The Internet of Experiences – Towards an Experience-Centred Innovation Approach

Stefan Wellsandt, Thorsten Wuest, Christopher Durugbo, Klaus-Dieter Thoben

The Internet of Experiences –Towards an Experience-Centred Innovation Approach

Stefan Wellsandt[1], Thorsten Wuest[1], Christopher Durugbo[2], Klaus-Dieter Thoben[1]

[1] BIBA – Bremer Institut für Produktion und Logistik GmbH, Hochschulring 20, 28359 Bremen, Germany
{wel, wue, tho}@biba.uni-bremen.de

[2] University of Bristol, 8 Woodland Road, Clifton BS8 1TN, United Kingdom
Christopher.Durugbo@bristol.ac.uk

Abstract. The paper depicts an experience-centred approach for innovation enabled by the Internet of Experiences. Based on findings from innovation research as well as the internet-based approaches of the web 2.0 and the Internet of Things, it is argued that artificial systems, e.g. intelligent products, are capable to make experience on their own out of interactions, similar to user-experience today. After an introduction into the field of "experience" from a knowledge management perspective, a broad definition for experience is suggested. According to this definition, the experience-making possibility of artificial conscious systems is substantiated. Based on these findings, an experience-centred innovation approach, utilizing experience from intelligent objects and human users, is argued. The main outcome of this section is a depiction of the Internet of Experiences.

Keywords: Experience, Innovation, Internet of Things, Artificial Consciousness

1 Introduction

Driven by globalization, competition among enterprises and enterprise networks led to the advent of the knowledge worker responsible for constant innovation. Being one step in front of competitors can be a significant core competence resulting in economical, societal and ecological returns. As an effect of shortened product-lifecycles, partially caused by the rapid developments in information and communication technologies, companies had to improve innovation frequency and quality. In order to realize this goal, the innovation process itself was re-thought to take all available sources of innovation into account, be it inside or outside of the enterprise – the idea of *open innovation* was born [1]. One of the richest sources for the new innovation paradigm is the user. The user's experience, created during his daily life and interaction with products and services, is the ideal source for enterprises to learn how to satisfy needs of the people. Importance of the users' experience is also expressed through the development of various tools to capture it, e.g. Living Labs [2]. Changes

adfa, p. 1, 2011.

in the innovation domain were also influenced by prominent societal shifts, induced by technological paradigms such as the participatory internet.

Over the last years, with the development of web 2.0 after the bursting dot-com bubble [3] and the rise of social networks, the internet itself became more social and a place for communication and social interaction [4]. The social component is steadily becoming more important and builds a basis for new and innovative advances. Within this development, concepts and tools for gathering, sharing and distribution of information and knowledge appeared and became widely popular, Wikipedia being the most famous and most commonly used, LycosIQ [5] or ResearchGate. Another example for knowledge sharing through the internet is Amazon's review function allowing customers to share their experience-based knowledge about products.

User-created content within web 2.0 appears in different forms and qualities ranging from data and information to knowledge and experience. The relation between different qualities of content is illustrated in Fig. 1.

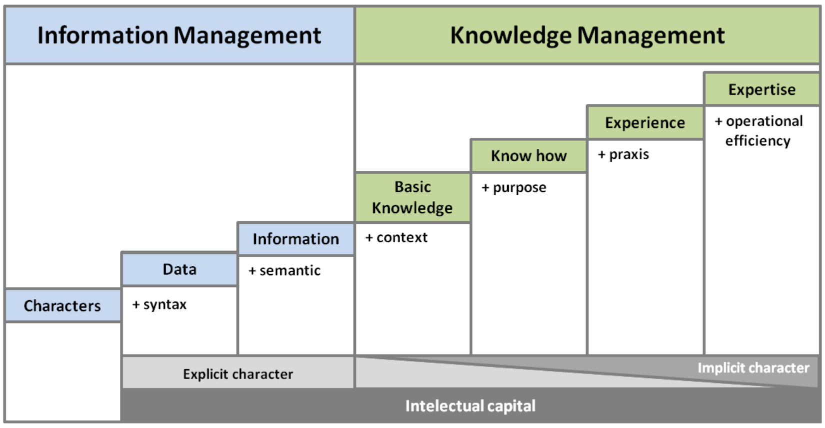

Fig. 1. Illustration of information and knowledge management terms (based on [6] & [7])

From a general point of view, most authors support the definition of Probst et. al. that linking of *information* allows its use in a certain field of activity, which can be interpreted as *knowledge* [8]. In Fig. 1, contextualization of data and information towards basic knowledge and know-how is shown. Until *know-how*, it is challenging but possible to save and share, though it becomes hard, if not impossible, for *experience* and expertise due to their individual character.

Referring back to the participative character of web 2.0, another development is interesting called *Internet of Things* (IoT). One of the central ideas of IoT is the extension of the internet into the physical world to embrace everyday objects [9]. The IoT is realized through networked systems of self-organizing objects that interact autonomously, and related processes that lead to an expected convergence of physical things with the virtual world of the internet [10]. One of the central aspects of the IoT is that objects are able to process information, communicate amongst each other and with their environment, and make autonomous decisions, thus becoming "intelligent" [9],

[11], [12]. Closely related to the principles of IoT are intelligent products (IP). A well-accepted definition for intelligent products is the following [13]:

"[...] a physical and information based representation of an item [...] which possesses a unique identification, is capable of communicating effectively with its environment, can retain or store data about itself, deploys a language to display its features, production requirements, etc., and is capable of participating in or making decisions relevant to its own destiny."

Up to now, IPs are not intelligent in a human sense [14]. They can be subject of interaction but typically lack complex learning abilities. However, the ability to perceive and communicate experienced situations raises the question how benefits can be taken out of these contents. One idea is to systematically consider their individual experience in order to complement existing open innovation approaches mainly based on user-experience.

This paper intends to identify similarities between two inputs of open innovation processes, i.e. user-experience and potential object-experience, in order to depict a future platform to share experiences – the Internet of Experiences (IoE). In the second section, the approach towards an Internet of Experiences will be introduced. This section covers an overview into experience from a knowledge management perspective and an elaboration on experience in natural and artificial conscious systems. The third section provides a description of the experience-centred approach of the IoE and answers the question of what the IoE could look like. Finally, the paper is concluded and an outlook is given, as well as a short paragraph of the limitations of the approach.

2 Approach

The scientific approach that is applied in this paper consists of two aspects: the recent understanding of "experience" from the perspective of knowledge management, and similarities between user-experience and the experience gained by artificial systems such as Intelligent Products.

2.1 Experience from a knowledge management perspective

The term "experience" is used and defined differently among research fields. Some of the more prominent fields dealing with experience are cognitive sciences (e.g. enactive framework) and open innovation research (e.g. Living Labs). In *cognitive sciences*, definitions for (human) experience can be found by arguing that experience is closely related to questions about what a situation or an activity feels like [15]. The concept of experience therefore is strongly defined by its subjective character, making it difficult to be addressed in a formal and systematical way in science. This is especially true for scientific disciplines that primarily focus on measurable results like those commonly used in engineering and information technology contexts. While cognitive sciences deal with experience in a broader way, other domains try to focus on certain subjects or categories of experience.

In the area of *open innovation research*, subject of experience are people that interact with products or services – this experience is stated as user-experience. Within innovation research, user-experience is frequently utilized in the context of Living Lab approaches – innovation ecosystems typically utilizing user-experience with ICT technology and related artefacts [16]. User-experience is defined in ISO 9241-210 as *"[…] a person's perceptions and responses that result from the use or anticipated use of a product, system or service"*. It can be expressed through feedback from the users in a codified way (e.g. questionnaire) or interviews. Within innovation ecosystems, formalized user-experience is evaluated and used to create or adapt ICT-services and products respecting user requirements. Other domains specify experience according to different content such as software-experience in computer sciences. According to Conradi and Dybå, software-experience is a composition of experimental data and aggregated models (i.e. knowledge) on these data [17].

The final example for experience raises an important point about the ambiguous relation between knowledge and experience. In order to better distinguish the different terms, especially related to knowledge, the point of origin of different intellectual capital (IC) types is used as illustrated in Fig. 2.

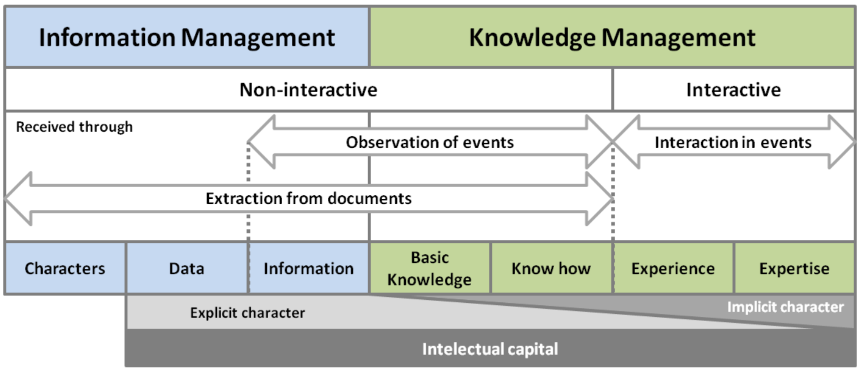

Fig. 2. Point of origin for different kinds of intellectual capital (based on [6] & [7])

Points of origin are differentiated into non-interactive (observation and extraction) and interactive ones. Based on this separation, a major difference between knowledge and experience is the fact that the latter is only created during interaction. However, an aspect that makes clear segmentation of IC types difficult is the ambiguous nature of knowledge in literature. As Nonaka proposed in the early 1990s, knowledge consists of explicit and tacit (i.e. implicit) elements [18]. Tacit knowledge can be gained through observation, imitation and practice. In this paper, tacit and explicit character of intellectual capital is seen as a continuum across the four IC types in knowledge management. The main purpose of the continuum is to address difficulties arising from tacit knowledge in relation to the question where it fits best in Fig. 2.

Different scientific perspectives on "experience" result in different understandings and definitions of the term. In order to avoid discussions digressing into the domain of philosophy, or scientific domains where in-depth discussions about "experience" are unavoidable, a broad definition is suggested for the purpose of this work. The definition takes into account findings in cognitive science, open innovation research, points of origin from IC types and is influenced by findings of Davis in [19]:

"Experience is an individual and in-tangible consequence of an interaction between a conscious system and real or digital entities inside or outside the system. Experience is related to explicit or tacit elements in the form of associated data, information, basic knowledge, or know how."

2.2 Experience in natural and artificial conscious systems

In the previous sections, it was pointed out that user-experience is a high value source for innovation processes. In this section, it will be examined whether there is evidence for *object-experience* or not. According to the definition proposed in section 2.1, several conditions need to be evaluated in order to assume that experience can be made by artificial systems such as intelligent products:

- The artificial system has to be <u>conscious</u>
- There has to be <u>interaction</u> between artificial system and other entities
- Consequence of the interaction must be <u>individual</u> and <u>in-tangible</u>

The *consciousness* of artificial systems is subject of investigation in the scientific domain of artificial consciousness [20], [21]. Assuming that, for example, an intelligent product is some kind of machine, we likewise assume that there is a general possibility that it can be conscious. The second condition refers to the *interaction* between artificial system and other entities. As described in the introduction, IPs have communication and decision-making abilities enabling interactive behaviour. Therefore, we consider the second condition as fulfilled.

Since the first two conditions are met, artificial systems such as IPs can be seen as generally capable of drawing consequences from interaction. In order to make clear that consequences belong to a specific artificial system, each system needs to have an identifier making it an *individual* element. For IPs, identifiers can be, for example, RFID tags or barcodes. Grounded on the artificial nature of intelligent products, their storage unit (e.g. hard disk) contains digital content. This leads to the conclusion that consequences related to interaction are *in-tangible*. Based on the examination of the three proposed conditions above, it is concluded that artificial conscious systems, like intelligent products, are *capable of making experience*.

3 The Internet of Experiences – experience-centred innovation

The general capability of natural (user) and artificial systems (smart product) to make their own experience during interaction, leads to the question how these kinds of experience can be transformed into benefits. Referring back to the introduction of this work, innovation is a key driver of sustaining competitive advantages. While common innovation processes take user-experience into account, it is reasonable to ask if object-experience can be considered likewise. With respect to the developments in the open innovation domain, it is assumed that *the quality of innovations increases* *with the number of experiencing systems* participating in the innovation process thus creating more valuable outputs. This assumption, but also the important role of experience innovation processes, is supported by findings of Taylor and Greve [22].

Artificial conscious systems, such as intelligent products, are connected through the Internet of Things. Through this network, data and information are shared to allow new product-based services and enable new product functionalities. With the experience-making ability of IPs, “things” in the IoT can go beyond simple sensing (collection of data and information). From a knowledge perspective, they can become actors, sharing through the internet what they learned or explored. Since the participative internet is already a place where experience is discussed, new actors providing additional input from a new perspective seem to be promising. The networked character of the internet can also help to handle interrelated user- and object-experience in order to derive further conclusions. The joint consideration of *user-experience and object-experience* could be beneficial, for example, to identify requirements for new products and services.

User behaviour or specific requirements that aren’t articulated by users (e.g. through questionnaire or interview) might be revealed by considering the perspective that intelligent products, as interaction counter-parts, can take. IPs could reason interaction behaviour of formerly experienced situations and consolidate with similar or complementary products through the internet. The *consolidation process* is meant to identify whether an experience is related to a single or multiple spatial-temporal contexts. Based on the consolidation, the artificial system proposes aspects with hidden innovation potential. Examples for these aspects can be complementary functions of an existing product (incremental innovation) or novel products (radical innovation). These suggestions can be further elaborated and consolidated based on user-experience in the internet, potentially leading to better and/or faster innovation. This depiction of the Internet of Experiences is summarized in Fig. 3.

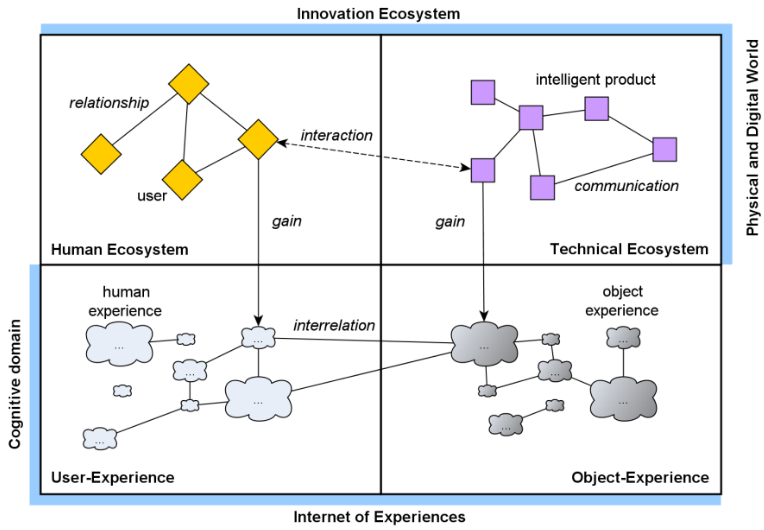

Fig. 3. Depiction of the Internet of Experiences

4 Conclusion and Outlook

The paper depicted an innovation approach that is centred on experience utilizing an Internet of Experiences. Based on developments in the areas of web 2.0, IoT, knowledge management and open innovation, an experience-centred approach – the Internet of Experiences – seems promising to complement human-centred innovation with experiences from artificial systems. Different understanding of "experience" in scientific domains was presented in order to suggest a wider definition for the term. Grounded on this definition, the general experience-making ability of artificial systems was argued. Concluded from these findings, an experience-centred innovation approach and the Internet of Experiences are depicted.

Since the experience-centred approach of this work is still under development, further effort needs to be done to provide sufficient foundation for the assumptions of this work (e.g. experience-making ability) and derived theoretical concepts. Some of the unaddressed challenges related to this work are closely based on the current state of research about intelligent artificial systems, e.g. machine learning, artificial consciousness or Internet of Things. For example, artificial systems, such as intelligent products, often-times lack cognitive abilities compared to artificial systems inside of laboratory environments. Other issues are the ontological relationships between experiences as well as the importance of experience and other intellectual capital types for the innovation process. Furthermore, it needs to be elaborated how user-experience and object-experience can be combined on operational level in order to facilitate innovation.

5 Limitations

The intention of the introduced approach in this work is not to deeply elaborate what "experience" is, especially in relation to the domains of neurosciences and the human brain. Furthermore, the large field of cognitive sciences is only covered briefly to give a basic understanding of aspects that should be considered when dealing with experience as such.

References

1. Chesbrough, H.: Open Innovation. Harvard Business School Press, Boston (2003)
2. Eriksson, M., Niitamo, V., Oyj, N., Kulkki, S.: State-of-the-art in utilizing Living Labs approach to user-centric ICT innovation - a European approach. (2005)
3. O'Reilly, T.: What is Web 2.0: Design Patterns and Business Models for the Next Generation of Software. Communications & Strategies, no. 65, pp. 17-37, (2007)
4. Gosling, S.D., Augustine, A.A., Vazire, S., Holtzman, N., Gaddis, S.: Manifestations of Personality in Online Social Networks: Self-Reported Facebook-Related Behaviors and Observable Profile Information. CyberPsychology, Behavior & Social Networking, vol. 14, no 9, pp. 483-488, (2011)

5. Alby, T.: Web 2.0 – Konzepte, Anwendungen, Technologien. Hanser Verlag, Munich (2006)
6. North, K., Güldenberg, S.: Produktive Wissensarbeit(er) – Antworten auf die Managementherausforderungen des 21. Jahrhunderts. Gabler Verlag, Wiesbaden, (2008)
7. Auer, T.: ABC des Wissensmanagements. http://pwm.at/wp-content/uploads/2010/11/688_tmpphpKCYPlE.pdf, accessed: May 2012
8. Probst, G., Raub, S., Romhardt, K.: Wissen managen – Wie Unternehmen ihre wertvollste Ressource optimal nutzen. Gabler Verlag, Wiesbaden, (2006)
9. Mattern, F., Floerkemeier, C.: From the Internet of Computers to the Internet of Things. In: Sachs, K., Petrov, I., Guerrero, P. (Eds.): Buchmann Festschrift, LNCS, vol. 6462, pp. 242-259, Springer Verlag, (2010)
10. Brand L., Hülser T., Grimm, V., Zweck A., "Internet der Dinge – Perspektiven für die Logisitk". Zukünftige Technologien Consulting, vol. 80, (2009)
11. Isenberg, M.A., Werthmann, D., Morales-Kluge, E., Scholz-Reiter, B.: The Role of the Internet of Things for Increased Autonomy and Agility in Collaborative Production Environments. In: Uckelmann, D., Harrison, M., Michahelles, F. (Eds.): Architecting the Internet of Things. pp. 195-228, Springer Verlag, (2011)
12. Hribernik, K.A., Hans, C. Kramer, C., Thoben, K.-D.: Service-oriented, Semantic Approach to Data Integration for an Internet of Things Supporting Autonomous Cooperating Logistics Processes. In: Uckelmann, D., Harrison, M., Michahelles, F. (Eds.): Architecting the Internet of Things. pp. 131-158, Springer Verlag, (2011)
13. McFarlane, D., Sarma, S., Chirn, J.L., Wong, C.Y. & Ashton, K.: Auto ID systems and intelligent manufacturing control. Eng. Appl. of Artificial Intelligence, no.16, pp. 365-376, (2003)
14. Erickson, T.: Social systems: designing digital systems that support social intelligence. AI & Soc, 23, pp. 147-166, (2009)
15. Rhode, M.: Enaction, Embodiment, Evolutionary Robotics: Simulation Models for a Post-Cognitivist Science of Mind. In: Kühnberger, K.-U. (eds.), Atlantis Thinking Machines. Atlantis Press, Paris, (2009)
16. Folstad, A.: Living Labs for Innovation and Development of Information and Communication Technology: A Literature Review. The Electronic Journal for Virtual Organizations and Networks, vol. 10, pp. 99-131, (2008)
17. Conradi, R., Dybå, T.: An empirical study on the utility of formal routines to transfer knowledge and experience. Proceedings 8th European software engineering conference, pp. 268-276, (2001)
18. Nonaka, I.: The Knowledge-Creating Company. Managing for the long term: Best of HBR - November-December 1991; Harvard Business Review, July-August, pp. 162-171, (2007)
19. Davis, M.: Theoretical Foundations for Experiential Systems Design. Proceedings of the 2003 ACM SIGMM workshop on Experiential telepresence, Berkeley, CA, USA, pp. 45-52, (2003)
20. Haikonen, P.: The Cognitive Approach To Conscious Machines. Imprint Academic, Exeter, (2003)
21. Koch, C., Tononi, G.: Can Machines Be Conscious?. IEEE Spectrum, June 2008, pp. 55-59, (2008)
22. Taylor, A., Greve, H.R.: Superman or the Fantastic Four? Knowledge Combination and Experience in Innovative Teams. The Academy of Management Journal, vol. 49, no. 4, pp. 723-740, (2006)