Visualizing Organizational Competences: Problems, Practices, Perspectives

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Abstract: Although receiving significant attention in management research, the organizational competence concept still remains difficult to apply, due to the vagueness of the theoretical construct, and due to the lack of pragmatic procedures to make it actionable. According to recent research, knowledge visualization may mitigate the elusiveness of the competence concept by assisting the identification, management, and communication of competences. In this paper, we thus review the academic literature in search for conceptual representations designed to support organizational competence mapping at the intra-, and inter-organizational level. By taking a synoptic overview of the collected representations, we single out the building blocks of competence visualization, and develop a corresponding classification. Drawing on this classification, we position twelve existing competence representation methods in an integrative framework to assist practitioners in selecting the right representation method and to inform scholars about future research and development needs.

Keywords: Organizational competences, competence management, competence visualization, competence mapping
Categories: M.0, M.3, M.4, M.8, M.9

1 The Need for Competence Visualization

Introduced by Prahalad and Hamel on the basis of the resource-based view of the firm, the concept of core competence has received widespread recognition within the academic literature in the management domain. In their seminal article, [Prahalad, 90] defined a core competence as the collective learning of an organization, providing "the glue that binds existing businesses, and the engine for new business development". More importantly, core competences lead to sustainable advantage, because they are resistant to imitation, central to customer value, and conducive to market penetration. Therefore, accurate analysis of core competences is necessary in order to profitably exploit internal resources, and to correctly identify external opportunities [ibid]. Whilst the relevance of the competence perspective is never contested, the actual detection of competences can be quite difficult due to the vagueness of the theoretical construct. As pointed out by several researchers, the competence concept remains at an abstract level, leaving practitioners without clear guidance for the application stage [Klein, 98; Javidan, 98; Mills, 02; Tampoe, 94; Walsh, 01]. Recognizing the need for operational definitions, concerned scholars in

diverse domains set out to develop procedures for assisting competence management. According to a broad definition, *competence management* has the primary objective to identify, maintain, and develop competences in agreement with the corporate strategy [Berio, 05]. In the domain of *knowledge management*, knowledge-based techniques can be used to understand and manage the firm's competence configuration in order to create sustainable advantage [Roos, 92; Berio, 05; Sawyer, 06]. In a similar way, a research stream in *strategic management* deals with the clarification of the competence concept, and the definition of practitioner guidelines for competence management [Javidan, 98; Tampoe, 94; Torkkeli, 02; Walsh, 01]. In the field of *computer science*, IT-based competence management systems are designed for collecting, analysing and representing large amounts of data about organizational competences [Klein, 98; Lindgren, 02; Pareto, 07]. Alongside the literature streams described above, *competence visualization* is gradually emerging as a meta-discipline which explores the use of visual representations to support competence management. In this regard, *visual frameworks* for competence management are found within - and at the intersection of - knowledge management, strategic management, and computer science [Fig. 1]. By comparing the three literature streams, we can identify key topics regarding the *content*, *methodology*, and *theoretical* soundness of competence visualizations, as described below.

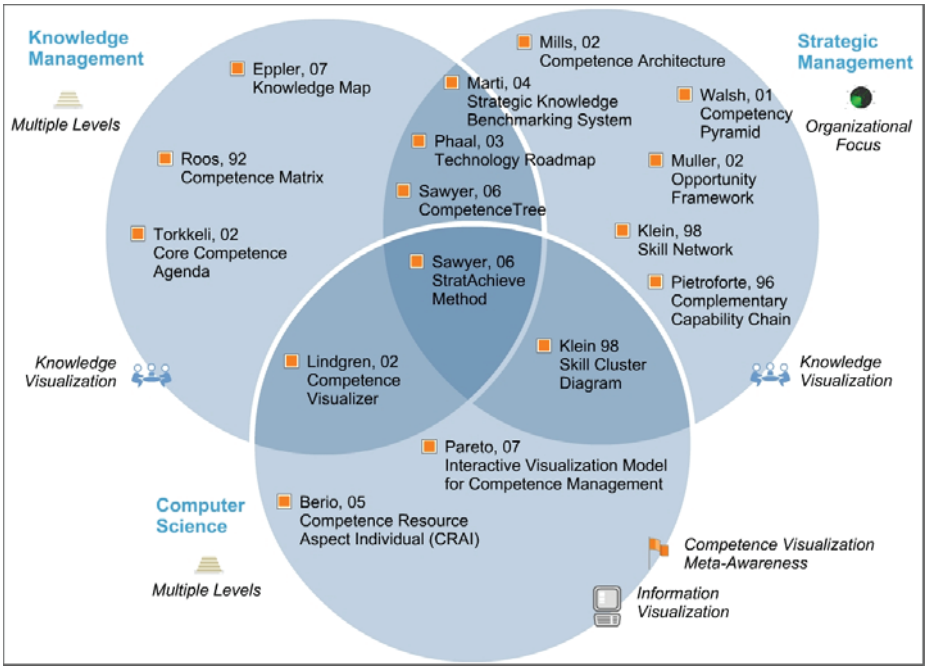


Figure 1: Visual Frameworks for Competence Management: A Literature Mapping

Visualization content. Whereas the strategy literature focuses essentially on organizational competences, knowledge management and computer science attempt to integrate the three levels of individual, team, and organizational competences [e.g.

Lindgren, 02; Pareto 07]. In particular, computer science exhibits a high level of interdisciplinarity, as several contributions include findings from organization studies, knowledge management and strategic management, in the attempt to define an ontology of competence modelling [e.g. Berio, 05; Sawyer, 06].

Visualization methodology. On the one side, computer science is focused primarily on information visualization, namely the interactive representation of competence data for amplifying cognition about organizational competences. On the other side, the organizational or strategic literature is oriented towards knowledge visualization, intended as the joint production of visual representations for sharing knowledge about organizational competences.

Visualization theory. A difference can be drawn between computer science and organizational research (i.e. most of knowledge management and strategic management) as regards the degree of meta-awareness about competence visualization as a scientific domain. The research stream in computer science explicitly points to the necessity, as well as to the challenge of effectively visualizing data in competence management systems [Klein, 98; Lindgren, 02; Pareto, 07]. As an example, [Klein, 98] underline the relevance of visual depictions to cognitive processes, and accordingly shift their focus toward competence metaphors and diagrams, beyond the computer-based representation of data. Conversely, the organizational literature is less concerned with the systematic application of visualization methods to competence management; although with few exceptions [Eppler, 07; Mills, 02; Phaal, 03], organizational researchers generally develop visual frameworks without making systematic reference to visualization theory.

Despite receiving a rather unsystematic treatment in the organizational literature, graphic depictions may play a catalyst role in identifying, managing, and communicating organizational competences. With the term graphic depictions, we refer - in this paper - to conceptual, diagrammatic representations of organizational competences, produced in a non-automated manner, with or without the use of dedicated software. The reasons for focusing on knowledge visualization - as opposed to information visualization - are threefold, and all take into consideration the fundamental essence of competences. First, conceptual representations give account for the knowledge intensity of competences, defined in terms of collective learning [Prahalad, 90], actionable know-how [Roos, 92], and skill network [Klein, 98]. A non-automated mapping approach supports the sense making and clarification process about such collective learnings and can lead to new meta-knowledge. Second, while information visualization supports the representation of known competences, knowledge visualization assists the detection of unknown competences, thus bringing the identification process a step forward. Third, knowledge visualizations can be seen as experimental proto-stages for information visualization applications, providing conceptual frameworks for representing data in competence management systems [Klein, 98].

A variety of crucial *benefits* can be associated with the use of visualization by, for example, cross-functional teams concerned with the overall process of competence management. First, visualization may facilitate *competence identification*, and ultimately contribute to the constitution of 'organizational self-knowledge' [Rulke, 00], by increasing managers' awareness of organizational competences. Conceptual representations assist the elicitation of tacit knowledge [Mengis, 07] and clarify the

connections among organizational competences and resources [Mills, 02]. In addition, conceptual representations may promote a shared understanding of competences, by acting as "boundary objects" [Carlile, 04]. Conceptual representations provide a common structure with the potential to facilitate knowledge integration across individual, functional and organizational boundaries. Visualization also allows for reviewability and revisability [Mengis, 07], thus facilitating the collective refinement of the elicited competences. By re-examining arguments with the use of visual frameworks, team members can build common ground [ibid], and ultimately achieve a co-constructed understanding of organizational competences.

In addition to facilitate competence identification, visualization may assist *competence management*, with particular reference to the processes of competence alignment, exploitation, and exploration. Competence visualization may facilitate the integration and alignment of distinctive competences with an organizational strategy. As an example, the competence tree by [Sawyer, 06] visualizes operational and core competences in a hierarchical connection to the corporate vision, and to the success factors in a competitive domain. Competence visualization may also support the competence agenda by directing the exploration of novel competences, and guiding the exploitation of existing competences. In this regard, the core competence agenda matrix by [Torkkeli, 02] relates novel and existing competences with novel and existing product markets. By assisting competence planning, visualization ultimately helps avoiding 'competence traps', defined in terms of a dysfunctional imbalance between knowledge exploration and exploitation [Liu, 06].

Finally, visualization may support *competence communication* to external audiences, thus contributing to build the perceived distinctiveness of an organization. The clear illustration of organizational competences can foster stakeholder relations, by facilitating the attraction of potential investors, clients, and employees. In particular, competence visualization may be pivotal for strategic alliances, supporting the *inter-organizational communication of competences*. In this context, visualization may facilitate the decision to enter a strategic alliance, enabling prospect partners to understand each others' resources, foresee competence complementarities, and estimate the potential value of an alliance. Visualization may support on-going collaboration, by assisting corporate partners in appreciating reciprocal competences, and identifying a suitable direction for their joint activities. Competence visualization may permit to connect co-workers across the partner organizations, and to define interaction rules for expanding the collaboration beyond specific projects; as summarized by a manager of the Philips-Swarovski partnership interviewed by us: "Competence visualization is central for the early stages of a strategic alliance, serving not just planning purposes, but also mutual understanding and trust building".

2 Current Practices of Competence Visualization

Having illustrated the importance of graphic competence representations in intra- and inter-organizational settings, we now proceed with a critical review of the competence visualizations thus far developed in the academic literature. For this purpose we have screened methods across the domains of strategic management, technology management, knowledge management, and alliance management research. In particular, the current review is focused on competence frameworks, intended as

conceptual instruments for assisting competence management. In searching the academic literature, we have collected a total of twelve frameworks with substantial applicability to competence management in the intra- and inter-organizational setting. Since a detailed review of the collected frameworks is beyond the scope of the present article[1], an attempt is made to provide a general overview of competence visualization, by introducing a simple overview classification [Tab. 1]. We have developed this classification in order to identify the building blocks of competence visualization. As a result, the classificatory dimensions capture the fundamental components of competence representations, and converge to define a tentative ontology of this domain. As an organizing principle for this overview, we use the five main interrogatives of what, how, why, for whom and where.

What?	How?	Why?	Whom?	Where?
Core competence	Hierarchical	Identification	Int. Audience	In praesentia
Competence	Supportive	Development	Ext. Audience	In absentia
Supportive comp.	Temporal	Allocation		
Operational comp.	Matching	Communication		
Resources				

Table 1: Classification of competence visualization elements

The *what dimension* refers to the content represented in a competence visualization. In particular, *core competence* is the collective knowledge of an organization, essential to the implementation of a strategic vision, and critical for long-term survival [Prahalad, 90; Tampoe, 94]. By contrast, a *competence* is functionally-based, and represents 'ordinary' knowledge which contributes to organizational success, although without being conducive to sustainable advantage per se [Mills, 02; Tampoe, 94]. A *supportive or dynamic competence* is meta-knowledge with the potential to enhance ordinary competences, with applicability to a wide range of organizational activities [Mills, 02; Winter, 03]. Finally, *operational competence (or skill)* is procedural knowledge with reference to a series of processes and routines whereby the organization coordinates the interaction among resources [Javidan, 98; Torkkeli, 02]. In this context, *resources* represent the building blocks of organizational competences, and include tangible resources such as plants, technology, and equipment, as well as intangible ones, such as culture, values, and beliefs [Mills, 02].

The *how dimension* refers to the coordination mechanisms whereby the objects represented within a competence representation – either competences or resources – are connected into meaningful relations. The visual framework may underline *hierarchical* relations, linking competences via vertical and horizontal connections in a pyramidal or tree-shaped structure [Mills, 02; Sawyer, 06; Walsh, 01]. Alternatively, the competence graphic may represent *supportive* relations, e.g. by

[1] Due to space constraints, the collected frameworks are not all illustrated. However, the collection of competence frameworks can be either requested from the authors or accessed via the webpage http://www.knowledge-communication.org/OrgCompetenceVisualization.pdf.

depicting competences as a series of interlinked nodes, forming a network structure [Klein, 98]. The competence visualization may emphasize the *temporal* dimension, by relating competences either in a linear, or in a cyclical manner. For example, [Pietroforte, 96] portrays competences in a linear relation along the value chain, while [Marti, 04] depicts a reinforcing cycle between customer analysis, individual competences, core competences, and financial results. A competence visualization may represent *matching* relations, supporting the connection of relevant elements to facilitate the generation of new insights. As an example, the opportunity framework by [Muller, 02] enables managers to match the core competences of future partners, as a means to elicit the innovation opportunities related to a strategic alliance.

The *why dimension* addresses the purpose of a competence visualization, i.e., the managerial processes supported by it. In particular, the *identification* process consists of making organizational competences explicit, a primary function which provides the ground work for the subsequent processes. The *development* process consists of competence exploration, directed at the acquisition of important competences, whereby the organization can close crucial gaps, and strengthen its competitive position. The *allocation* process consists of competence exploitation, requiring managers to conceive novel uses of the existing competences, in order to leverage a competence for multiple products and across several markets. The *communication* process allows managers to convey competences to various audiences.

The *whom dimension* makes reference to the primary audience addressed by the competence framework, either *internal* or *external* with respect to the organization. On the internal side, a competence framework may be directed to department managers, cross-functional teams, employees, and particularly to newly recruited employees. On the external side, a competence framework may be intended for a variety of stakeholders, including alliance partners, suppliers, (potential) investors, and the public at large.

The *where dimension* indicates the fruition context of the competence depiction, with a basic distinction between *in praesentia*, synchronous interactions, versus *in absentia*, asynchronous interactions. In the first case, the competence visualization is co-constructed in a face-to-face context, such as workshops, meetings, and seminars. In the second case, the competence framework is used in a mediated context, such as via the organization's website, intranet, or via its publications.

Besides its function to synthesize existing approaches, the classification depicted in [Tab. 1] may also provide general directions for the production of competence visualizations. As a general rule, a competence depiction must address the five questions underlying the classification dimensions, in order to effectively support competence management. In particular, the competence manager should be aware that different purposes, target groups, and contexts require the selection of different visualization formats. For example, competence allocation by senior management requires *in praesentia* visualizations with links to the competence agenda, while competence communication to the public at large demands simplified visualizations with high impact. Furthermore, the classification dimensions may serve as a guideline for structuring the evaluation of the competence visualizations found in the academic literature. By taking an overall outlook at the collected visualizations, it is possible to identify at least two areas of improvement: With respect to the *what dimension*, the current visualizations generally neglect the representation of *supportive competences*,

with the few exceptions of [Mills, 02] and [Bernhardt, 09]. Overall, the current visualizations suggest a *static* depiction of competences, failing to represent the dynamic processes whereby an organization strengthens, and adjusts its competence configuration. With respect to the *how dimension*, the current representations of *coordination mechanisms* are somewhat tentative, neglecting the actual processes whereby organizational competences are integrated, deployed and recombined. The visual representation of coordination mechanisms should be further explored, beyond the sketchy categories currently reported under the how dimension. For example, a future representation may capture the knowledge intensity of the coordination mechanisms employed for managing competences. Knowledge-intensive coordination is required to recombine competences for innovation purposes, while routinely-based coordination enables the connection of resources and competences for ordinary procedures.

3 Towards an Integrative Framework for Competence Mapping

3.1 The Framework in Overview

Drawing on the classification described above, this section proposes an integrative framework for the use of competence visualizations, [see Fig. 2]. It is integrative in the sense that it provides a comprehensive view on existing (and potential) competence visualization methods according to their purposes and depiction schemes. As illustrated in [Fig. 2], our framework was obtained by positioning the *how* and *why* dimensions of the previous classification along two axes. The *how* dimension reflects the coordination mechanisms utilized for connecting competences visually, and ultimately defines the graphic structure of the competence visualization. The *why* dimension points to the processes supported by the competence visualization, consisting of competence identification, management and communication. By combining the *how* and *why* dimensions, we have been able to position the competence visualizations available in the academic literature according to their purpose and form. In the framework above, we also include the content (or what dimension) of each of the twelve methods that we have identified. The categorization of the methods in the grid is not mutually exclusive, as a competence visualization may serve more than one purpose and may make use of multiple coordination or depiction mechanisms. The core competence agenda by [Torkkeli, 02], for example, supports competence allocation and development, whereas the competence architecture by [Mills, 02] depicts both hierarchical and supportive relations. Nevertheless, the framework presents the dual advantage of *synthesis* and *scalability*, meaning that it captures existing methods, and that it can be used to better understand the function of (or need for) future ones. Above all, the integrative framework provides valuable support to practitioners who want to use visualization systematically for competence management. It facilitates the selection of one or several competence visualizations with regard to the task at hand. It also shows where multiple methods are available (such as for competence identification), and where more research is still needed (such as in the competence development and communication area). The framework can thus provide valuable pointers for future development efforts by researchers. Further research, however, is needed for the

integrative framework to reach the maturity stage. At present, it is subject to an ongoing revision, and the underlying dimensions are regularly checked, and eventually refined against the addition of further elements. Moreover, in future research, we will perform surveys among practitioners, in order to assess to which degree the competence visualizations really support the processes indicated in the framework (as claimed by the respective authors).

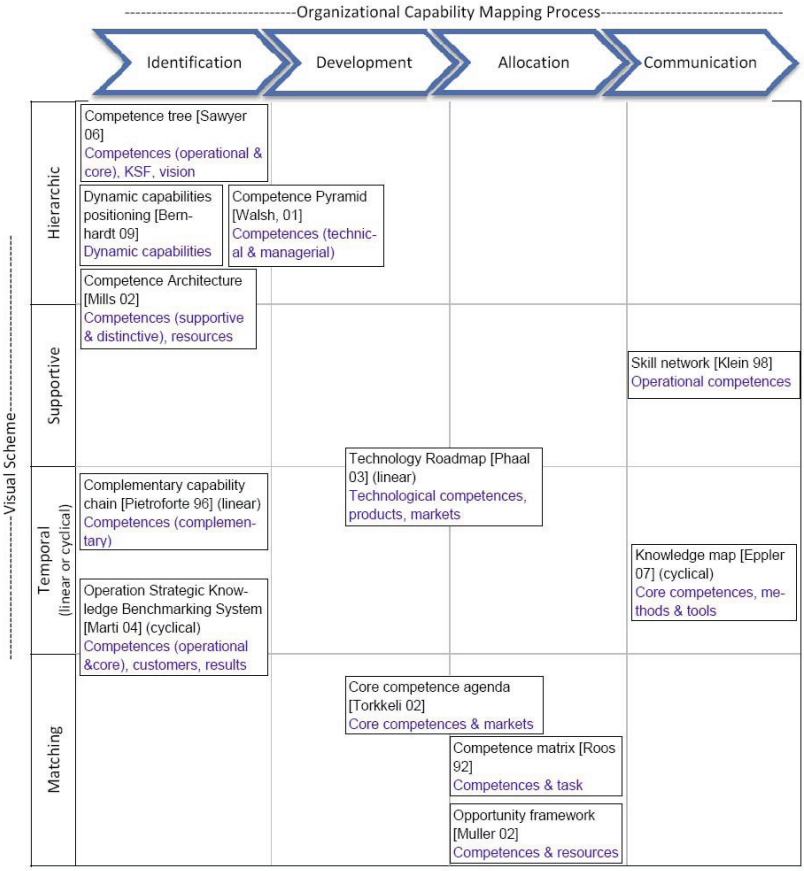


Figure 2: An integrative framework of competence visualizations

3.2 Illustrating the Integrative Framework for Competence Mapping

In this section we describe the integrative framework in greater detail, by illustrating diverse visualizations according to the *what*, *why* and *how* dimensions of competence mapping. In order to cover the broad scope of the integrative framework, we have selected competence visualizations which serve diverse purposes and present various graphical schemes [Fig. 3]. Besides illustrating the building blocks of competence mapping, the following descriptions should clarify the rationale behind the positioning of visualization techniques within the integrative framework.

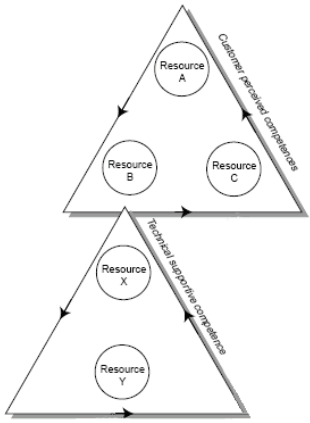
The *competence architecture* by [Mills, 02] is a conceptual framework assisting practitioners in identifying organizational competences, along with the underlying resources. Defining competency as a network of resources, [Mills, 02] propose to represent competency like a triangle, containing a variety of circles to symbolize resources. As a first step, practitioners identify distinctive competences - perceivable by customers - and accordingly uncover the underlying resource network. Therefore, practitioners explore supportive competences, which reside deeper in the organization, and provide the implicit ground for strategic resources. As a general rule, the triangle "supportive competence" is drawn with the apex penetrating the triangle "distinctive competence", in coincidence of the most relevant resources. In a progressive way, practitioners expand on the competence architecture, by drilling down competences, and exploring competence-resource relations. In summary, the competence architecture supports the *identification process*, by connecting competences in a *hierarchical order*, and showing *supportive relations* within the resource networks.

Intended to support strategic planning, *technology roadmapping* is a visual technique for mapping and linking technological competences, product developments, and market opportunities [Phaal, 03]. While technology roadmaps are customizable to fit a wide range of organizational contexts, the generic structure is comprised of three layers, and explicitly includes the temporal dimension. The top layer relates to industry trends and drivers, whereas the bottom layer represents the organizational knowledge base. The middle layer acts as a bridging mechanism and relates to the tangible systems developed to address industry trends and drivers, such as engineering processes, operational capabilities, and products. By drawing connections among the three layers, senior managers explore innovation opportunities, and accordingly plan for *competence allocation* and *development*. As depicted in [Fig. 3], the visual scheme of technology roadmaps underlines the *temporal dimension* according to a linear perspective, and displays *supportive relations* among competences, products, and markets.

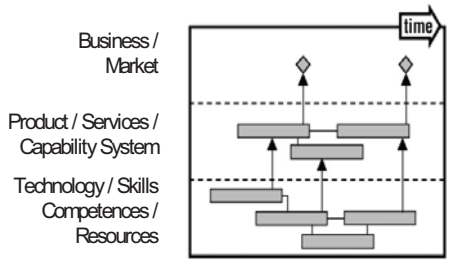
The *opportunity framework* is a n-by-n matrix, created by [Muller, 02], to support alliance managers in identifying innovation opportunities based on complementary competences between prospect partners. In order to produce the matrix, the alliance manager lists organizational competences on the vertical axis and repeat for the prospect partner on the horizontal axis. By cross-checking the listed competences, the alliance manager identifies complementary competences with an innovation potential. In the corresponding cells, the alliance manager writes an innovation opportunity, and eventually comes up with an innovation map to be realised via the strategic alliance. In summary, the opportunity framework visualizes *matching relations* between competences, and supports the *allocation process* via the recombinant exploitation of existing competences for innovation purposes. Besides the unilateral application suggested by [Muller, 02], the opportunity framework may be used simultaneously by prospect partners, as a basis for discussing the viability of a strategic alliance.

The *skill network* by [Klein, 98] enables an organization and its members to understand competences as a network of interrelated skills. It allows them to visualize the dynamics whereby skills flow through an organization to create a product advantage. The skill network builds upon the systematic analysis of competence data, collected via structured interviews with organizational informants. In particular, the

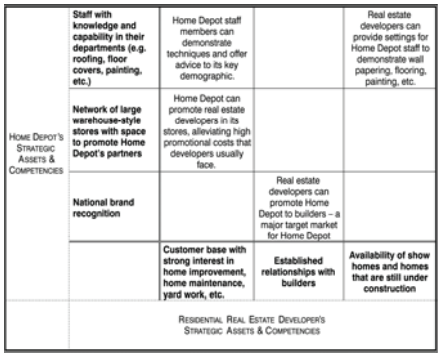
diagram is produced by applying a mathematical technique to compute what skills contribute the most to product development, and the extent to which skills tend to be used in combination. Graphically, the diagram represents skills as triangles, and skill connections as straight lines converging in a broader network. In this regard, the visual scheme emphasizes *supportive relations* among skills, and serves the purpose to *communicate* competence data across the entire organization. According to [Klein, 98], while numeric data can easily lead to detail views, the corresponding visualization can convey the big picture, and build up greater commitment.



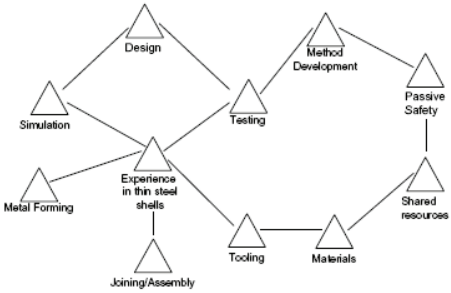
Competence Architecture [Mills 02]



Technology Roadmap [Phaal 03]



Opportunity Framework [Muller 02]



Skill Network [Klein 98]

Figure 3: Selected Examples of Competence Visualizations

By taking a general view at the integrative framework [Fig. 2], it is possible to draw tentative associations between the visual schemes and the mapping processes served by competence visualizations. While the competence frameworks reported in [Fig. 2] differ substantially with regard to their aesthetic appearance, consistent patterns can be observed by looking at the individual phases of the mapping process. On occasion, the observation of the collected frameworks provides the starting point to formulate tentative suggestions for the development of novel frameworks:

Competence identification. As visible in [Fig. 2], a large cluster of competence frameworks supports the identification process by underlying hierarchical relations in the visual scheme. As pointed out by [Walsh, 01], "much of the difficulty in identifying competences arises from the hierarchical and multidimensional nature of competencies". Accordingly, the identification frameworks operationalize the competence concept by suggesting a visual hierarchy whereby the competence components are singled out in building blocks, and connected to the overarching strategy.

Competence development. As suggested by [Fig. 2], only a handful of visual frameworks is currently available for competence development, therefore making pointless any attempt to identify consistent patterns. However, the linear temporality portrayed in technology roadmapping seems a promising perspective, since competence planning is by itself a future-oriented activity. Moreover, novel frameworks may assist competence development by visualizing the gap between the current and desired competence portfolio.

Competence allocation. Interestingly, the allocation frameworks collected in the academic literature are communed by a visual scheme supporting the representation of matching relations. In this regard, existing competences are checked against relevant benchmarks - such as industry trends - to foresee allocation opportunities with the potential to fulfil strategic objectives. As a next step, visual schemes may account for the systemic recombination of existing capabilities, in order to support the implementation of exploitative strategies based on core competences. In other words, novel frameworks should not only point out what competences are relevant, but also focus on processes whereby competences can be combined, rearranged, and exploited.

Competence communication. The communication frameworks in [Fig. 2] consistently propose simplified representations to facilitate understanding of organizational competences among target audiences. In this regard, the adoption of *visual metaphors* presents the potential to improve competence communication, by assisting the transfer of implicit knowledge, and amplifying the cognition process. Being "tools for cognition", visual metaphors facilitate connection to personal knowledge, and ultimately increase retention on the receiver side [Eppler, 07].

4 Conclusion

Besides delineating the theoretical underpinnings of competence visualization, the present article provides a threefold contribution to this emerging discipline: First, the article provides *descriptive value* in the form of a collection of twelve existing competence visualizations spread across various literature streams. Second, the article provides *analytical (or synthetic) value*, as the building blocks of competence visualizations are singled out and arranged in a classification [section 2]. Third, the article presents *prescriptive value,* as the integrative framework in [section 3], albeit tentatively, provides guidance for selecting among different competence visualization formats. It also shows areas where more research is needed. Future research could strengthen the theoretical foundations of competence visualization by exploring the advantages and disadvantages associated with competence mapping in intra- and inter- organizational settings. Moreover, future work could validate our framework, and eventually develop parameters for evaluating visualizations regarding their

contribution to competence management. Ultimately, future research should strive to systematize the practice of competence visualization, by defining a standard toolset of visualization frameworks for assisting the different phases of competence management.

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