Product Design and Development 2.0
Applied C-K theory [to innovate in a digital age]

Abstract

The purpose of this paper is to discuss some applied implications of the Concept-Knowledge Theory (C-K Theory) introduced by Armand Hatchuel and Benoît Weil in their 2003 paper. This analysis is required because in a new information age; where powerful IT tools provide the means to work in multiuser collaborative virtual spaces, and where advanced automated semantical indexing engines allow the knowledge to be more readily available than ever, the implications for a design theory of these characteristics is deep since the concepts as well as the knowledge can be accelerated and reinforced. But this can only happens if the right tools are applied understanding the nature of the underling process that dominates creativity and innovation in human endeavours.

Some of the tools and theories that will be explored here to understand the potential links and interactions with C-K theory are: Web 2.0 collaboration tools, computer supported cooperative work (CSCW), knowledge management and Henry W Chesbrough´s Open Innovation model.

Keywords: C-K theory, web 2.0, CSCW, Knowledge Management, Design Theory, Innovation, Creativity.

Introduction. The C-K theory interesting approach

The relatively new C-K theory (2003), represents an interesting opportunity to give a look at the design theory from an integral, more comprehensive new view which is not anchored to any specific systematic process such as those which focus on stages and the recursive nature of the design or the product oriented design theory. Rather they are actually centred in the more organic and less systematic process of creation and thus in the core of creativity and innovation. (Hatchuel and Weil, 2003).

While the more traditional design theories have been very useful to understand and improve typical mass production design challenges, given that they were able to reproduce the characteristic functional set up of companies (with multiple semi communicated niches working in highly specialized roles) C-K theory seems to have a better fit in project based or matrix company organizations with a strong focus on innovation. This is because it allows a more natural understanding of the flow between the knowledge and the concept spaces and clearly shows the need for powerful new tools and procedures such as more intensive knowledge management best practices and the use of computer supported cooperative work platforms (CSCW) and information management systems (Zeiler and Savanovic 2009). This would accelerate the creation process and also increase the chances of incremental innovation as well as radical innovation.

The reflexion here is that if we consider C-K theory point of view in regard to the design process, on one hand its approach highly matches with the focus of current knowledge management in terms of knowledge space and its expansions. On the other hand, collaborative web 2.0 communication and creation tools seems to match the needs of the work in the concept space, it expansions and the eventual *conjunction* with the knowledge space. Thus, it is important to explore these links in more depth and try to understand if C-K theory framework can provide an effective way to establish what is required to harness innovation inside organizations, work that is put into practice in the following sections.
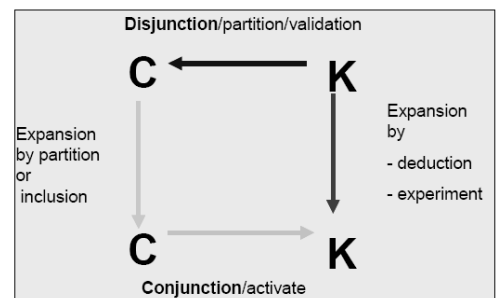
C-K theory at a glance.

As shown in figures one and two, C-K theory approach to the design process is wide, simple and abstract when it is compared with the traditional stage-gate models introduced by Cooper (1990), where it is much easier to imagine the actual work flow and the tasks. Nevertheless it is exactly this separation from the actual tasks and regular work flows which allows C-K theory to be practical and particularly relevant when the idea is to understand innovation. This is because creativity is embedded in its hearth, and given that innovation is fundamentally based on natural mental processes and human behaviour in creative tasks (Christensen, 2009), rather than stages and gates, C-K approach seems to have a much better explanatory power in these cases.

Figure 1, The C-K Square (Hatchuel and Weil, 2003)

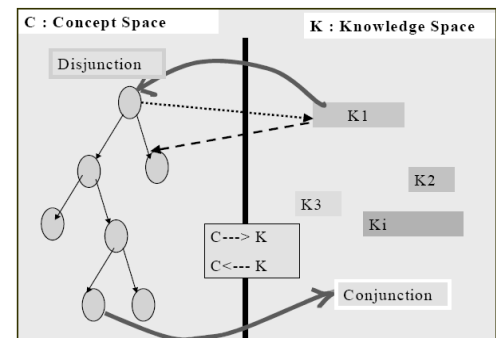**Figure 2, Illustration of the *spaces* (Hatchuel and Weil, 2003)**

For the purposes of this paper the most important elements of this theory are the definitions of the concept and knowledge space and the interactions that happen between and inside them. This is because is there where the connections between this theory and some new information technologies arise.

To understand these connections better a brief and simplified description of the basic elements of the C-K Theory (Hatchuel and Weil, 2003) is provided below:

- **Concept Space (C):** Concepts are propositions that are neither true nor false, they might emerge from technical or market requirements that currently have no known satisfactory answer and thus there is a need to satisfy these requirements by means of new creative developments.

- **Knowledge Space (K):** Is the group of propositions with known logical status (we know if they are true or false). All previous knowledge from the designers point of

view is here and all concepts after they are tested, successful or not, become part of this knowledge space.

- **Conjunction (C->K):** Every time a concept is tested in reality it becomes an expansion of the knowledge space and leaves the concept space. Nevertheless expansions of the original concept that are not yet tested can remain in the concept space.

- **Disjunction: (K->C):** To generate new concepts previous knowledge is required and the disjunction is the process that reflects this transformation from K to C.

- **C -> C:** Concepts can grow and multiple variants from an original concept can coexist in the concept space. For effective innovation it is important to support, incentive, visualize and eventually guide this process. (Zeiler and Savanovic, 2009)

- **K -> K:** These are regular expansions of the knowledge by combinations of it or new discoveries. This is particularly important in research and development activities.

Tools to enhance the "concept space"

As described before, one of the critical elements of the C-K theory is the concept space, a place where all the concepts are developed and where fluidity of the interactions and the visualization of what is happening is a great advantage, especially if several people are involved in the design process at the same time (Gillier, Piat, Roussel and Truchot, 2009). For example if a flying bicycle is the concept that is being developed, not only several designers from the main team but also people ranging from potential users to providers might also been interested in collaborate and provide early feedback to enrich the concept generation. Without IT platforms this would be nearly impossible on a daily basis because real time interactions between multiple stakeholders require great effort and usually implies stopping the regular design activities making it very difficult to practice recurring engineering or user driven design at this stage.

With the emergence of more sophisticated real time online collaboration tools, the process of working in the concept space, developing new ideas and interaction while doing this, suddenly has became easier and much more scalable not only outside the frontiers of the design team but also outside of the company. **Some examples of these "Computer-supported collaboration" or "Computer supported cooperative work (CSCW)" tools are:**

- **Private (white label) and public online social networks (OSN):** Social networks can be of great help to gather around one topic or challenge groups of interest and indentify potential collaborators with the needed expertise and motivation. In these networks it is also possible to start brief open dialogues that help to build concepts and ignite ideas. They are also a safe ground to test concepts. Depending on the need the OSN can be a large public one like Facebook, Linkedin or Twitter or a private white label network for more professional work such as Ning.com or other customizable corporate networks.

- **General Groupware:** Solutions like Wikis, GoogleDocs and Zoho provide a great space for sharing ideas and concepts as well as collaborating and building ideas in real time. Ambitious projects like Google wave claim to bring this way of working to the masses, combining synchronic and asynchronous communications and interactions with an easier way to transform communications and ideas in a real flow, independent from the generating platform. These experimental approaches to a new way of communication and interaction open the door to an increase in the rate at which concepts are generated. indeed we should expect not only more concepts but also better visualization and clustering of them.

- **Real time visualization tools:** Given that over IT platforms everything is coded and explicit visualizing the interactions and the evolution of the concepts is not only possible but also quite useful, as is stated by Zeiler and Savanovic (2009):

  > *"...Through visualization of contributions within a design team, morphological overviews can show how (integral) design concepts are emerging within design teams... Potentially this makes it easier for design managers to manage these design steps."*

  Some interesting examples of these visualization technologies are Google Analytics, fidgt.com and Google Trends where the otherwise plain content becomes visual and alive because of its close to real time updates.

Tools to enhance the "Knowledge Space"

Modern knowledge management (KM) has developed an extensive theory to understand and enhance learning process inside organizations as well as how to deal and make the best use of their intellectual assets in the form of explicit or implicit knowledge (McMahon, Lowe and Culley, 2004). Thus it seems natural to connect these theories together when it comes to manage the ever-growing knowledge space. One of the biggest challenges here is to identify the vital pieces of information in an ocean of data. Only in this way can the cycles of conjunction and disjunction be effectively improved. Shai, Reich, Hatchuel and Subrahmanian (2009) are very clear, stressing this point in their conclusions between the link of K-C Theory and KM, indicating that "*Knowledge-based systems with embedded C-K logic*" are potentially able to discover hidden knowledge which has powerful implications for the final outcome of the product design and development as well as for sciences in general.

Some applied KM and IT tools that might allow enhancing the knowledge space are:

- **Search and semantical indexing tools:** The first step to access encoded information is to have it available in an indexed space when it is needed. New and affordable solutions such as the Google Search Appliances (GSA) and more sophisticated algorithms search inside all the available documents and also understand their meaning and provide ad-hoc alerts depending on the requirements. These are

already available and with the right implementation represent a huge step toward a more complete and efficient use of available knowledge.

- **RSS, Blogs and other 2.0 tools:** Really Simple Syndication (RSS) combined with easy to implement publication and content generation platforms such as blogs and wikis, are undoubtedly a powerful combination when it comes to distribute quickly and effectible knowledge, contributing in this way to expand the knowledge and find quickly connections with real life design problems.

Open Innovation Models and the C-K Theory

Innovation is embedded deeply in the C-K theory and Henry W Chesbrough´s Open Innovation (OI) model (2003) can provide light about how to take better advantage of the new technologies that allow to enhance C-K theory bringing concepts and knowledge from outer sources and enabling more rich interaction both in *conjunctions* and *disjunctions* (Gillier, Piat, Roussel, Truchot, 2009).

In particular, after analysing the implicit point of contact between OI and C-K, a revealing surprise came from it; the concept space where usually the required, and not yet satisfied, technology, design or product is found is strongly similar to what is usually known in OI terms as the "Technology Need" or "Request for Proposal" (RFP) and the knowledge space is basically analogue to a "Technology Offer". This is typically managed by technology brokers and technology transfer offices who try to push it to the market and eventually find a technology need for which it is a satisfying match.

This connection implies that a unified model is possible and desirable not only because these theories would enrich and strengthen each other but also because both can take advantage of an integrated toolset composed by the IT elements described in the sections above.

Conclusion. C-K Theory´s modern Toolbox

This paper focus was to draw lines between the C-K Design Theory, a set of web 2.0 inspired tools, the knowledge management theory and the open innovation model. To summarize and conclude the findings, an integrated toolbox and an example of the past described elements is proposed in figure three.

The figure shows how starting from Knowledge a (Ka) a knowledge expansion to Kb (Ka->Kb) occurred helped, for example, by a semantic, automated generated match alert from an indexed available knowledge database. This expansion made clear a new design requirement to explode the potential of this expanded knowledge which is expressed in concept 1 (c1). To start the development of concept 1 and its derivations, a set of groupware tools was deployed including an intranet Wiki and a development blog which is linked to open and closed social networks to receive feedback in real time from the stakeholders. All this interactions resulted in concept derivations (C2) to (C7). (C2) received

important feedback from already available knowledge K(c) in the form of a disjunction, facilitated because this knowledge was stored in a Blog using RSS to update users from changes. This alerted designers about this new possibility. After several iterations and discarded concepts that were evaluated using social media and concept visualization tools, C7 arises as the best alternative generating a conjunction to the new knowledge K(f). This successful conjunction is facilitated because most of the process is explicit and easy to compile since most of the interactions can be directly retrieved from the linked IT platforms which not only exposes the content but also all its creators and the evolution of the project.

In all this process the open innovation model is implicit because the interactions are not limited by people inside one single company and actually every concept and knowledge might well be generated by different companies, individuals or organizations ranging from providers to customers. They may participate in the process because they are looking for a monetary reward, social recognition or other motivations.
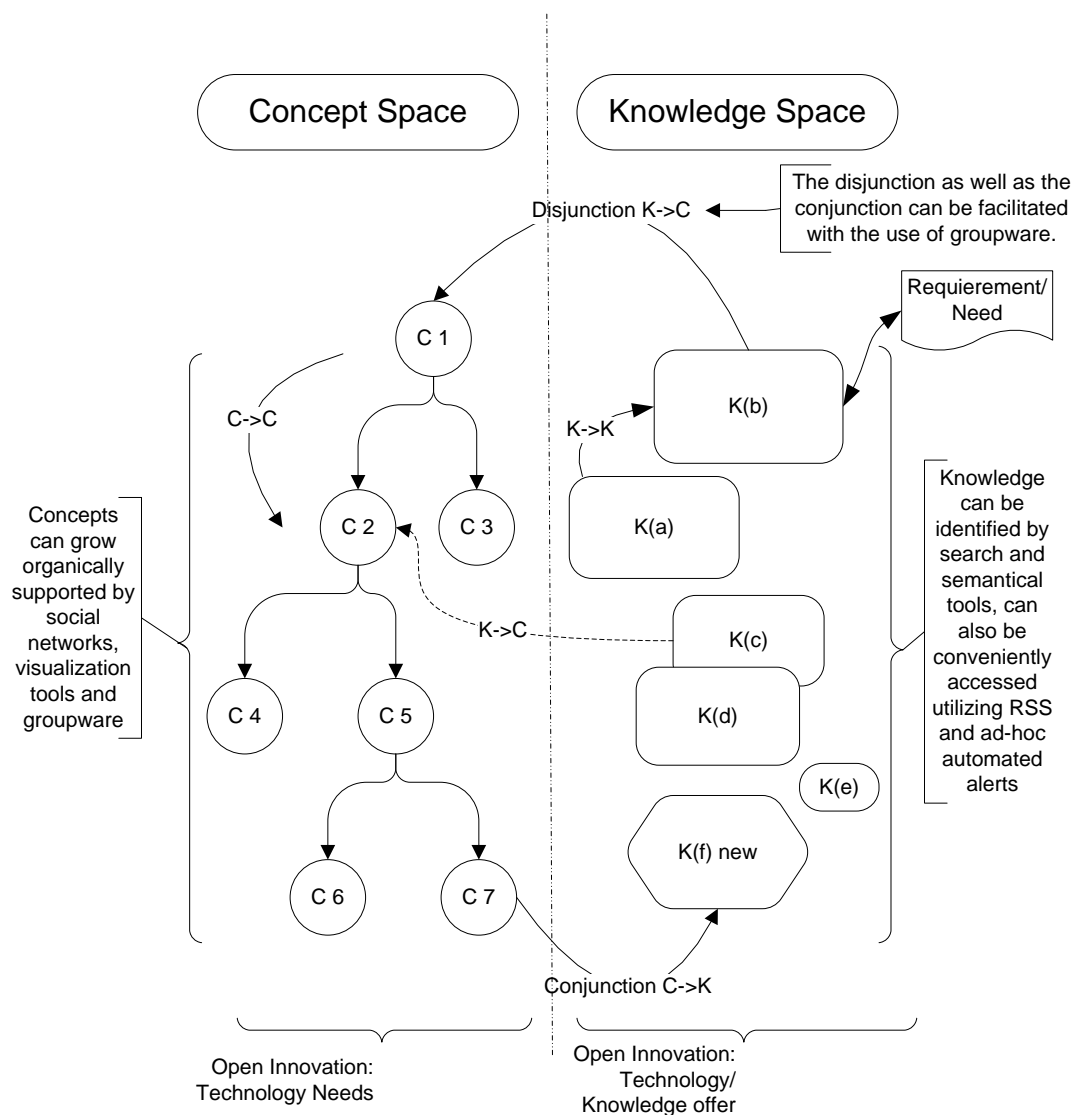

Figure 1, Example of a possible integration between C-K, OI, KM and Web 2.0

References

- Chesbrough H, 2003, "Open Innovation: The New Imperative for Creating and Profiting from Technology", Harvard Business School Press Books.

- Christensen C, 2002, "The Rules of Innovation", Technology Review, June 2002;105(5):32.

- Cooper R, 1990, "Stage-gate systems: A new tool for managing new products", Business Horizons, May 1990;3:44-54.

- Hatchuel A. and Weil B, 2003, "A new approach of innovative design: an introduction to C-K theory", Proceedings of 14th International Conference on Engineering Design, international conference on engineering design, iced 03 stockholm, august 19-21, 2003.

- Mcmahon C, Lowe A, Culley S, 2004, "Knowledge management in engineering design: personalization and codification", Journal of Engineering Design, August 2004;15(4):307-325.

- Shai O, Reich Y, Hatchuel A, Subrahmanian E, 2009, "Creativity theories and scientific discovery: a study of c-k theory and infused design", international conference on engineering design, 24 - 27 august 2009, Stanford University, Stanford, CA, USA.

- Gillier T, Piat G, Roussel B, Truchot P, 2009, "Portfolio management of innovation fields : Applying ck design theory in cross industry exploratory partnership", 16th International Product Development Management Conference, "Managing dualities in the innovation journey", Twente, June 7-9, 2009

- Zeiler W, Savanovic P, 2009, "A new way of design thinking based on integral c-k design methodology", 8th European Academy Of Design Conference - 1st, 2nd & 3rd April 2009, The Robert Gordon University, Aberdeen, Scotland.