A Hierarchical Modelling Approach to Intellectual Capital Development

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Abstract: An approach for intellectual capital development in an organisation is given. It is based on a new conception of knowledge and knowledge dynamics and raises the notion of knowledge conversions to the level of intellectual capital domains. Intellectual capital development can be modelled with this approach by means of general transformations between domains and between appropriate parts of these domains, which themselves are refined and modelled with general knowledge conversions. To attain this approach, a new conception of knowledge and knowledge dynamics is introduced. The knowledge conception is represented by a knowledge cube, a three-dimensional model of knowledge with types, kinds and qualities. The type dimension addresses the internal-external aspect of knowledge, seen from the perspective of the human being. The kind dimension distinguishes various knowledge kinds like propositional or procedural knowledge. Finally, in the quality dimension, several quality measures of knowledge are given. Built on this conception, knowledge dynamics is modelled with the help of general knowledge conversions between knowledge assets. A set of basic knowledge conversions is given in a way, such that more complex general conversions may be easily gained by building on this set. Through this conception, we gain a sound basis for knowledge management and development in an enterprise. Raising this knowledge development approach to the more strategic and resource-oriented intellectual capital level in an organisation, general transformations between the three main intellectual capital domains (individual competence, internal and external structure) and between parts of them can be described. With their help a model for intellectual capital development is gained: In a top-down approach, general transformations of intellectual capital are broken down to the notion of general knowledge conversions. This leads to development of the intellectual capital, i.e. to value creation in a company. To indicate the applicability of our approach, an example for the development of customer relations capital is given.

Keywords: intellectual capital development, transformations of intellectual capital, intangible resources, value creation, conception of knowledge, knowledge conversions

1. Introduction

The intellectual capital of a company is defined as all non-monetary and non-physical resources that are fully or partly controlled by the organisation and that contribute to the value creation of the organisation (Roos 2005). Three domains of intellectual capital can be distinguished: External structure is a family of intangible relationships with customers and suppliers, which partly may be converted into legal properties such as trademarks and brand names. The internal structure includes patents, concepts, models, IT systems and processes, which are created by employees and owned by the company. The third domain is the individual competence of the employees (see Sveiby 2001). This concept of intellectual capital helps to let intangible resources of a company be measured, communicated and interpreted. See (Andriessen 2004, Sveiby 2001 and Roos 2005) for more detail. Note, that also 5-domain models of intellectual capital exist. In these models the internal structure domain is renamed to structural capital and divided into organizational and technological capital. External structure is called relational capital and divided into business and social capital (Intellectus Model, IADE-CIC 2003 and Bueno 2006). As further and central domain, organizational culture is added in the proposed model in (Sánchez-Canizares et al. 2007).

Economic value creation of a company is based on intangible resources to a high and increasing degree. Development of intellectual capital of a company therefore is a key activity for value creation. Especially small and medium sized enterprises (SME) rely on intellectual capital commitments in clusters and networks for sustainable competitiveness (Mertins et al. 2010). Assessing and making transparent of intellectual capital is fostered by the German “Wissensbilanz” (Alwert et al. 2008) and the intellectual capital statement supported by the European commission (European Commission 2008).

In generalizing the transformation approach between intellectual capital domains given by Sveiby (Sveiby 2001), we introduce general transformations between whole domains and between intangible resources, which make up the intellectual capital domains. These transformations are drivers for intellectual capital development in a company on a strategic level. Using general n-to-m transformations instead of simple 1-to-1 transformations also recognizes the frontiers of linearity of the

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intellectual capital metaphor, where pieces do not necessarily sum up when brought together in a transformation (Bratianu 2009).

In a top-down approach, they can be refined to be modelled as general knowledge conversions. We introduce these general knowledge conversions based on a new conception of knowledge and knowledge dynamics. In a way our approach augments and complements the complex system approach to intellectual capital development, where in a hierarchical structure intellectual capital components, elements and variables together with their interconnections are identified. See (Bueno 2006) for an introduction into this kind of approach. It represents a static system view with only 1-to-1 interconnections, while our approach targets on dynamic n-to-m transformations. It is important to note however, and this a common core between the approaches, that our general transformations are taking course along interconnections, which can be identified with the complex system approach.

Our new conception of knowledge and knowledge dynamics establishes a sound basis for knowledge management in a company. A number of knowledge management approaches exists, including the classic asset-oriented, the process-oriented approach, the knowledge-intensive process-oriented and the community-oriented approach, see (Ammann 2008, Gronau/Fröming 2006, and Lehner 2008). While the management aspect of knowledge management seems to be understood to some extent, there is no common concept and understanding of knowledge and of knowledge development as basis for it. Existing approaches include the knowledge development model by Nonaka and Takeuchi (Nonaka/Takeuchi 1995), which is built on the distinction between tacit and explicit knowledge and on four fundamental knowledge conversions between those knowledge types (SECI-model), and the introduction of the type/quality dimensions of knowledge in (De Jong/Fergusson-Hessler 1996). Important distinctions of implicit knowledge (namely conscious, latent and tacit knowledge) are given in (Hasler Rumois 2007). Finally, Gorman describes types of explicit and tacit knowledge and their roles in technology transfer (Gorman 2002).

In this paper, we introduce a new conception of knowledge, which combines and resembles parts of existing approaches and extends them substantially. It is represented by a knowledge cube, a three-dimensional model of knowledge with types, kinds and qualities. The type dimension addresses the internal-external aspect of knowledge, seen from the perspective of the human being. Here explicit knowledge is a kind of interface between those two types, which drives human interaction and knowledge externalisation. This type dimension is crucial for knowledge management, because knowledge conversions in the explicit direction make the knowledge of employees more available. As second knowledge dimension, the kind dimension distinguishes various knowledge kinds, namely propositional, procedural and strategic knowledge, and familiarity. Finally, in the quality dimension, several quality measures of knowledge are given.

Using this conception we introduce general knowledge conversions between the various knowledge (and information) assets. First a basic set of such conversions is defined, which extends the set of the four conversions of the SECI-model. Building on this set, general knowledge conversions can be defined, which reflect knowledge transfers and development more realistically and do not suffer from the restrictions of the SECI-model. These conversions are the building blocks to model knowledge dynamics, i.e. all of acquisition, conversion, transfer, development and usage of knowledge.

General transformations of intellectual capital can be refined to general knowledge conversions. Following this path, we end up in an approach to model those general transformations on the level of knowledge dynamics, with a model at hand which has been introduced in this paper. In total, we present an approach for intellectual capital development based on refinement to the deeper level of knowledge conversions. These general knowledge conversions have been built up in a bottom-up approach, based on a new conception of knowledge and on basic knowledge conversions.

As an indication of the applicability of this approach, an example of the development of intellectual capital in the external structure domain in a company is given. This example aims at the development of the customer relations capital, more specifically at the introduction of an inquiry contact scheme for customers, developed under involvement of individual and organisational resources.

2. Intellectual capital domains and their transformations

Intellectual capital of a company is defined as all non-monetary and non-physical resources that are fully or partly controlled by the organisation and that contribute to the value creation of the

organisation (Roos 2005). Intangible assets, which are main contributors to intellectual capital, include legal assets like trade secrets, copyrights, patents and goodwill as well as competitive assets like knowledge, collaboration, leverage and structural activities. Legal intangible assets partly generate legal property rights, which are defensible in court of law, while competitive assets do not. The concept of intellectual capital helps to let intangible resources of a company be measured, communicated and interpreted. See (Andriessen 2004, Sveiby 2001 and (Roos 2005) for introductions into the discipline. Three domains of intellectual capital can be distinguished: External structure is a family of intangible relationships with customers, suppliers and other external stakeholders, which partly may be converted into legal properties such as trademarks and brand names. The internal structure includes patents, concepts, models, IT systems and processes, which are created by employees and owned by the company. The third domain is the individual competence of the employees (see Sveiby 2001). As already explained in the introduction, five domains of intellectual capital may be distinquished instead of only three. Our approach to intellectual capital development as described in this paper can be analogously applied to these 5-domains models.

Transformations between intellectual capital domains and between their parts are the means of intellectual capital development. The following two subsections introduce the concepts of domain transformations and of general intellectual capital transformations, respectively.

As an ongoing example the development of an inquiry contact scheme for customers as part of the external structure of a company is presented. While in this section this development undertaking is modelled on the intellectual capital layer (see Figures 2 and 3), it will then be refined to the layer of general knowledge conversion in section 3.

2.1 Transformations between domains

Intellectual capital development succeeds by means of the deployment and management of intellectual capital resources and their transformations (into other intellectual capital resources or into traditional economic resources) to enable and foster value creation in the organisation as seen by its stakeholders (changed from Roos 2005). Here transformation is understood as both conversion and transfer as will be clear in the following. The development of intellectual capital in a company is therefore modelled on an overall level by transformations between the three intellectual capital domains: external structure, internal structure and individual competence.

Basic intellectual capital domain transformations are 1-to-1 transformations between the three domains. There exist nine basic domain transformation, which are depicted in Figure 1. For example, the third transformation from external structure to individual competence applies to learning effects of employees of a company from customer, supplier and community feedback such as new ideas, experiences or new technology (see Sveiby 2001).

In reality intellectual capital development often succeeds not in this 1-to-1 manner, but relates to several domains on both source and destination sides of transformations. Therefore we generalise

this notion of basic domain transformations to general intellectual capital domain transformations, which are n-to-m transformation between the three domains. Figure 2 gives an example of a general 2-to-1 domain transformation. This is the high-level representation for our ongoing example; it models the development of the external structure under involvement of the individual competence and the internal structure domains.

Here resources from the individual competence and internal structure domains are utilized to enhance the external structure. In total there exist 43 general intellectual capital domain transformations, among the 9 basic transformations described before.

From an overall perspective, the notion of intellectual capital domains and of general domain transformations between them constitutes a meta-model for intellectual capital development. In the next sub-section, we instantiate the entities and relations of this meta-model and gain the notion of general transformations between the parts, i.e. the single resources, of the three domains.

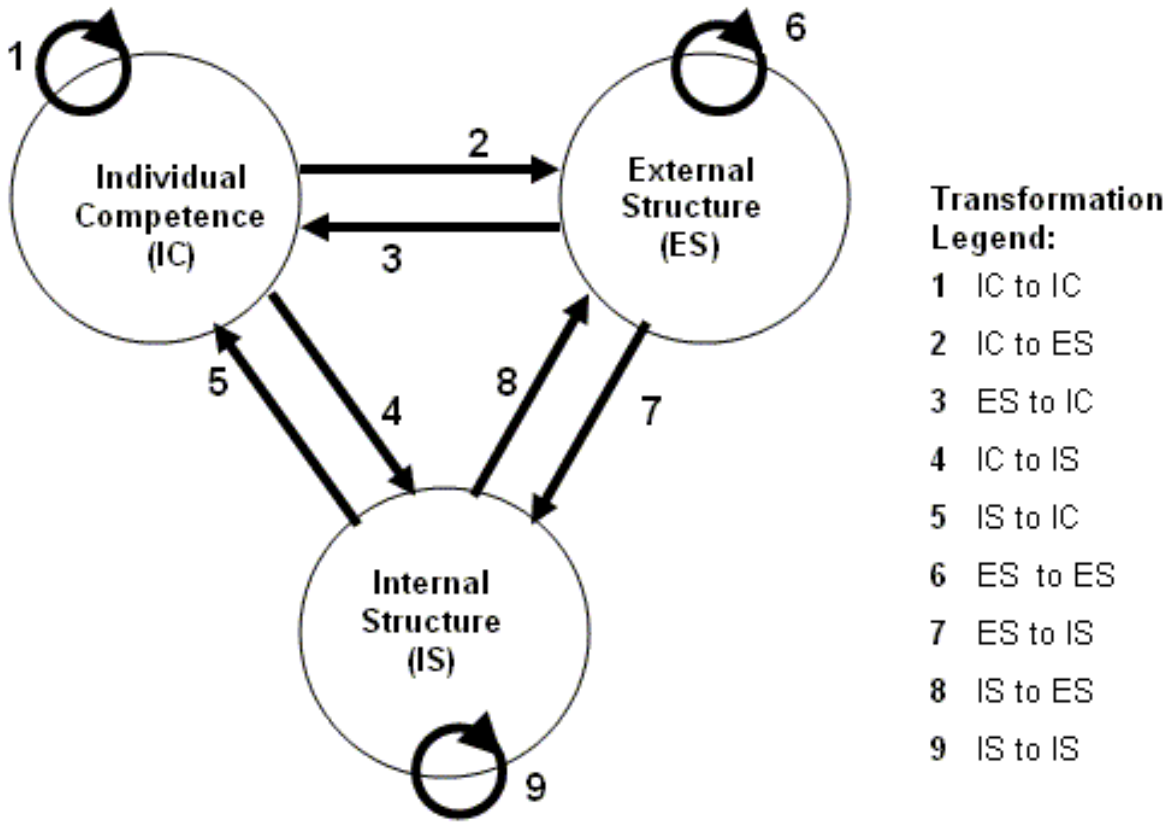

Figure 1: Basic domain transformations (reworked after (Sveiby 2001))

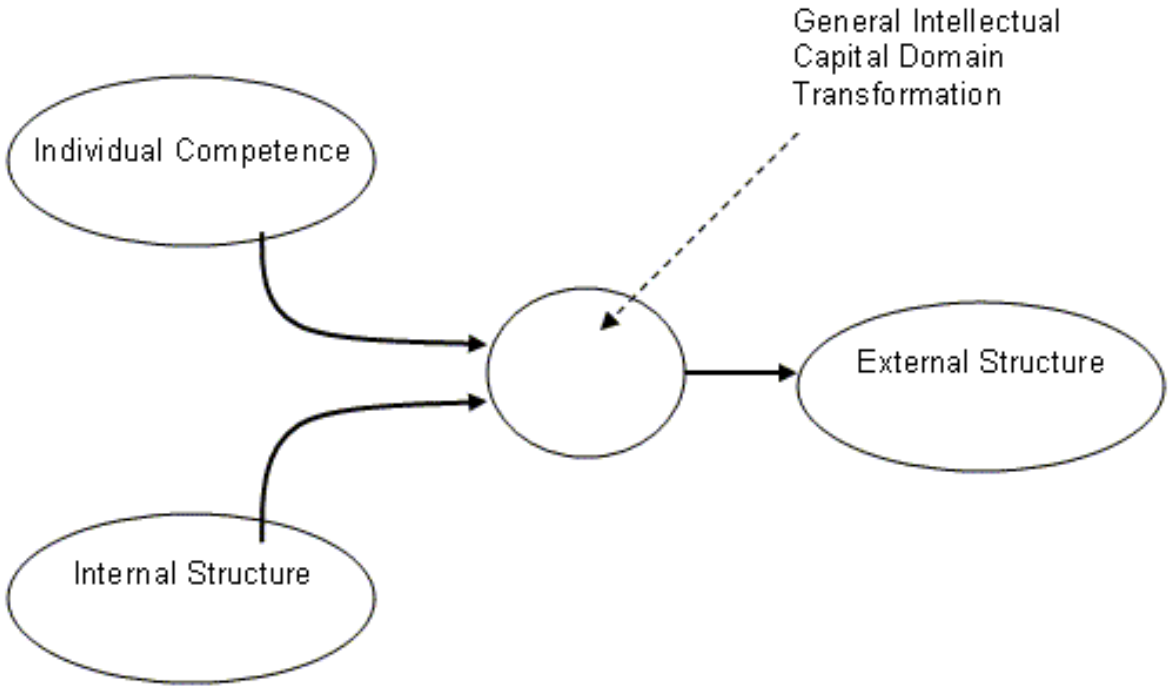

Figure 2: Example of a general domain transformation

2.2 General intellectual capital transformations

Going down one layer of abstraction we now treat single intellectual capital resources instead of the whole domains. In analogy to the domain transformations in the previous sub-section, we are able to introduce general intellectual capital transformations, which are n-to-m transformations between single resources. Figure 3 gives an example, where in a general intellectual capital transformation the

individual competences of several employees and contents of the internal structure are utilized in order to further develop the external structure of the company. Here the single resources are symbolically named together with the domain they are belonging to. An inquiry contact scheme and an information system for customers are to be developed.

As a method to identify the single arrow connections between source and destination assets in a general intellectual capital transformation of a company, the complex system approach (e.g. see Bueno 2006) can be used. Our approach augments and complements this approach to intellectual capital development, where in a hierarchical structure intellectual capital components, elements and variables together with their interconnections are identified in a more or less static way. Our dynamic n-to-m transformations would therefore utilize a set of possible interconnections identified with the complex system approach.

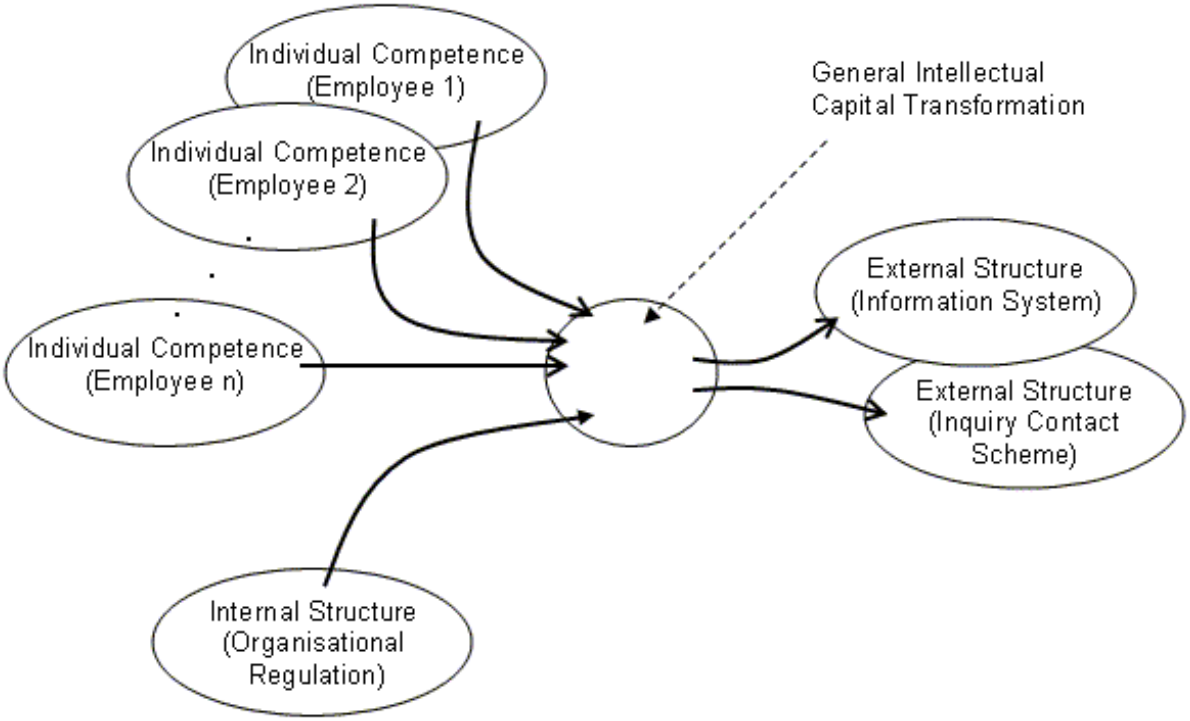

Figure 3: General intellectual capital transformation

In the next section, a new conception of knowledge and knowledge dynamics is introduced. The general knowledge conversions, which constitute knowledge dynamics, will be the means for refinement of general intellectual capital transformations. That means, that a general intellectual capital transformation can be broken down and modelled as a group of interrelated general knowledge conversions.

3. A Conception of knowledge and knowledge dynamics

In this section, a new conception of knowledge and knowledge dynamics in a company is described. More details of this conception are given in (Ammann 2009c).

3.1 Knowledge conception

We provide a conception of knowledge, and of knowledge types, kinds and qualities. As our base notion knowledge is understood as justified true belief (at least in the propositional kind), which is (normally) bound to the human being, with a dimension of purpose and intent, identifying patterns in its validity scope, brought to bear in action and with a generative capability of new information, see (Hasler Rumois 2007, Lehner 2008). It is a perspective of “knowledge-in-use” (De Jong/Fergusson-Hessler 1996) because of the importance for its utilisation in companies and for knowledge management. In contrast, information is understood as data in relation with a semantic dimension, but without the pragmatic and pattern-oriented dimension, which characterises knowledge.

We distinguish three main dimensions of knowledge, namely types, kinds and qualities, and describe those in the following three sub-sections. The whole picture leads to the three-dimensional knowledge cube, which is introduced at the end of this section.

3.1.1 The type dimension of knowledge

The type dimension is the most important for knowledge management in a company. It categorizes knowledge according to its presence and availability. Is it only available for the owning human being, or can it be communicated, applied or transferred to the outside, or is it externally available in the company's organisational memory, detached from the individual human being? It is crucial for the purposes of the company, and hence a main goal of knowledge management activities, to make as much as possible knowledge available, i.e. let it be converted from internal to more external types.

Our conception for the type dimension of knowledge follows a distinction between the internal and external knowledge types, seen from the perspective of the human being. As third and intermediary type, explicit knowledge is seen as an interface for human interaction and for the purpose of knowledge externalisation, the latter one ending up in external knowledge. Internal (or implicit) knowledge is bound to the human being. It is all that, what a person has "in its brain" due to experience, history, activities and learning. Explicit knowledge is "made explicit" to the outside world e.g. through spoken language, but is still bound to the human being. External knowledge finally is detached from the human being and may be kept in appropriate storage media as part of the organisational memory. Figure 4 depicts the different knowledge types.

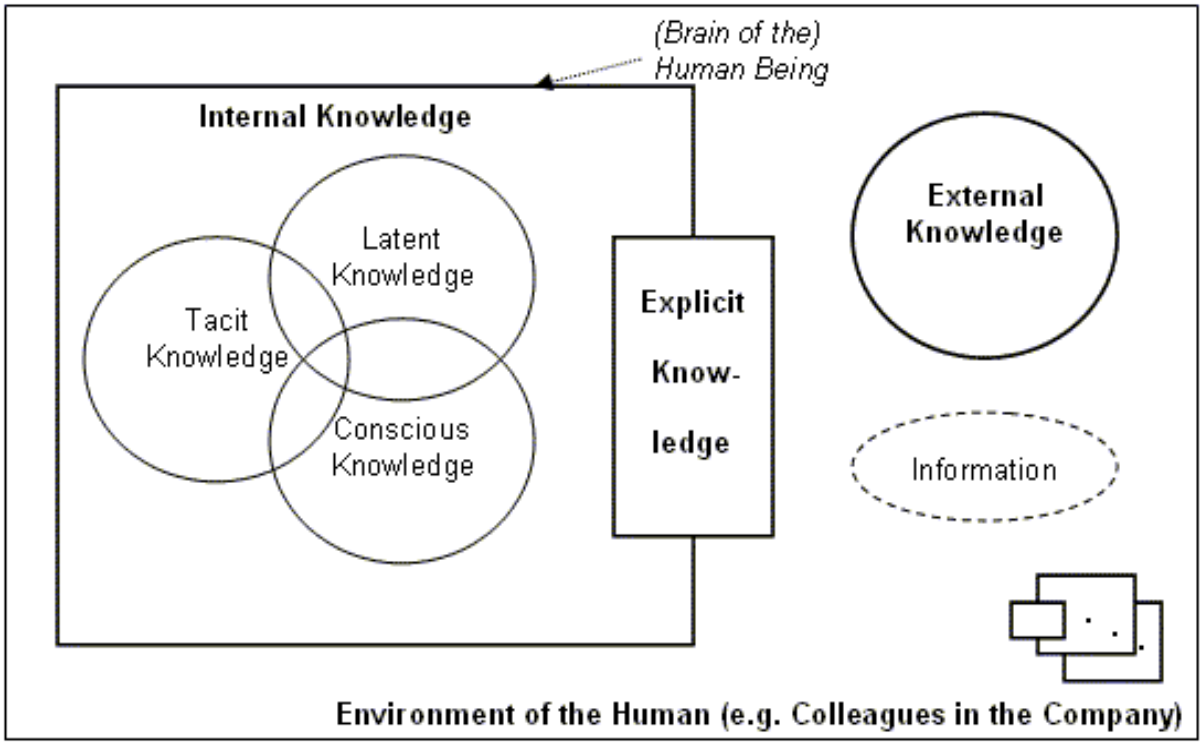

Figure 4: Conception of knowledge types

Internal knowledge can be further divided into tacit, latent and conscious knowledge, where those subtypes do partly overlap with each other, see (Hasler Rumois 2007). Conscious knowledge is conscious and intentional, is cognitively available and may be made explicit easily. Latent knowledge has been typically learning as a by-product and is not available consciously. It may be made explicit, for example in situations, which are similar to the original learning situation, however. Tacit knowledge is built up through experiences and (cultural) socialisation situations, is specific in its context and based on intuition and perception. Statements like "I don't know, that I know it" and "I know more, than I am able to tell" (adapted from Polanyi 1966) characterise it.

3.1.2 Kind dimension of knowledge

In the second dimension of knowledge, four kinds of knowledge are distinguished: propositional, procedural and strategic knowledge, and familiarity. It resembles to a certain degree the type dimension as described in (De Jong/Fergusson-Hessler 1996). Propositional knowledge is knowledge about content, facts in a domain, semantic interrelationship and theories. Experience, practical knowledge and the knowledge on "how-to-do" constitutes procedural knowledge. Strategic knowledge is meta-cognitive knowledge on optimal strategies for structuring a problem-solving approach. Finally, familiarity is acquaintance with certain situations and environments, it also resembles aspects of situational knowledge, i.e. knowledge about situations, which typically appear in particular domains.

3.1.3 Quality dimension of knowledge

The quality dimension introduces five characteristics of knowledge with an appropriate qualifying and is independent of the kind dimension, see (De Jong/Fergusson-Hessler 1996). The level characteristics aims at overview vs. deep knowledge, structure distinguishes isolated from structured knowledge. The automation characteristic of knowledge can be step-by-step-doing by a beginner in a domain of work or automated fast acting by an expert. All these qualities of knowledge measure along an axis and can be subject to knowledge conversions, see section 3. Modality as the fourth quality of knowledge asks for the representation of it, be it words versus pictures in situational knowledge kinds, or propositions versus pictures in procedural knowledge kinds. Finally, generality differentiates general versus domain-specific knowledge. Knowledge qualities apply to each knowledge asset.

3.1.4 The knowledge cube

Bringing all three dimension of knowledge together, we gain an overall picture of our knowledge conception. It can be represented by the knowledge cube, as shown in Figure 5.

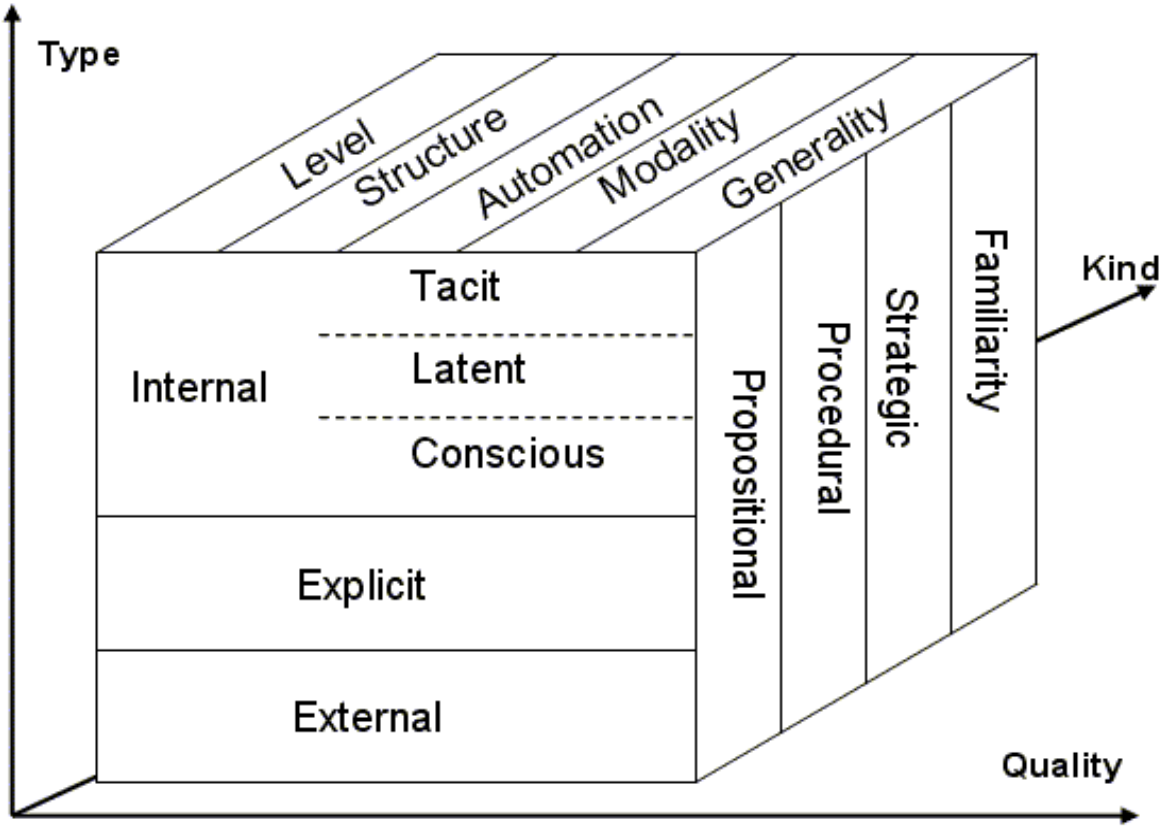

Figure 5: The knowledge cube

Note, that the dimensions in the knowledge cube behave different. In the type and kind dimensions, the categories are mostly distinctive (with the mentioned exception in the sub-types), while in the quality dimension each of the given five characteristics are always present for each knowledge asset.

3.2 Knowledge dynamics

In this section we give a conception of knowledge conversions. The transitions between the different knowledge types, kind and qualities are responsible to a high degree for knowledge development in an organisation. These general knowledge conversions are the building blocks to model knowledge dynamics, i.e. all of acquisition, conversion, transfer, development and usage of knowledge, in an enterprise. Most important for knowledge management purposes are conversions between the knowledge types and they will be the focus in the following. Among those especially those conversions, making individual and internal knowledge of employees usable for a company, are crucial for knowledge management. The explicitation and externalisation conversion described in this section achieve this. Implicitly, socialisations between tacit knowledge of different people also may contribute to this goal.

3.2.1 Basic knowledge conversions

Five basic knowledge conversions in the type dimension are distinguished here: Socialisation, explicitation, externalisation, internalisation and combination. Basic conversion means, that exactly one source knowledge asset is converted into exactly one destination knowledge asset. Furthermore exactly one knowledge dimension is changed, i.e. the type dimension in this case. More complex conversions may be easily gained by building on this set as described later in the sub-section 3.2.2. They will consist of n-to-m-conversions and include information assets in addition.

Socialisation converts tacit knowledge of a person into tacit knowledge of another person. For example, this succeeds by exchange of experience or in a learning-by-doing situation. Explicitation is the internal process of a person, to make internal knowledge of the latent or conscious type explicit, e.g. by articulation and formulation (in the conscious knowledge type case) or by using metaphors, analogies and models (in the latent type case). Externalisation is a conversion from explicit knowledge to external knowledge or information and leads to detached knowledge as seen from the perspective of the human being, which can be kept in organisational memory systems. Internalisation converts either external or explicit knowledge into internal knowledge of the conscious or latent types. It leads to an integration of experiences and competences in your own mental model. Finally, combination combines existing explicit or external knowledge in new forms. These five basic knowledge conversions are shown in Figure 6.

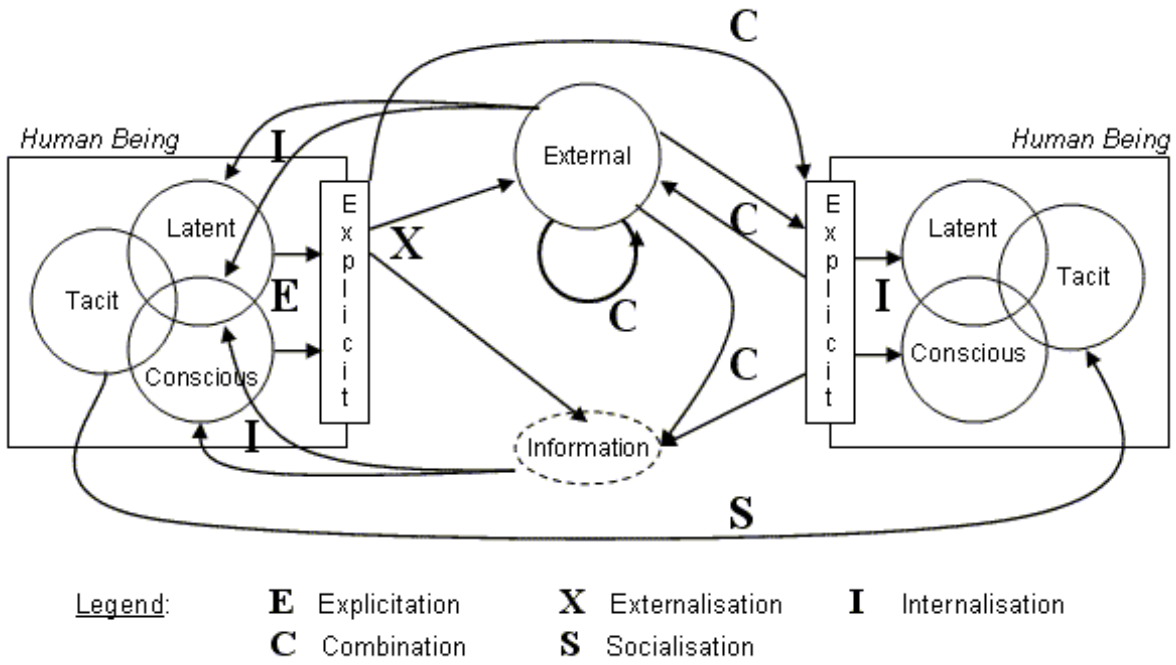

Figure 6: Basic knowledge conversions in the type dimension

The Nonaka/Takeuchi-model (Nonaka/Takeuchi 1995) uses four basic knowledge conversions in the sense defined above and interacts in a spiral of knowledge creation, which becomes larger in scale as

it moves up the ontological dimension from the individual to groups and the whole organisation. This limiting linearity of its knowledge development spiral concept and the restriction to basic conversions in their approach have been criticised, besides the discussions on the meaning of explicit knowledge.

Basic knowledge conversions in the kind dimension of knowledge are very seldom, normally the kind dimension of knowledge remains unchanged in a knowledge conversion changing the type dimension. Those in the quality dimension are mostly knowledge developments aiming at quality improvement and will not change the type and kind dimensions of the involved knowledge assets. In three out of the five quality measures, basic conversions can be identified, which are working gradually. Those are, firstly, a deepening conversion, which converts overview knowledge into a deeper form of this knowledge. Secondly, a structuring conversion leading to a change in the singular-versus-structure scale of the structure measure. And finally, conscious and step-by-step-applicable knowledge may convert into automated knowledge in an automation conversion, which describes a process from beginner to expert in a certain domain. The remaining two quality measures of knowledge, namely modality and generality, do not lend themselves to knowledge conversions. They just describe unchangeable knowledge qualities.

3.2.2 General knowledge conversions

Our conception allows the generalisation of the basic five knowledge conversions described above. General knowledge conversions are modelled converting several source assets (possibly of different types, kinds and quality) to several destination assets (also possibly different in their knowledge dimensions). In addition, information assets are considered as possible contributing or generated parts of general knowledge conversions. Note, that a general knowledge conversion may change any knowledge dimension of the involved knowledge assets.

For example, in a supervised learning-by-doing situation seen as a complex knowledge conversion, a new employee may extend his tacit and conscious knowledge by working on and extending an external knowledge asset in a general conversion, using and being assisted by the tacit and conscious knowledge of an experienced colleague. A piece of relevant information on the topic may also be available on the source side of the conversion. See Figure 7 for a visual representation of this general knowledge conversion in the BPMN-KEC2 notation for knowledge-intensive business processes (Ammann 2009a). Here the grey-shading of knowledge objects is decreasing as the corresponding knowledge asset is becoming more externalized. The additional tagging of knowledge assets with their specific knowledge type and their knowledge kind has been omitted in Figure 7 for the sake of clarity.

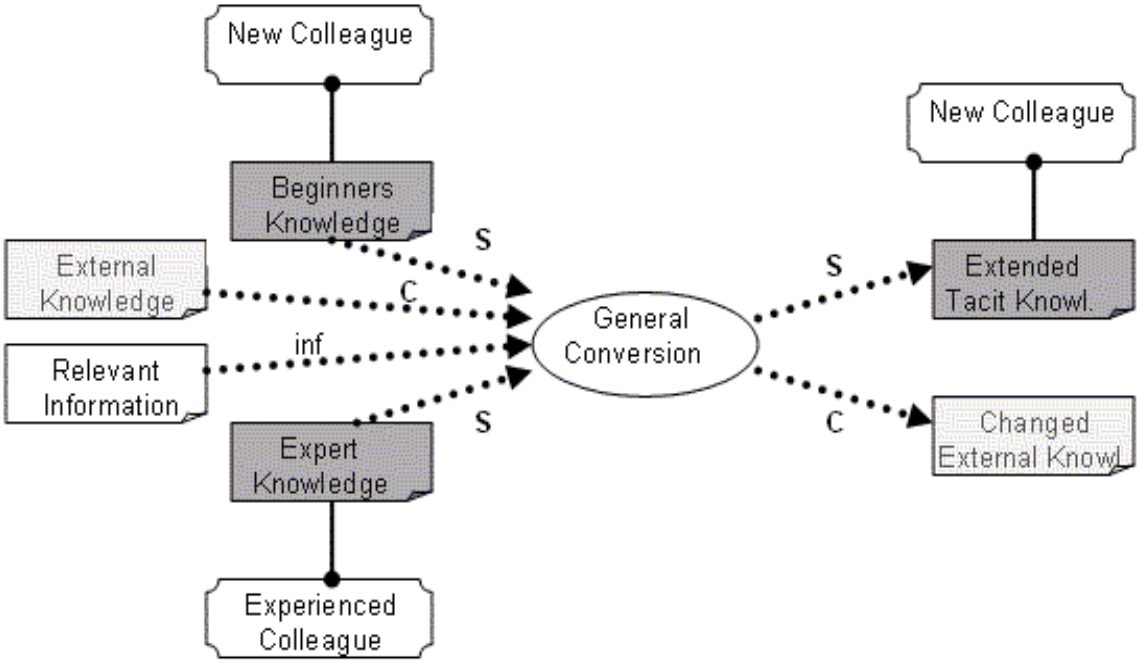

Figure 7: Supervised learning-by doing situation

4. Implementation of intellectual capital transformations

Section 2 described the path down from the three intellectual capital domains, to basic and general domain transformations and finally to general transformations between parts of the three domains. Section 3 laid the foundation in form of a knowledge conception and of basic and general knowledge conversions. Implementation of intellectual capital development activities now succeeds by sticking the two parts together. The important thing to this end is the refinement of general intellectual capital transformations as composition of general knowledge conversions. This means to refine a more strategic view of intangible resources and their transformations to a more operative view of knowledge and knowledge conversions. Important to note is, that human-to-human interactions, which are a substantial part in intellectual capital development activities, can also be modelled with the help of our knowledge dynamics approach (see Ammann 2009b). From an overall perspective, the top-down approach from intellectual capital domains and their transformations meets the bottom-up approach from knowledge and knowledge conversions, see Figure 8. Hence our approach to intellectual capital development can be seen as appropriate combination of the two single approaches.

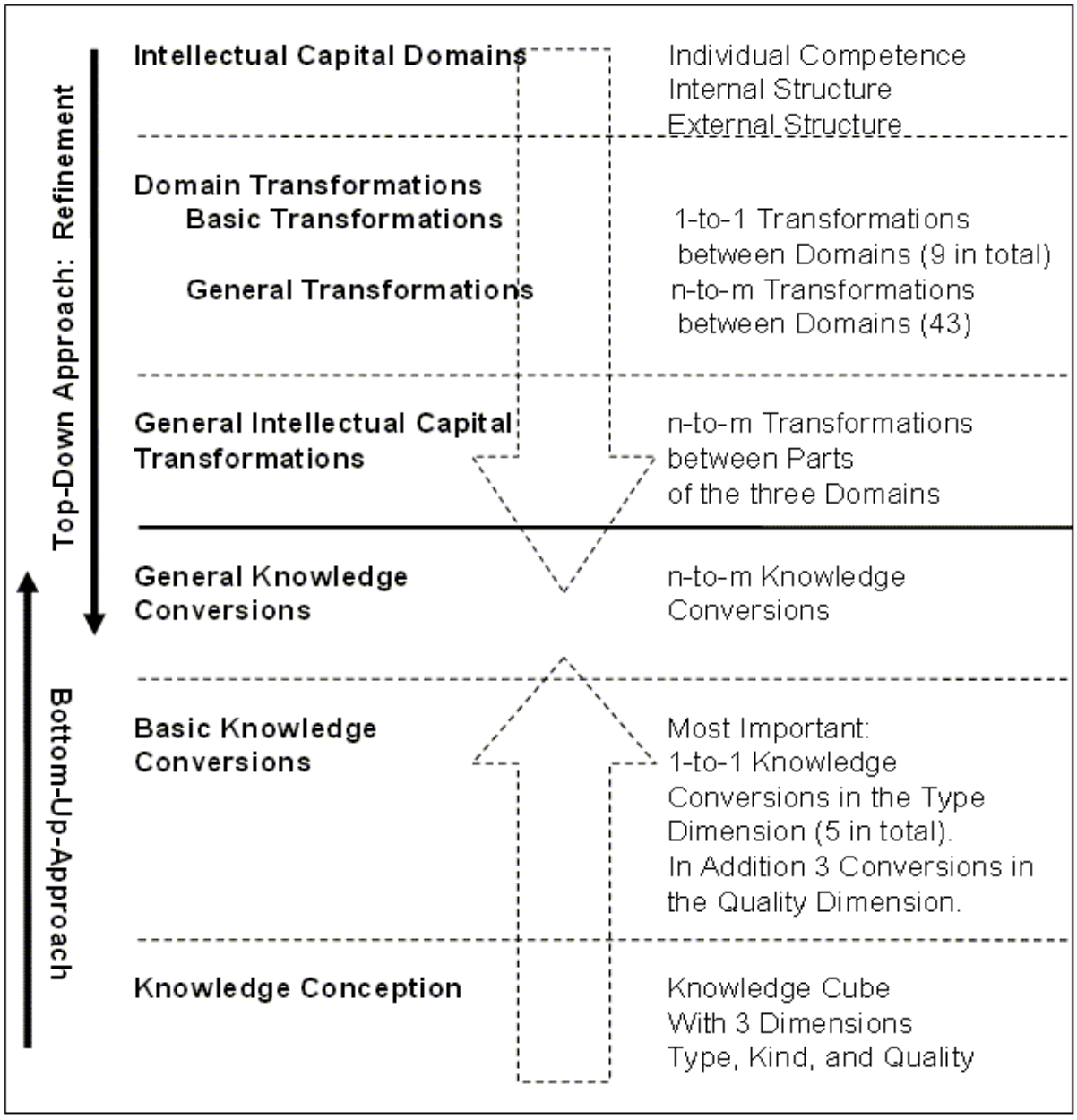

Figure 8: Layers of modelling

In the ongoing example, the development of a inquiry contact scheme for customers is described, which would allow customers to selectively contact appropriate employees of the company and/or use a customer information system. To this end Figure 2 in section 2 gave the general 2-to-1 domain

transformation, involving individual competence and internal structure domains on the source side and external structure on the destination side. Figure 3 broke this down into a general (n+1)-to-2 intellectual capital transformation, having several employees with their individual competences and organisational regulations on the source side and two external structure resources (customer information system, customer inquiry scheme) on the destination side. Here we concentrate on the inquiry scheme introduction and restrict n to 4. Figure 9 shows a sequence of general knowledge conversions, which together refine the general intellectual capital transformation (at least the first part of this activity until a documented proposal of a customer inquiry scheme). Two sales persons, a sales manger and a developer bring in their competences, a security person seen as part of the internal structure guarantees the compliance of the inquiry scheme to security regulations in the organisation. Note, that in Figure 9 the knowledge objects are tagged. The internal knowledge objects of the sales person 1 and the developer are of subtype conscious as defined in section 3. The three explicit and external knowledge objects all have the propositional knowledge kind.

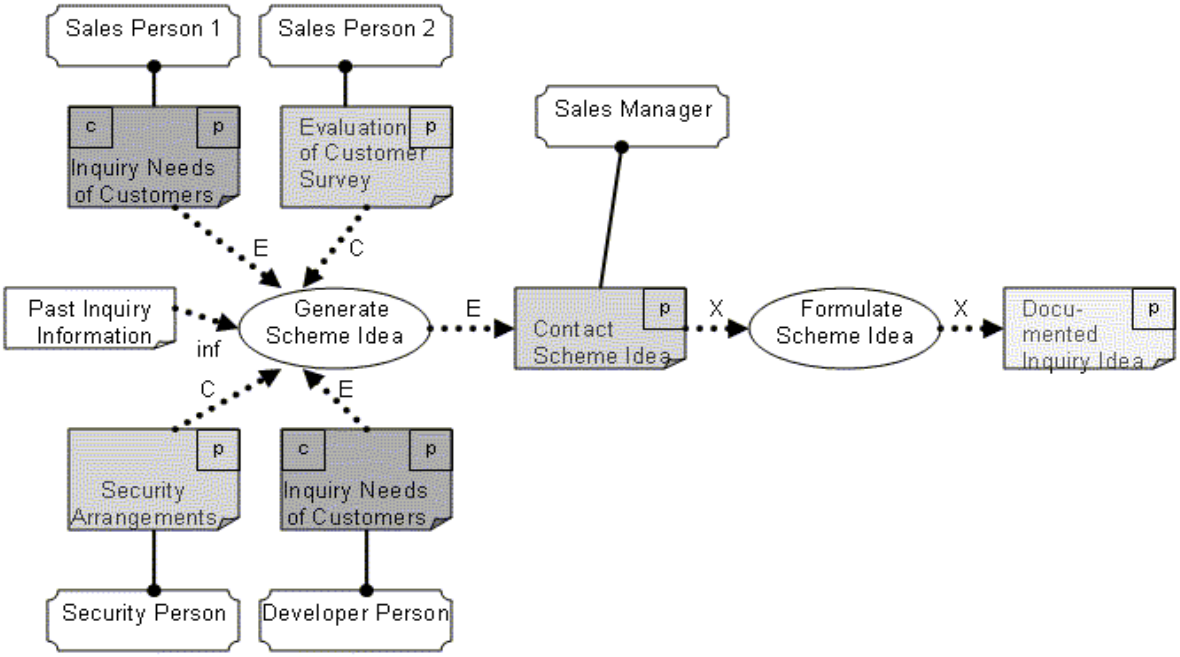

Figure 9: Propose customer inquiry scheme (refinement of Figure 3)

5. Summary and conclusion

An approach for intellectual capital development has been given, which is based on general transformations between whole domains and between parts of the three intellectual capital domains. These transformations can be refined to general knowledge conversions. In order to attain these knowledge conversions, a new conception of knowledge has been described. Built on it, knowledge dynamics in a company can be described with the help of general knowledge conversions.

In the end, a comprehensive and overall approach for intellectual capital development has been gained. From the strategic domain level it refines overall development undertakings to more operative knowledge conversions, while from the knowledge management perspective it builds up from a new knowledge conception. Unlike existing approaches, it not only identifies and describes one-to-one interrelationships between intellectual capital domains and between parts of them, but general many-to-many transformations, which are further refined to the knowledge development level.

To indicate the applicability of this approach, an example of the development of intellectual capital in the external structure domain in a company has been given. Specifically the given example targets at the development of the customer relations capital of a company by introducing an inquiry scheme for the company's customers.

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