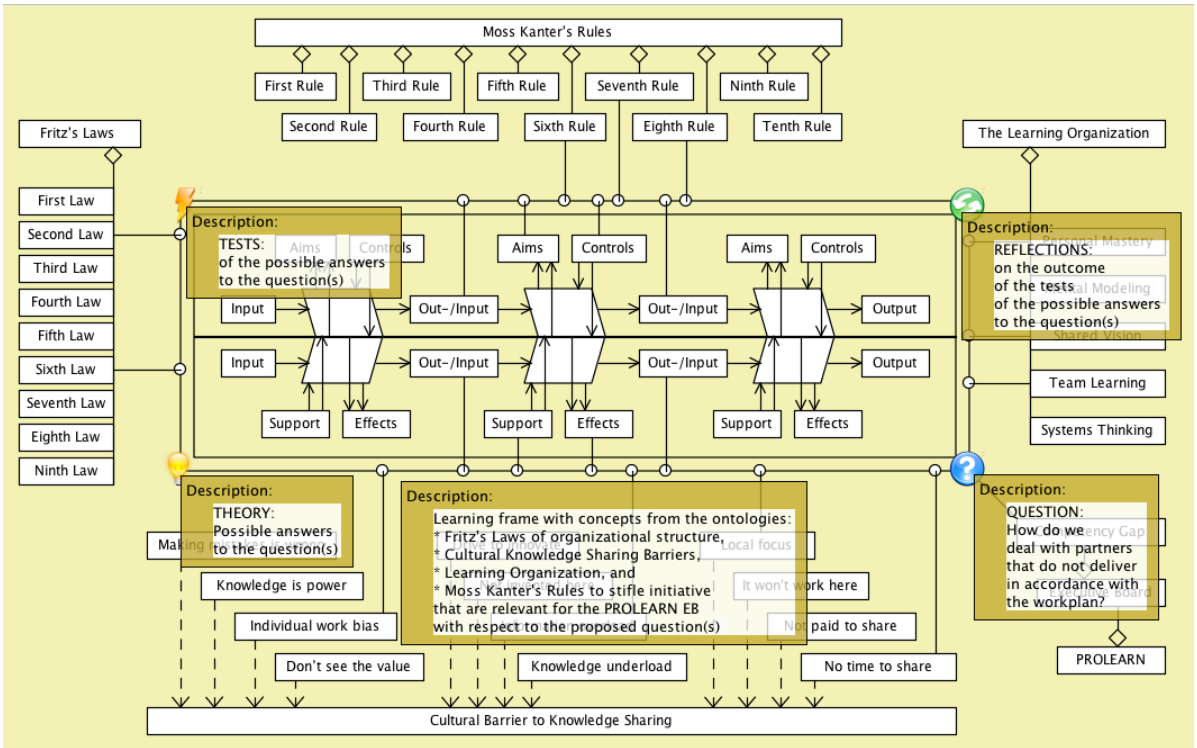

Figure 67. **Same learning frame as in Figure 66 with some of its pop-up metadata exposed**

12. CONCLUSIONS AND FUTURE WORK

12.1. Results achieved so far

In this deliverable we have introduced a number of different ideas and aspects on professional learning and shown how they can be used as discourse-supporting structures in a Professional Learning Process Framework that is powerful and flexible enough to encourage double-loop learning for both individuals and organizations. Moreover, this PLPF has been constructed in the Conzilla tool (with its Collaborilla service), which enables collaborative learning processes to be documented and shared across the web in a distributed fashion. The examples chosen have aimed at showing that the PLPF is powerful enough to be used for our own professional learning process - based on our own experiences within the PROLEARN project.

It is important to emphasize that the PLPF is completely open-ended, in the sense that any aspects (concepts, ontologies, theories, experiences, processes, …) that are deemed relevant to a specific Learning Frame can be brought in to support it in the same way as shown in section 11. Hence, the aspects on learning@work presented in this deliverable should be regarded as examples of such discourse-supporting material, and not as "the final word" on what is important for professional learning.

12.2. Expanding and disseminating the results beyond PROLEARN

According to the findings of WP6, there is potentially a significant worldwide B2B market for fast and cheap ways to identify and emulate the competencies and SECI processes of high-performing individuals, groups and organizations in any business sector. Within PROLEARN we are developing useful insights into how some of this might be done in idealized organizations (e.g., organizations that do not exhibit cultural barriers to knowledge sharing, which was discussed in section 2.4). The complexity of real-world organizations and the knowledge they create and manage is harder to represent, but a promising start has been made in the KMR group at KTH by using an information structure called a *Knowledge Manifold* [55]. A KM consists of a number of linked information landscapes (contexts), where one can navigate, search for, annotate and present all kinds of electronically stored information. A KM is constructed by conceptual modelling of a specific knowledge domain in order to capture its underlying thought patterns in the form of context-maps. The KMR group makes use of the KM architecture to construct a *human-semantic web* [57], which functions as a conceptual interface to the underlying (machine) semantic web.

The earlier introduced *concept browser*, *Conzilla*[35] ([56], [68]), which has been developed by the KMR group since 1999, supports the construction, navigation, annotation and presentation of the information stored in a knowledge manifold. Conzilla presents *content in contexts through concepts*. A concept is regarded as the boundary between its *inside*, which contains its content(-components), and its *outsides*, which represent the different contexts in which the concept appears. Conzilla has a human-semantic front-end and a (machine-) semantic back-end, and by using Conzilla, and its collaborative enhancement *Collaborilla* [22], the human-semantic web can be constructed in a collaborative fashion [23] - reusing globally identifiable concepts across different contexts.

Collaborilla makes it possible to:
- Reuse and extend contributions published by others. (For example, students can refine "skeleton maps" published by teachers).
- Create new context-maps that include existing concepts and concept-relations from other publishers.
- Add content to the contributions of others,
- Add comments (metadata) on the contributions of others.

The overall aim of Collaborilla is to support distributed discourse management, more precisely, to support agreement- and disagreement management in the form of "bottom-up conceptual calibration" by building "conceptual bridges" between different perspectives (context-maps), thereby agreeing, disagreeing, commenting on, or refining each others' concepts and/or concepts-relations.[36]

The main point with constructing the PLPF as a Knowledge Manifold in Conzilla is that it can be made available online and expanded by Technology Enhanced Professional Learners on a global basis. This enables a value-accumulating process where learning experiences can be refined and shared within and between different

[35] www.conzilla.org

[36] This type of activity is already going on within the community of students of the PROLEARN Summer Schools.

communities of practice for TEPL across the world.[37] By brokering this potentially global professional learning process, PROLEARN has a change of establishing a type of activity that could support itself beyond the EU-based funding of the NoE.

12.3. Connections with the PROLEARN Sustainability Review (D10.10)

Several Conzilla-based Knowledge Manifolds related to PROLEARN have already been constructed and are being continually expanded.[38] They include Conzilla models of

- the PROLEARN NoE [39]
  (http://www.conzilla.org/projects/roadmapping/presentation/CM#87070109b7c16962241)
- the PROLEARN Roadmapping process
  (http://www.conzilla.org/projects/roadmapping/presentation/CM#15a94f1105ee8e827)
- the Collaborative Modelling efforts of the PROLEARN Summer Schools
  (http://www.conzilla.org/projects/roadmapping/presentation/CM#8c6f69109f3a81cd7)
- the PROLEARN Professional Learning Process Framework
  (http://www.conzilla.org/projects/roadmapping/presentation/CM#689e12113fcda8a0f)

The Conzilla model of the PROLEARN Summer School activities ties together four of the most successful tools that has been used within the PROLEARN NoE: Conzilla, Confolio, Flashmeeting, and PROLEARN TV. From a SECI perspective, the two latter tools have been mainly used to externalize tacit knowledge, while the two former ones have been mainly used to combine explicit knowledge. Plans are under way to combine Conzilla, Confolio, and Flashmeeting into a tool (CoCoFlash) that will leverage the synergetic power of the three separate tools to support knowledge creation along the entire SECI spiral. A first prototype (FlashFolio) combining some aspects of Flashmeeting and Confolio will be constructed during the fall of 2007 and presented in Deliverable 2.8 (due month 48).

The plans for tying together the models and tools discussed here into a self-sustainable PROLEARN Conceptual Web for TEPL will be presented in Deliverable 10.10 (the PROLEARN Sustainability Review).

13. ACKNOWLEDGEMENTS

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[37] This is also the reason why the PROLEARN Roadmapping process has been documented in Conzilla.

[38] In order to navigate (and contribute to) these models, you must presently install Conzilla 2.1, which can be done by pointing your web browser to www.conzilla.org, clicking "Download" and then "Launch". However, with the release of Conxilla (= AJAX-based Conzilla), which is planned for the near future, these maps will be viewable and navigable in an ordinary web browser.

[39] This is an "online showcase" of the structure and results of the Prolearn NoE modelled in Conzilla/Confolio with the key deliverables uploaded to the corresponding folders of the partner Confolios and connected as content to the corresponding Conzilla context.

[40] All listed URLs have been accessed on 2007-08-22.

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