

The Use of Digital Tools in Training to Real Estate and Building Sectors – a Study from French University

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Abstract - This paper presents an analysis of two complementary evolutions, in work situations in the real estate and building sectors, using new digital tools such as the ones based on digital tablets. It concerns a bachelor degree in individual home building and new interactions in master degrees, mixing and integrating real estate and Information and Communication Technologies (ICTs) around the innovative Univcamp device. The latter promotes new real estate services with interactions between different actors in action-research situations. These evolutions correspond to a new approach of the French Universities, in particular the University Paris East Marne-la-Vallée and its component units Ile-de-France Services Engineering Institute (IFIS) and Information and Communication Devices in the Digital Era in Ile-de-France (DICEN idf). They support a specific way of apprenticeship training with the use of a new intermediation artifact between students and companies, the e-booklet. This work may help to develop a specific observatory space from work situations in an action-research perspective to promote a new “ideas integrator” interface between universities and companies. This interface will also allow observing evolutions of professions facing the challenges of new digital uses, corresponding to new skills, at first in real estate and building sectors.

Keywords - *pedagogic innovations; interactions; apprenticeship; digital tools; skills; data*

I. INTRODUCTION: GENERAL CONTEXT

ICTs strongly impact all our digital society and particularly companies and universities. Today Universities are not only producers of knowledge but also act to develop new skills for students, so they may work more efficiently in the companies, by introducing specific way of apprenticeship with particular organization and pedagogical approaches: sandwiches courses, use of an intermediation and traceability tool - the e-booklet. This new approach is particularly developed at the University of Paris East Marne-la-Vallée (UPEM) with strong partnerships with other learning organizations and companies. The synergy challenges between training and research fields have also become essential, particularly the challenge of innovation, through association of one or more partners to Universities. In our case, in the UPEM, the teaching side is provided by the IFIS – *Institut Francilien d’Ingénierie des Services* while the DICEN idf – *Dispositifs d’Information et de*

Communication à l’Ere Numérique en Ile-de-France is the Research team, located in the CNAM (*Conservatoire National des Arts et Métiers*), in the IFIS institute in UPEM and for some other researchers at Paris Nanterre University.

ICTs also question all our society. They change all the working conditions, especially with new digital and intermediation tools (tablets, etc.), access to information and new uses of data (especially big data). The integration of young people of the “Y Generation” also constitutes an important challenge for the companies in their new ways to cooperate with older employees (older than 50 years).

In this working paper, we propose to analyze these evolutions using case studies with students of two complementary degrees in the Building or Real Estate sectors: the Bachelor degree of Building of Individual Homes (CCBMI) and the Master degrees of Innovation Management in Real Estate (MIPI) and Digital Tools (MITIC). It is important to note that digital tools considerably change relations with customers with the idea of services co-production between all the stakeholders.

This work is a first step to introduce, through Univcamp device, CCBMI Bachelor, and the e-booklet artifact mediator, different ways to develop a specific observatory space from work situations in an Action Research perspectives to promote a new “ideas integrator” interface between university and companies. This interface will also make it possible to observe evolutions of professions in the face of the challenges of new digital uses, corresponding to new skills, first in real estate and building sectors.

After the introduction (section I), in a first step, we present the evolutions of the French Universities through the case of UPEM (section II) whose specificity is to bet on the apprenticeship. In a second step, we outline our scientific position, our goals and the methodology used (section III). Then, we show the specificity of the two degrees corresponding to this study. We also outline the challenge of ICTs for the considered companies and the importance of new ICTs tools (tablets) as levers of changes for better efficiency, developing new interactions with customers but also for new co-operations between employees (CCBMI) and for new interactions area for the Master degrees (Univcamp) (section IV is dedicated to results and section V to discussion). We also point out the importance of the e-booklet as an interactive tool (section VI). In a conclusive

part (section VII), we will give some perspectives for our future work.

II. TRAINING IN UPEM, REAL ESTATE AND BUILDING, ICTS AND SKILLS CHALLENGES

Universities do not only produce general knowledge but try to train their students for specific jobs with specific skills. In France, it is particularly the case of the University Paris East Marne-la-Vallée (UPEM). More than 25 % of its students are trained through apprenticeship. They are students with job contracts with companies. In UPEM, IFIS is much involved in this specific training way with 600 apprentice students.

In different degrees, for apprentice students, the skills approach has become essential. It is not only a question of acquiring knowledge but also of acquiring professional skills in work situations (in a “learning by doing” way). With this in mind, a system of professional references built with professional advice provides the pedagogical frameworks for these professional diplomas.

This is particularly the case of two different degrees in the Real estate and Building sectors: a Bachelor degree of Manager Building of Individual Houses - *Conducteur de Chantier Bâtiment en Maison Individuelle* (CCBMI) and Master degree of Innovation Management with two coordinated options in Real Estate Management - *Management, Innovation de Services et Patrimoine Immobilier* (MIPI) and in Digital Tools Integration - *Management, Innovation de Services et Technologies de l'Information et de la Communication* (MITIC). We particularly focus on tutored projects (a supervised work in a work situation) around the new use of tablets in the building sector in the Bachelor degree proposed with a partnership with Individual Houses Building Federation and François Mansart School. We also analyze the specificity of the Univcamp training / research relationship or interaction space born from a collaborative history initiated in these masters in 2006 to foster exchanges between students, business professionals and local community actors in the sectors of ICTs and real estate around new services designed and prototyped by students. It also finds its source in the construction of Sandbox, a collaborative space imagined in 2011 and realized in 2014 by the students of MIPI and MITIC, with their professors and some services of the university, as the first collaboration space of a French university, then extended to other IFIS degrees.

The family home construction market accounts for 135,000 operations per year in France. The profession played an essential role for the creation of the CCMI bachelor, expressing the lack of qualified personnel able to meet its requirements with both technical and management profiles: building technicians, facilitators of their sub-networks and real business skills (communication / negotiation) in the relationship with customers. The main skills to be given to apprentice students are especially technical: construction right and uses, management of sub contactors (coordination aspects), technical control of the

construction, communication (negotiation) and relations with consumers and neighbors in the construction area, management of the construction budget of the individual house, etc. Until yesterday, largely absent in the construction of family homes, the uses of digital tools (especially tablets) are now strongly emerging, they also constitute a major challenge for the companies. We try to analyze new digital uses (tablets) in the essential economic sector of the building of individual houses [1].

In the MIPI and MITIC Master courses, Univcamp has built an ecosystem set up in its current form in 2012. Univcamp develops a cross-reflection on the collaborative society of tomorrow and especially on the use of ICTs devices in the real estate sector around innovative services imagined by students [2].

In these two degrees (bachelor and master), we particularly focus on the new Information and Communication challenges in companies around the development of new digital tools. We outline the idea of companies becoming “Digital Ecosystems”, i.e. being considered as systems built by the interactions between all their actors and new uses of information with new digital tools such as tablets or smartphones, etc.

It also provides an opportunity to analyze the divided identity of the “Y generation” and its interactions with that of older workers, with the challenge of building new collective representations to improve performance in companies. We are also taking up the new challenge of the General Data Protection Regulation (GDPR). GDPR is a regulation of the European Union constituting the reference text for the protection of personal data when using personal and sensitive data in a global context of “augmented human” and data analysis for traceability and memory purposes.

In an idea of services co-production, these evolutions also question the relations with customers, becoming more involved actors, with new relations with employees of building companies through digital interface tools.

III. SCIENTIFIC POSITION AND METHODOLOGY

In terms of scientific position, we situate ourselves at the crossroads of Information and Communication Sciences and Management Sciences, to produce knowledge for action in an Action Research (AR) approach. Action Research is a process to uncover solutions through progressive problems solving activities. This process involves investigation through activity rather than theoretical response. It is also called participatory action research [3].

We refer to a constructivist perspective of construction of the social reality by the actors themselves or Constructivism, emerging first in psychology, with the Palo Alto researchers as Watzlawick [4]. As a learning theory, constructivism explains how people might acquire knowledge and learning. It suggests that humans construct knowledge and meaning from their experiences [5]. Brown-Martin [6] distinguishes “instructionism” (transmission of knowledge) from “constructionism” (reconstruction of

knowledge), or teaching versus learning. According to Noy [7], in education, constructivism is a ground practice and constant questioning. For us, this pedagogical approach promotes the participation and commitment of apprentice students in a process of empowerment by improving skills through interactions with human actors and non-human devices. It is also a way of observing changes in the companies.

We also give special importance to the approach by the “complexity”. Following Morin [8] [9], “complexity” is a holistic and multidimensional thought to connect in a systemic way interacting elements (actors, socio-technical devices, etc.). Genelot [10] focuses on “managing in (and with) the complexity” with the challenge of converging different representations to build a collective meaning for the organization performance. “Complexity” converges with the idea of “reliance” at different levels (micron, meso and macro) between actors in a systemic approach. We try to understand how a social system works with actors who interact to form an ecosystem of interactions. According to Le Cardinal et al [11], we also focus on the importance of trust to better develop complex projects, particularly in information systems and communication devices.

In the field of French Information and Communication Sciences (SIC), we are following Bernard [12] at the convergence of link issues (interactions), meaning, knowledge and action, in an Action Research way to produce knowledge for action, with all the importance of interactions [13]. As outlined by Gramaccia [14], project and quality management are two main tools in a more and more digitalized society.

We also follow the specific paper of technical objects developed by Simondon [15], corresponding also to the Actor-Network Theory (ANT) and the sociology of translation, proposed by Callon [16], Akrich et al. [17]. Originally created by French researchers Latour and Callon, ANT is an attempt to understand processes of technological innovation and scientific knowledge-creation, emphasizing all surrounding factors and not only on the acts: tools, labs, cultural factors and environment, and various other technical and non-technical elements. It has been criticized to give too much importance to non-human actors [18]. We consider ANT as an interesting theory to highlight the importance of digital devices but not as an analytical tool.

Our approach to using tools, better than Human-Computer Interfaces (HCI), corresponds to Computer Supported Cooperative Work (CSCW). CSCW is a generic term, which combines the understanding of the way people work in groups with the enabling technologies of computer networking, and associated hardware, software, services and techniques [19]. We point out the specificity and ambivalence of ICTs devices, that is to say positive aspects to improve performance but also constraints and possible suffering at work (stress and burn out). It may correspond to the ambivalence of technology explained by Ellul [20].

Following Goffman, we give special importance to the notion of situation, for a long time “too neglected” [21]. We

also work in an idea of “situated action” as proposed by Suchmann [22]. We favor the notions of situation, context and meaning with the idea of “interactionist and situational semiotics” as Mucchielli [23]. We also position ourselves as Carayol [24] in an approach of analysis of changes, especially induced by the ICTs in daily organizational innovation as analyzed by Alter [25]. Innovation is also important to improve skills to promote the economic development of the territories as explained by Godet et al. [26]. Following Leleu-Merviel [27], we focus on the concept of “design”, particularly of jobs and skills, especially in services companies, to combine project dynamics, innovation and quality dynamics in an organizational ecosystem and on territory. We meet then the idea of competitive intelligence on a territory developed by Carayon’s report [28]. As well as CPDirSIC [29], we consider “Design” as “science of project” and tool to “organize the group”, an ecosystem or a territory.

Extending the approach of Putnam and Nicotera about “The Constitutive Role of Communication” for organizations [30], we propose an ICOE approach: Information (new uses of data) and Communication (interactions, mediations) for Organizing Ecosystems (organizations, territories and also work situations, etc.).

From a methodological point of view, during apprenticeship situations, we develop interviews with the main actors of these courses (universities and companies). For CCBMI Bachelor, we have also periods of participatory observations in the work situations of the apprentice students in their companies’ periods with their interactions with other workers and through the use of the e-booklet.

Thus, for the CCBMI Bachelor, our case study focused on a group of 17 apprentice students from January to April 2018. We help them answer to a survey (*questionnaire*), used as a prerequisite for individual interviews. During visits to apprentice students in the workplace, the training coordinator was also able to observe some of them in their work situations (9) and was able to talk with a majority of tutors (10). The results of this study were presented at the committee meeting of this degree in September 2018, where a majority of companies’ apprentice students tutors (10) and all apprentice students were present.

The Univcamp interaction device is composed of three different phases. The first phase of nearly 4 months where, following a call for proposals drafting around a central theme (2019 theme: responsible ecosystems), “caring customers” propose topics to explore related to their professional and concrete needs. The call for projects is distributed in the Master’s network companies.

A work of definition and verification of compatibility with both the thematic and the university operation is carried out by a team of six teachers, who will then be university referents of the projects. The “caring customers” belong to organizations as different as SNCF (Railways) Development, the IT77 Association of the attractiveness cluster of the Seine-et-Marne department, the Digital Companies Federation (Syntec), etc., the property management and the digital campus of the University Paris East-Marne-la-Vallée University, the University Paris-East

staff of the i-site project, CROUS (Services for Students), the intercommunity of Meaux area, etc..

Then, there is a second 6-month phase, during which about 50 students will carry out 10 innovative and viable service projects. They form small groups of five or six students who deal with the problematic entrusted to each group by a benevolent customer from a user-centric approach to build a prototype and a sustainable model. Projects are designed and implemented with the help of an extended team of 10 teachers from resource classes (agile project, conflict management, design thinking, prospective) as part of a skills-based approach.

The third phase (the heart of Univcamp process), more hectic, takes place during a day of interactions between all the actors. It is centered on dissemination and collaboration. The essential link between these three phases for the success of the whole system is managed by a team of 9 teachers and teachers-researchers of the Master.

We have collected data as part of participatory observation approach. The team of 9 teachers (IFIS) took the lead role with other researchers of DICEN idf. They were helped by students to take notes. For the next years, to improve our observation of the restitution phase, we will use video recordings.

IV. FIRST RESULTS

Our observations, both in tutored projects for CCBMI Bachelor and Masters MITIC and MIPI interactions in the Univcamp device, have allowed interesting conclusions.

ICTs question all our society, changing our identities, our representations, the work conditions and our relations to information and communication, introducing an important gap between Internet natives or “Y Generation” and other people, the challenge of making them working together is particularly important for the survival of the companies.

The apprentice students of CCBMI Bachelor are “connected” people. They are especially interested in new digital uses in work situations. It is a new manner to discover their new job from their “apprentice” position. They also have a “lever” position, helping other older employees in their companies to discover these new tools and so their position is valued in a perspective of a “learning organization” (*organisation apprenante*) at two levels: training its employees but also developing their new skills especially digital ones. In this way, this approach is very appreciated by their companies, and especially by their apprenticeship supervisors. Customers are also interested because these digital tablets may favor information and knowledge sharing and, consequently, new ways of co-operation in a co-production of services approach.

The results of the survey and especially the interviews revealed different positions of apprentice students, according to their different situations of activities in the companies and their different corporate cultures. Some are very dependent on the guidance of their apprenticeship tutors (4), others have more autonomy and can take

initiatives (6), others are in intermediate situations with more or less autonomy of action (7).

The answers also bring differences in the dual identity of apprentice students: at the same time students, but largely co-constructing their knowledge as employees of a company, therefore already involved in the world of business.

Our interviews and observations also outline the challenge of the digital gap (*fracture numérique*) between two generations of workers in the building companies: the young digital native workers and the older ones. This evolution changes the work relations, particularly regarding knowledge transmission and apprenticeship situations. In the past, especially in the building sector, the experience and the knowledge of older workers were very valued. The oldest passed on their knowledge to the youngest, especially in the guild or corporations companies. Now, with digital tools as tablets, in some situations, it is no longer the skill acquired by the experience that is essential but the ability to use these new digital tools. The change is important because the formerly highly valued workers (often over 50 years old) have now become partly dependent on the youngest, with virtually a reversal of markers or skills sliders. It is an interesting aspect of the ambivalence of technology [20] and its strong force in change [24] that can improve the companies' performances but can also, with new job design [27] [29], changes the old standards and hierarchies and thus possibly cause stress and suffering situations at work.

In the Univcamp device, three types of actors (students, professionals and teachers-researchers) meet to discuss the projects presentations and workshops. The debates are animated at the beginning of the morning by a jury of 6 people composed of academics and professionals. The actors are then brought to the workshops designed by the students to allow each guest to experience the innovative service on the basis of model (s), prototype (s), proof of concept(s) and numerous media communication explaining the project.

Since 2013, Univcamp device brings together, each year, more than one hundred and twenty people to imagine the society of tomorrow on such important topics as the University of tomorrow, smart and digital city, ecosystem on territories around the potential of digital and new collaborative spaces (station 2.0, workspace, telecentres, fab lab using open data, bots etc.). The format adapts year by year to the expectations of the public: from a two-days BarCamp, the event has evolved into experimental workshops around projects to test ideas and answer questions asked by benevolent customers. For the 2019 edition that we are setting up a scientific committee whose objective will be to support the publication of a collective work bringing together scientific productions around Univcamp's subjects of recent years, and thus promoting co-operations in an action research perspective.

V. DISCUSSION: BEYOND THE ICTs, THE IMPORTANCE OF THE PROBLEM OF THE USES

Real estate is tackling major challenges that are partly mediated by the issues raised by the concept of “smart city” around the idea of “smart building”. The smart city promises a more intelligent urbanized world to better control the irreversible growth of cities (and therefore the evolution of territories impacted by this urbanization) with at heart the global infrastructures and logistics issues: energy management, mobility, connection of buildings, and also societal ones such as healthcare, evolution of jobs, etc. The questions also arise inside buildings with life quickly changing with digital uses: new areas, new ways of working (co-working, third places, etc.). They constitute important levers of changes in territories [25] [26] [28]. In this context, ICTs participate in the emergence of three new trends:

- Using digital tools and technology to offer new services and facilitate access to improve the quality of life and live better.
- Putting users (building occupants / city inhabitants) in the center of the problematics, integrate them, make them participate and co-create, etc.
- Creating sustainable value, considering all actors and their responsibilities with all the importance of interdependencies.

However, many digital projects at the building and city levels begin with organizational silos and transform them into digital silos. The challenge is to introduce more cross-cutting approach and network with the new digital technologies to overcome the silos (platforms, data and open data, networks etc.) It is becoming important to start from the needs of the occupants of the houses and the inhabitants of the areas. All this in a balanced way with the organizational needs and to design the new interactions between all the actors, in particular from the data deposits offered by the large-scale digital deployment (Internet of Things, data storage, silos, etc.).

We identify Univcamp as a global situation or ecosystem allowing the observation of the interactions and the CCBMI Bachelor as a favorable ground for the observation of job transformations.

In this way, we refer to the emerging idea of HDI or Human Data Interfaces in order to analyze new mediated data carried between all the human actors (and from non-human devices) and to promote new uses of these data to improve services in an interactive approach of services co-production.

For us, the constructivist approach is also an interesting way to observe the changes in the companies from the level of work situations in an attempt to tackle the invisible part or unformulated part of the work.

The key question of the uses raised by this observation can be organized into three themes for reflection as shown in the figure below:

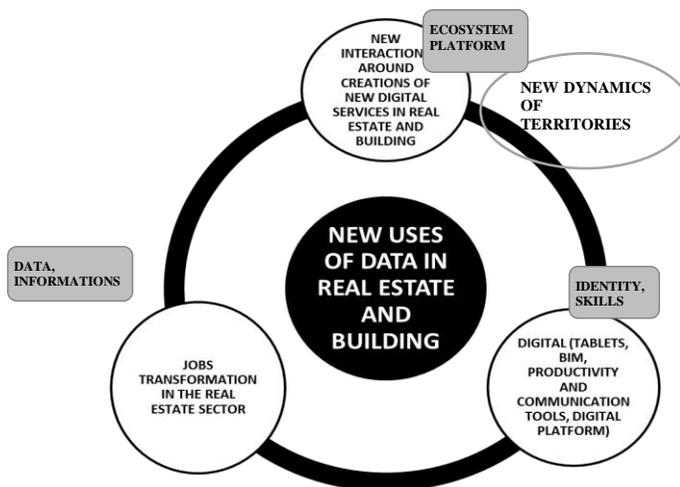


Figure 1. An Ecosystem of Interactions Developed by New Uses of Digital Tools and Data.

This figure is a synthesis of our analysis. It invites us to consider that a situation, consequence of the introduction of a technology, is for us the result of the information really mobilized by the actors in the situation, in relation to the questions of language, social representations, needs and skills and uses of new socio-technical devices.

VI. A POTENTIAL LEVER FOR COOPERATION IN APPRENTICES SITUATIONS, THE E-BOOKLET

In an approach based on the skills and competencies for collecting data in the workplace, we also wish, for future research, to attach particular importance to an intermediation tool in apprenticeship training: the e-booklet (*e-livret*). It is a compulsory tool to give traceability to the evolution of activities of the apprentice students during the year of their training, both in University and in companies in their work situations as analyzed by Bourret et al. [31].

Better used, the e-booklet may become an important interactions tool, focused on competencies and skills development, to show the evolution of the “employability” of the apprentice students during their training year, both in the university and in the company. It may also be an interesting support to collect new data about work in interactive situations.

More globally, for the apprentice students, the e-booklet may constitute a first step for a comprehensive skills booklet throughout their working lives, in the same way, for example, as the Electronic Health Record (EHR) for the

digital health memory of all the citizens and for patient pathways including their travels or their new jobs in other countries during their lifetime.

For us, these paths represent interesting action research opportunities in a digital memory approaches to develop the traceability of our students' skills, as a first step, especially in real estate and building sectors.

VII. CONCLUSION: TOWARDS AN OBSERVATORY OF CHANGES IN WORK SITUATIONS

Based on the promising results of Univcamp, around the Master degrees MIPI and MITIC and from the Bachelor degree CCBMI co-operations around new uses of digital tablets in the building sector, IFIS and DICEN idf wish to create an "incubator of ideas" space, as an interactions space between companies and university. It may correspond to a field of experimentation and innovation in order to analyze the changes in jobs, particularly around new digital uses. Our first steps concern the real estate and building sectors.

Its mission would be to try to respond to the societal challenges of the East of the Ile-de-France region as part of the i-site project, on the sustainable and inclusive city, central topic of the development of the UPEM University into the new one Gustave Eiffel University (January 2020), in cooperation with the French research Institute on Sciences and Technologies, Transports, Planning and Networks - *Institut Français des Sciences et Technologies des Transports, de l'Aménagement et des Réseaux* (IFSTTAR).

More globally, this interaction space aims to become a center of resources and expertise that federates the initiatives of the five Masters of the IFIS and some Bachelors (*Licences professionnelles*) for the development of new projects at two levels. First we will propose a label "incubators of ideas" for already existing initiatives as Univcamp or CCBMI Bachelor. Secondly we wish to develop new projects promoting transversal expertise between other IFIS Masters as digital tourism, quality, or healthcare and social welfare in the idea of analyzing jobs dynamics in specific ecosystems promoted by digital tools.

In this working paper, we have analyzed some of the work situations developed by new uses of digital tools, especially in the building and real estate sectors, through two complementary university degrees in a French University (UPEM) very focused on apprenticeship way of learning. This work is the first step for larger-scale works, always observing work situations of apprentice students through co-operations with their companies and discussing their feelings and their requirements, to develop their employability, that is to say to improve their skills and develop their efficiency in work situations.

IFIS Institute and Research Team DICEN idf plan also work together on a project of an observatory of job changes induced by digital tools, especially in the real estate and building sectors. We may begin with the idea of smart house

or smart building linked for example to the use of Building Information Modeling (BIM) tool to an idea of Smart Building in a Smart City in a Smart Territory. It is a part of the new challenge of the UPEM in the i-site project of creation of a new federative establishment (Gustave Eiffel University) centered on the innovative, creative, integrative and sustainable city.

REFERENCES

- [1] C. Bourret and T. Drapier "Training in a Job Approach and Digital Uses in the Building Sector in France. The example of the Individual Houses in a French University Degree in An Apprenticeship Perspective", Proceedings, EDULEARN18 (10th annual International Conference on Education and New Learning Technologies), IATED, 2nd - 4th of July, Palma de Mallorca (Spain), pp. 2287 – 2290, 2018.
- [2] C. Meyer and C. Bourret, "Developing Learning / Research Interactions in a French University from the Univcamp Device (Paris East University)", 11th Annual International Conference of Education, Research and Innovation – ICERI, Sevilla (Spain), 12 – 14th November, 2018.
- [3] Available from: <http://www.businessdictionary.com/definition/action-research.html/2018.12.26>
- [4] P. Watzlawick, The invention of reality. Contributions to constructivism / *L'invention de la réalité. Contributions au constructivisme*, Paris: Seuil, 1988.
- [5] Available from: http://sydney.edu.au/education_social_work/learning_teaching/ict/theory/constructivism.shtml/2018.12.26
- [6] G. Brown-Martin, Learning (Re)imagined. How the connected society is transforming learning, Bloomsbury Academic, 2014, 328 p.
- [7] C. Noy, "Constructivism part in university studies / *La place du constructivisme dans l'enseignement universitaire*" in A. Mucchielli dir., Conference Constructivism part for communications studies / *La place du constructivisme pour l'étude des communications*, Béziers (France), pp. 225 – 238, 2003.
- [8] E. Morin, Think global / *Penser global*, Paris: Flammarion, Champs-Essais, 2016.
- [9] E. Morin, The seven necessary knowledges to education in the future / *Les sept savoirs nécessaires à l'éducation du futur*, Paris: Unesco, 1999.
- [10] D. Genelot, Managing in (and with) the complexity / *Manager dans (et avec) la complexité*, Paris: Eyrolles, 2017.
- [11] G., Le Cardinal, J.-F. Guyonnet, B. Pouzoullic and J. Rigby, "Intervention Methodology for complex problems: The FACt-Mirror method", European Journal of Operational Research, Elsevier, n° 132, pp. 694-702, 2001.
- [12] F. Bernard, "Information and Communication Sciences (ICS) : an openness and decompartmentalization discipline / *Les SIC une discipline de l'ouverture et du décloisonnement*", in A. Bouzon, coord., The organizational communication in debate Fields, concepts, perspectives / *La communication organisationnelle en débat. Champs, concepts, perspectives*, Paris: L'Harmattan, pp. 33 – 46, 2006.
- [13] L. Bègue and O. Desrichard, co-dir., Treatise of social psychology. The science of human interactions / *Traité de psychologie sociale. La science des interactions humaines*, Bruxelles: De Boeck, 2013.
- [14] G. Gramaccia, "Quality, project, digital : 3 symbolic variations of managerial efficiency / *Qualité, projet, numérique : 3 variations symboliques de l'efficacité gestionnaire*", in C. Batazzi coord., Communication, organisation, symbols / *Communication, organisation,*

- symboles*, Revue MEI n° 29, Paris: L'Harmattan, pp. 55-67, 2008.
- [15] G. Simondon, The mode of existence of technical objects / *Du mode d'existence des objets techniques*, Paris: Aubier, 1958.
- [16] M. Callon, Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St Brieuc Bay. In John Law (ed.), *Power, Action and Belief: A New Sociology of Knowledge*. London: Routledge & Kegan Paul, 1986.
- [17] M. Akrich, M. Callon and B. Latour, *Sociology of translation. Founding texts / Sociologie de la traduction. Textes fondateurs*, Paris: Les Presses Mines de Paris, 2006.
- [18] Available from: <https://www.learning-theories.com/actor-network-theory-a/2018.12.26>
- [19] Available on: https://en.wikipedia.org/wiki/Computer-supported_cooperative_work/2018.12.26
- [20] J. Ellul, *The technique or the challenge of the century / La technique ou l'enjeu du siècle*, Paris: Economica, 1990.
- [21] E. Goffman, "The Neglected Situation", in J.J. Gumperz and D. Hymes dir., "The Ethnography of Communication", *American Anthropologist*, Washington DC, pp. 133 – 137, 1964.
- [22] L. Suchmann, *Plans and Situated Actions. The Problem of Human-Machine Communication*, Cambridge: Cambridge University Press, 1987.
- [23] A. Mucchielli, *Communication & Influence. Situational approach / Communication & Influence. Approche situationnelle*, Nice: Les Editions Ovadia, 2010.
- [24] V. Carayol, *Organizational communication. An allagmatic perspective / Communication organisationnelle. Une perspective allagmatique*, Paris: L'Harmattan, 2004.
- [25] N. Alter, *The ordinary innovation / L'innovation ordinaire*, Paris: PUF, 2005.
- [26] M. Godet, P. Durance and M. Mousli, *Unleash innovation on territories / Libérer l'innovation dans les territoires*, Paris : Conseil d'Analyse Economique - La documentation Française, 2010.
- [27] S. Leleu-Merviel and H., Boulekbache-Mazouz, *Design Researches Conception processes, writings and representations / Recherches en design. Processus de conception, écriture et représentations*, Paris ISTE Editions, 2014.
- [28] B. Carayon dir., *Economic intelligence, competitiveness and social cohesion / Intelligence économique, compétitivité et cohésion sociale*, Paris : La Documentation française, Available from: <http://www.ladocumentationfrancaise.fr/rapports-publics/034000484/index.shtml>, 2003.
- [29] CPdirSIC (Permanent conference of lab directors in ICS / *Conférence Permanente des Directeurs / trices de laboratoires en SIC*), *Researches Dynamics in Information and Communication Sciences / Dynamiques de Recherches en Sciences de l'Information et de la Communication*, Paris, 2018.
- [30] L. L. Putnam and A.M. Nicotera, *Building Theories of Organization. The Constitutive Role of Communication*, New York and London: Routledge, 2009
- [31] C. Bourret, K. Fraoua, R. Eppstein, and B. Simon, "Knowledge construction and sandwiches trainings : reflections elements on monitoring lifelong learning and skills around the new role of Universities in France / *Construction de connaissances et formations en alternance : éléments de réflexions sur le suivi des acquis de formation et des compétences tout au long de la vie autour du nouveau rôle des Universités en France*", Proceedings Xth international ISKO (International Society for Knowledge Organization,) Strasbourg, November 2015, Chevry-Pebayle E. dir, Paris : ISTE Editions, pp. 372 – 388, 2017.