This paper was presented at The ISPIM Innovation Forum, Boston, MA, USA on 13-16 March 2016. The publication is available to ISPIM members at www.ispim.org.

Finnish BIM Pioneers: Like Hackers Architects in a Community Studio[1]

Albert Lejeune*

ESG-UQAM, Université du Québec à Montréal, 315, rue Sainte-Catherine Est, Montréal, (Québec), H2X 3X2, Canada.
E-mail: lejeune.albert@uqam.ca

Hamid Nach

Université du Québec à Rimouski, 1595, boulevard Alphonse-Desjardins
Lévis (Québec), G6V 0A6E Canada
E-mail : hamid_nach@uqar.ca

Georges Rizkallah

École de Technologie Supérieure, 1100 Notre-Dame Street West, Montréal (Québec), H3C 1K3, Canada.
E-mail: georges.rizkallah.1@ens.etsmtl.ca

Gulnaz Aksenova

School of Arts, University of Liverpool, 19 Abercromby Square
Liverpool, L69 7ZG, UK
Email: Gulnaz.aksenova@liverpool.ac.uk

*Corresponding author

Abstract: When implemented in knowledge spaces, BIM (Building Information Modeling) imposes high complexity associated with managing a virtual 3D mock-up design and its different views, which requires the actors to represent their actions at higher levels of abstraction and apply formalisms and standards that may question the performance of traditional business processes and practices. Finland is one of the world's most advanced countries in the implementation of BIM. The question arises as to why there exists such a large gap between the deployment of BIM in Finland and Quebec (Canada). This paper aims to answer the question on the Finland - Quebec difference in BIM implementation in the AEC (architecture – engineering – construction) industries, and will do so by examining two distinct knowledge spaces: the space of the community and the space of individual work.

Keywords: BIM, Quebec, Finland, knowledge spaces, AEC industry, macrocognition, collective mentality, hacking, individual space, community space.

[1] This research is financed by a SSHRC grant to Albert LEJEUNE, # 430-2014-01070 (2014-2016).

Problem

"We are all hackers…We've always been a profession of hackers. Every building is a one-off made up of countless elegant hacks, each bringing disparate materials and systems together into a cohesive whole. But when it comes to the software that designers have come to rely on, most of us have been content with enthusiastic consumerism, eagerly awaiting the next releases from software developers like Autodesk, McNeel (Rhino) and Bentley (MicroStation)". (Source: http://www.archdaily.com/tag/bim)

Building Information Modeling (BIM) is the "process by which a digital representation of a building's physical and functional characteristics is created, maintained, and shared as a knowledge resource. Since the early 2000s, BIM has become a necessary part of new building construction" (Briscoe, 2015: 1). But in Finland, a leading country with BIM and architecture[1], architects and engineers pioneering BIM have not been content with enthusiastic consumerism. It is the intuition behind this paper that collective mentality or macrocognition (Huebner, 2014) around BIM desirability is an essential characteristic of an innovative community inside the AEC (Architecture – Engineering – Construction) business ecosystem. Macrocognition can start with a computing step, implemented both in minds and machines. In the words of Huebner (2014), collective mentality requires a specification of the types of information that a collectivity is sensitive to and an account of the computational procedures that implement those mental states and procedures. When addressing different implementation speed and scope of BIM in AEC business ecosystems respectively in Québec (Canada) and in Finland, we found distinct types of information and computational procedures. This paper results come from 30 interviews with true BIM pioneers in Quebec and in Finland[2]. We discovered that Finnish architects and engineers pioneering BIM were creating a new software, programming scripts for existent CAD software and defining data standards; they were programming, computing and exchanging their code for free inside the community. Some plugins after twenty years are still used amongst architects. At a community level, Finnish members of the AEC industry and the State were setting up programs, round-tables, new organizations, and proactively connecting internationally through US leading universities like Stanford and innovation grants from the EEC. Since 1985, exploiting personal computer power and defining new buildings representations and construction processes, they were developing a collective mentality. This paper goal is to show that combination of innovative behaviors at individual work level and community level set the foundation for firms' innovation by developing a new collective mentality.

[1] Finland has more great architects /…/ in proportion to the population than any other country in the world (Frédéric Edelman, article in Le Monde, Paris, September 19, 2000).

[2] Professor Arto Kiviniemi (U. of Liverpool, UK), architect, innovation manager, BIM pioneer in Finland and collaborator to this research helped us to select 20 BIM pioneers in Finland. Professor Daniel Forgues (ETS), co-researcher, did the same for Province of Québec.

Current Understanding

In Finland, BIM' importance grew quickly which is reflected by the increasing number of owners demanding BIM use (Krygiel & Nies, 2008). To gain a better understanding of this increasing trend, many researchers studied the drivers of BIM adoption, some focusing on the institution level (e.g. Andy, Francis, & Abid, 2011), others interested in the organizational level (e.g. Aranda-Mena, Chevez, & Crawford, 2008; Guillermo, John, Agustin, & Thomas, 2009), while other groups of researchers have focused on the technological aspect (e.g. Underwood & Isikdag, 2011). There are some researchers examining the numerous obstacles that hinder BIM use, including technical barriers, legal and liability issues, regulation, inappropriate business models, and the need to educate large numbers of professionals (Eastman et al., 2011). When examining BIM adoption mechanisms, Succar and Kassem (2015) distinguish between the notions of 'BIM adoption' as the successful implementation of BIM tools and workflows within a single organisation, and 'BIM diffusion' as the rate of BIM tools and workflows adopted across markets. Notwithstanding the contribution of Succar and Kassem (2015) work, which definitely helped better understand how BIM is diffused into organizations, their approach, however, doesn't take into account individuals - engineers and architects - at the individual work space level and business ecosystems at the community level. This research takes a step toward filling this gap. Its main objective is to shed light on the mechanisms and the conditions that explain BIM adoption and wide use in Finland and that can explain, concurrently, the restrained use in Québec.

Table 1 synthetizes BIM evolution as it evolved in Finland from 1985 to 2015. The rows illustrate the four knowledge spaces while a fifth row present the platform level, first ICT-based and then a possible fusion of ICT, processes, GIS, IoT and social media into an open collaborative platform. The three columns are a combination of Zuboff (1988), Isikdag (2015) BIM and El Sawy and Pereira (2013) ICT views indicating a progression from automating to informating to knowledging. The theory of systems hierarchy adapted by Checkland (1999) connects the transformation at hand (what?) in a specific period with a higher system (knowledge space) containing the question why? and with a sub-system offering means (how?) to succeed in a transformation. Over time, the causes (why?) are belonging to ever higher systems while the means levels (how?) are combining to elicit new collaborative responses. Following Cidik et al. (2015: 1): "There is a growing awareness that the problematic nature of collaboration in construction design projects is further complicated by the use of interoperable information technologies (IT) in Building Information Modelling (BIM) enabled projects." In their paper Cidik et al. (2015) draw a distinction between "model interdependencies" and "design interdependencies" concerned with the IT (automation era) and the design task respectively (informating and knowledging eras).

Research Questions

The main research project question is: What are the mechanisms and conditions of their emergence that best explain the difference between Finland and Québec regarding the dissemination of BIM in their respective construction industries? Specifically in this paper, by observing the actors involved in their respective industries in Finland and Quebec, secondary research questions are set out as follows:

1. What are the specific mechanisms in respective construction business ecosystems of Finland and Quebec that may explain the observed difference in the dissemination and implementation of BIM?
2. What are the specific mechanisms in respective work and individual spaces of Finland and Quebec that may explain the observed difference in the dissemination and implementation of BIM?

Table 1. Three BIM Eras in Finland

	Automating Era From pre-BIM to BIM *IT as Tool 1970-1995*	**Informating Era** BIM-M (BIM to manage construction) *IT as Environment 1991-2011*	**Knowledging Era** BIM 2.0 *IT as Fabric 2004-?*
AEC Business ecosystem K-space			**Why?** Value creation at industry level
AEC Firm strategic level K-space		**Why?** Processes integration	**What? Learning through collaborative strategies**
AEC Innovation project K-space	**Why?** Less waste, less people, less delays, less costs	**What? New integrative processes**	**How?** -New soft organizational attributes and collaboration capabilities -Better social network -Collaborative platform -IT platform common to the business ecosystem
AEC work K-space	**What? Automate drawing and documenting work through *Product data model***	**How?** -Processes redesign -BIM & LEAN	
Platform level	**How?** -New AEC specific software (Autocad) -Software to aid design coming from manufacturing and aerospace industries (CATIA)	-Integrated software -IT platform shared around a project (Revit Server)	-Internet of Things -GIS perspective -BIM for the City
	COLLABORATION	COLLABORATION	COLLABORATION

Research design

This research is exploratory in nature and is based on a series of 30 in-depth interviews conducted in 2015 with leading BIM pioneers involved in Finland and Quebec. Data analysis is conducted, as suggested by Langley (1999), by combining several techniques, such as "visual mapping", the temporal decomposition, quantification of the facts and the technique of "pattern-matching", i.e. examination of alternative techniques of data interpretation and competing theories which might explain the same data otherwise (Yin, 2009). Interview data related to the implementation of BIM are analyzed from the perspective of grounded theory (Corbin, 1997). Emerging concepts are analyzed and incorporated into the research model as the analysis evolves over time. Since BIM generates knowledge resources (Briscoe, 2015) this paper use the concept of knowledge space (Lillehagen et Krogstie, 2008) to explore and analyse some disparities between work spaces and community spaces in Finland and in Quebec. This paper skip business and innovation spaces to focus on community space and individual work space. For Lillehagen et Krogstie (2008) the poles within the community space are: *value, initiative, infrastructure and resources*. The poles of the individual work knowledge space are: *information, task, view and role*. Those poles are the first defined nodes in the closed coding beginning step.

Findings

In Quebec, the **role** of the employee working in a BIM environment is still unclear, as the different companies have not fully understood the scope and requirements of a BIM process: the business models have not yet adapted. The same logic applied to the **tasks** that an individual (an engineer, architect, technician or designer) can execute on a daily basis. In Finland, the change and the adaptation have already occurred, versus Quebec where there remains a resistance. The extent of **information** that an individual has access to and the type he is required to create and manipulate has been developed and adapted into the Finnish construction industry. Individuals understand better the need to organise and incorporate this information in a collaborative platform, in contrast to Quebec, where the industry does not work in such a transparent environment due to cultural reasons and where sharing of information is not in the culture per se, especially information that belongs to other parties in competition. The different disciplines work in a detached and isolated manner; some respondents describe this as “working in silos”. Whilst in Finland, everyone has access to information relating to all disciplines, the access is standardized, and there is trust and collaboration spirit that developed through the history. Whilst in Finland, the standardisation of the process is in Finnish culture, and there is trust and collaboration spirit that developed through the history. Practices are based on trust. One of the reasons of this mentality is that the population of the country is relatively small, just 5.5 million where 400 000 of people are foreigners. The **view** is also an important element in the workspace. In fact, the guidelines present the level of detail required from each individual for different elements, as well as the format of the information (2D

layouts, 3D models, 4D simulations, energy consumption simulation, etc.). In parallel, the Quebec industry reaches 3D geometric modeling, with discrepancies in information consistency and depth, and to some extent, 4D simulations. The main issue in this case, is yet again, the trust between the various participants.
At community K-space in Finland, the BIM added **value** is better perceived and understood. In Quebec, actors still do not understand the full benefits and value of BIM for construction. The difference is mostly expressed in terms of experience and maturity in BIM. In Finland, projects have been already realized and actors can monetize the gains and the value of the process much better nowadays. The digital content **infrastructure** of the community space is better defined in Finland than it is in Quebec; technology is very advanced and pushed, making their infrastructure more oriented towards technology advancement and innovation. The better understanding of the BIM processes and their maturity permits Finland to better develop standards and BIM regulations than in Quebec is oriented toward a lowest bidder contractual pattern for public construction projects. The term **initiative** has the same meaning in both countries pushing towards innovation and amelioration of construction processes through BIM. Standing at a much advanced step, Finland has overcome more obstacles than Québec, but the impact of the innovation on the construction industry is the same: improving productivity, lowering costs and providing a better quality project. In Finland, because managers are researchers and the reverse, the **resources** are rarely discussed as most of the respondents focus mostly on the processes involved and the business models. Their concerns are mostly about the technological advancements and the different projects that lead to the positions they are in. On the other hand, in Quebec, most resources are regarded upon as being important: software, hardware, financial support from the government, human resources and means.

Conclusion: A Genuine Hackers Community Studio in Finland

A long collaboration history, apparently since 1985, characterizes both interactions between individual actors at individual level and as members of the national Finnish AEC community. At work K-space level, individual self-learning, then inter-individual learning and group learning is observed. At this point we propose the hypothesis that a hacker collective mentality is developing helping new and established AEC actors to better perform individually at a work K-space level where the dynamic between new tasks-new views-new info-new roles is very demanding.
As emerging leaders, those key individuals will serve the AEC community by sharing, diffusing, connecting various kind of AEC organizations: private (like TEKLA), public (like TEKES), semi-public (like RYM). An informant describes the recent situation: “RYM is a SHOK – a Strategic Center for Excellence - for the construction industry. It has 53 owners; the idea was that it would collect all the research needs in the industry together and prepare research programs that would get TEKES funding. Once again, to collaborate so that the industry would define what they want to develop and then universities, research institutes do research that support this development”.
From 1985, the intention to built a common social collaborative network assisted by ICT becomes apparent. To be a real living phenomenon macrocognition implies according to Huebner (2014) the following principle: “Do not posit collective mentality where

collective behavior results from an organizational structure set up to achieve the goals or realize the intentions of a few powerful and/or intelligent people" (Huebner, 2014: p. 21). Raised in the best education system in the world, Finnish BIM pioneers did not wait for the big structure: through their interactions and their interactions with the environment, in a situated cognition and then a macrocognition stance, they have built a BIM hackers community.
Naturally, in November 2015, a Finnish team won the last AEC Hackathon in Helsinki!

References

Andy, K., Francis, K., & Abid, N., 2011. Government roles in implementing building information modelling systems. Construction Innovation, 11(1), 61-76.
Aranda-Mena, G., Chevez, A., & Crawford, J., 2008. Business Drivers for BIM: Cooperative Research Centre for Construction Innovation.
Briscoe, D., 2015. Beyond BIM: Architecture Information Modeling. Routledge.
Checkland, P., 1999. Soft Systems Methodology: a thirty year retrospective, in: Systems Research and Behavioral Science.
Cidik, M.S., Boyd, D., Thurairajah, N., 2015. Collaboration in BIM Enabled Design Projects: Effects of Interoperable Information Technologies.
Corbin, J.M., 1997. Grounded theory in practice. Sage.
Currie, W., Galliers, B., 1999. Rethinking Management Information Systems: An Interdisciplinary Perspective, Oxford.
Eastman, C., Eastman, C.M., Teicholz, P., Sacks, R., 2011. BIM handbook: A guide to building information modeling for owners, managers, designers, engineers and contractors. John Wiley & Sons.
El Sawy, O.A., Pereira, F., 2013. Business modelling in the dynamic digital space: An ecosystem approach. Springer.
Huebner, B., 2014. Macrocognition: A Theory of Distributed Minds and Collective Intentionality, Oxford University Press, Oxford.
Isikdag, U., 2015. Enhanced Building Information Models. Springer.
Underwood, J. Isikdag, U., 2011. Emerging technologies for BIM 2.0. Construction Innovation 11, 252–258.
Krygiel, E., Nies, B., 2008. Green BIM: successful sustainable design with building information modeling. John Wiley & Sons.
Langley, A., 1999. Strategies for theorizing from process data. Academy of Management review 24, 691–710.
Lillehagen, F., Krogstie, J., 2008. Active knowledge modeling of enterprises. Springer Science & Business Media.
Succar, B., Kassem, M., 2015. Macro-BIM adoption: Conceptual structures. Automation in Construction 57, 64–79.
Yin, R.K., 2009. Case study research: Design and methods, 4th. Sage.
Zuboff, S., 1988. In the age of the smart machine: The future of work and power. Basic Books.