Unexpected Artifact – A Modding Interface Design

Arminda Guerra Lopes

Madeira ITI/LarSys, Instituto Politécnico de Castelo Branco, Portugal
aguerralopes@gmail.com

Abstract. Human Computer-Interaction (HCI) has been handled in different ways, which permitted to interpret the theories, methods and practices according the chosen approach. Some considerations are presented about HCI approaches over the years, and the adopted pedagogical tactics to teach HCI disciplines is described. HCI was taught following the method of teaching / learning pointed to student-centered, supported by incentives for self-learning and integration of knowledge, preparing students for lifelong learning. The student was confronted with a set of theoretical and practical problems, based on real cases, for which they needed to present solutions. The attitude towards the students was challenging them to deal with creativity and how it was affected/supported by technology. The case that we describe in this paper concerns an artifact – a microwave –, which was modified to function differently from what it was built for. We present an example case where students were free to demonstrate their creativity and develop an artifact based on the concept of modding.

Keywords: human computer interaction; human work interaction design; creativity; modding; artifact; technology; interface design

1 Introduction

In general, human computer interaction (HCI) courses included in the curricula graphical user interface (GUI) design, HCI foundations, user centered software evaluation/development and human factors. Since several years it has been difficult to change and adopt new courses of HCI. The main reasons are probably, related to the engineer tradition and also due to the academics understand they consider HCI as a field and not as a discipline. Academics and industry do not have, yet, a common definition for HCI.

The researcher had some difficulties to make students understand that HCI is an important subject to study since the knowledge acquisition, in this area, will be applied in the professional computer science domains. The central argument concerns the changes of influences, which also change people behaviors. However, several constraints are faced: cultural barriers, the change of actors paradigm – design with people and by people -, the absence of definition of an intellectual or methodological core, the use of theories and methods from other disciplines and the fashion discipline that HCI became, which as fashion, changes over the time and context.

Another field that contextualized the study was Human Work Interaction Design (HWID). It promotes a better understanding of how and why people work in the ways they do and endorses a better understanding of the relationship between work-domain based empirical studies and iterative design of prototypes and new technologies.

Although the approach behind the development of the presented project be modding, which refers to the act of modifying hardware, software, or virtually anything else, to perform a function not originally conceived or intended by the designer it can also be considered a creative artwork.

Creativity helped students to develop the personal and technical skills to meaningfully shape their practical multidisciplinary knowledge.

2 Background

In this section the theoretical concepts and theories that will be tackled along the paper are described: human-computer interaction (HCI) approaches; human work interaction design (HWID) and Modding.

2.1 HCI Approaches

Grudin explained HCI as a cover to form disciplines: human factors, information systems, computer science, and library, and information science. He concluded that HCI wherever it is studied it will be in its early days [1]. The reasons for that are the changes on influences: new waves of hardware enable different ways to support the same activity; email changed the way we communicate; social networking came along; the desktop computer has lost the spotlight to portable devices; government and industry are investing on parallel computing; different patterns of technologies use emerge in different cultures, different industries; accessibility and sustainability are development areas; digital technologies changed people's behaviors. Grudin also stated the cultural barriers that still separate CHI and IS: CHI discovered the limitations of laboratory studies and surveys for understanding discretionary use of methods and IS research focus on the economic, organizational, and marketing theory and practice than CHI. Sanders argued that the way design is done, and who is doing it, changed based on a move from the designing of things to interactions to systems, and from designing for people to designing with people and by people [2]. Recent issues about the disciplinary HCI have been debated. Kostakos based on the CHI publications over the past 20 years showed that the field seemed to follow technical fashions rather than long-term research themes. He considers that HCI does not seem to have a solid intellectual or methodological core [3]. Then, Stuart Reeves recommends that HCI should be thought not as a discipline but rather as an interdiscipline, which is agreed by Rogers and Blackwell [4], [5]. Blackwell goes deeply on the discussion stating that there is a hole at the center of HCI research. To explain this hole, he is based on two case studies he did: one was a systematic analysis of 180 collaborative projects on research in interdisciplinary design to understand the insights into human behavior. The second case study was a survey of interdisciplinary innovation [6]. These studies allowed reflecting on the use of theories and methods on other disciplines to do HCI work. And this was the problem: is HCI a discipline or not? It might be not. Kim advised already for interdisciplinary cooperation in HCI. For him HCI field was not a discipline but being an interdisciplinary field it might be called as generality [7]. Pan and colleagues were concerned about HCI becoming a fashion driven discipline. They propose to examine and explore what might happen if HCI becomes a fashion driven discipline [8]. Several aspects of HCI research such as user experience, aesthetics,

design thinking will be more difficult to research in a traditionally scientific way. Pan argued that fashion in relation to interaction design has a place in HCI and it becomes an influence on the decisions and judgments made by HCI practitioners and researchers [9]. Other authors subscribe this approach that fashion affects interaction designers 'design thinking in relation to functionality, appearance, user experience, and visual experience. In the presented case study, we were not concerned with a particular definition of HCI approach, since we were focused on the output. Nevertheless, being HCI a cover to form disciplines, a change on influences, a media for interactions to systems, a way of designing by people or a fashion driven discipline, we used a combination of them and the background theoretical concepts to design the output which pleasured the developers and those who interacted with it.

2.2 Human Work Interaction Design

Human Work Interaction Design (HWID) is a Working Group 13.6 (WG13.6) established in September 2005 as the sixth working group under the International Federation for Information Processing specifically the Technical Committee 13 on Human Computer Interaction (HCI). A main objective of the WG13.6 as defined in 2012 is the analysis of this complexity and its relationships between extensive empirical work do mains studies and HCI designs [10]. For detailed information about HWID see: Frederica Gonçalves, Pedro Campos and Torkil Clemmensen [11] who use a HWID framework to present a literature review of 54 papers from HWID workshops, conferences and journals from the period 2009-2014.

HWID includes the study of how to understand, conceptualize, and design for the complex and emergent contexts in which HCI and work are entangled. HWID aims to increase the benefit derived from elements from both interaction design and work analysis knowledge, such as work analysis, prototyping, organizational change, computer-supported cooperative work, human-computer interaction, and participatory design, by interrelating them and capitalizing on their individual concepts and empirical instruments [12, 13].

Secondly, it aims to develop a new and harmonized interdisciplinary framework for trans-mediated and smart workplaces that addresses the core challenge: how do you take a balanced and holistic design approach to improve the work experience in the organization? It aims to engage with and learn from partners' research in different work domains when identifying key attributes in the effective trans- mediation of pervasive and smart technologies from one work domain to another.

Human work analysis is traditionally focused on user goals, user requirements, task and procedures, human factors, cognitive and physical processes, and contexts (organizational, social, and cultural). Today, generic designs are applied to use-situations with very different purposes, as the same social software or games are used for both work and leisure situations. Thus, design shifts from design of a technology to design of various use situations encompassing the same technological design.

2.3 Creativity and Learning through Modding

In the early literature it is stated that creative products needed to have novelty and value [14]. Boden agreed with this thought, suggesting that creativity involves generating ideas that are both novel and valuable [15]. Mayer refers to these two facets as originality and usefulness [16].

Creativity is becoming an intrinsic part of working life. Creativity denotes a person's capacity to produce new or original ideas, insights, inventions, or artistic products, which are accepted by experts as being scientific, aesthetic, social or technical value [17]. Much human creativity arose from activities that took place in the context in which interaction and the artifacts that embodied group knowledge were important providers to the process. Other approaches about creativity reflect on creativity as the tendency to generate or recognize ideas, alternatives, or possibilities that may be useful in solving problems, communicating with others, and entertaining ourselves and others [18].

Our notion of creativity, in the context of this study, focus on novelty and useful/usefulness however, something usefulness should functioning.

Learning and doing have become inseparable in face of conditions that invite us to be creative. We wanted that students create things based on what surrounded them, on their wishes, using their own creative skills. Our concern was to let students discover and provoke their interests, motivation, attitude, problem-solving capability, critical thinking and information handling abilities.

Creativity was expressed through modding since it introduced an entire element of creative implementation, and allowed students to share their creations for the other classes' students and teacher to enjoy.

2.4 Modding

In the field of computer science there are two types of modding: software modding, which consists of altering certain software in order to improve the performance; and modding in the hardware that consists of modifying the hardware of the computer with the aim of improving aesthetics and performance.

Mods have been around since at least the early eighties, following the release of the original first-person shooters, and they have been an integral part of the gaming experience for many gamers ever since. Most games produced since then, have had at least minimal modding capabilities.

The main areas where, more recently, modding have been applied are on game industry. Scacchi examined the role of open source software development within the world of game mods and modding practices (Game modding has become a leading method for developing games by customizing extensions to game software) [19].

Firms developing software and in particular, video game producers, seek to leverage the community of users/developers in enhancing product offering and increasing sales [20].

The video game mods have become an integral part of the gameplay experience for PC gamers and have drawn support of major game development companies [21].

Modding, the practice and process of developing game mods, is typically a "Do It Yourself" (DIY) approach to end-user game software engineering that can establish both social and technical knowledge for how to innovate by resting control over game design from their original developers [22]. Additional content for video games such as mods (modifications) or DLC (downloadable content) are increasingly prevalent in the current video game market. For cultural heritage institutions with video game collections, such content introduces various philosophical and practical challenges on multiple aspects including acquisition, description, access/use, and preservation [23].

There has been a recent increase in the number of game environments or engines that allow users to customize their gaming experiences by building and expanding game behavior. This article describes the use of modifying, or modding, existing games as a means to learn computer science, mathematics, physics, etc.[24]

The approach we followed was Modding as a similar mode to "Tunning" but applied on computers and not on cars. The spirit of modding is to create something

unique, personal and preferably more efficient than the original, giving priority to the aesthetics and efficiency of the components. At the level of our artifact's aesthetics the arrangement of components, the organization of cables, not only improved the aesthetics of the box but also improved the circulation of air inside it, giving the components a better "breathing".

The modding is divided into two parts - the modders change the boxes in aesthetic terms, and in terms of efficiency, being able to produce original boxes with personal taste, as well as to improve the efficiency of refrigeration. Also important is the pleasure these people have when they build something different. The development of nice artifacts has to do with experience (in the material's destruction) and above all, with some skills to work with various tools.

3 Case Study

This section presents the case study goals, the participants and the design process. Students based on their needs imagining that they will use a product or service, and strive to create designs that would give aesthetic pleasure as well as lasting satisfaction and enjoyment.

The main goal of this study was to motivate students using their skills and abilities concerning creativity and technology use and to engage them, putting in practice the HCI theories, concepts, and, methods in producing an artifact and HWID framework to guide their design process.

The participants in this study were undergraduate students of informatics and technologies degrees. The study had twenty-two participants. Students were invited to form a team with three partners. They had three months to accomplish the challenger. They could work during laboratory classes' timetables or at home. The work in progress should be presented and discussed weekly to the class. At the final deadline, they presented the whole work: the prototypes and the written report.

3.1 Methods

The research methods applied on this study were a qualitative research methods approach, namely, observations and interviews. Students were observed on laboratory classes about HCI during each phase of the artifacts' development. The number of participants was 25 students. The main goal was the application of HCI theories and concepts to the development of an artifact. HWID framework was the chosen tool for the preparation and analysis of the design process. Among other outputs, this paper presents a selected example about modding. During students work, notes were taken concerning student's behaviors and mood. The goal was to register task duration, students' refection time, communication among team members, difficulties encountered and number of questions directed to teacher to clarify doubts. The positive and negative points of the experience were also registered. Interviews were a complementary method to get students information about their motivation. Questions were open questions style. The goal was to understand students' satisfaction during the artifacts development and their opinions at the output phase, the artifact completion.

3.2 The design process

A challenge was proposed to the students: look around (search) and invent/re-design things that you would want to use yourselves. They needed to design an interactive artifact supported on creative activities, and to develop the prototype or final product. Goldschmidt considers that it is rare for instructors to explicitly state or prescribe specific design goals or to refer to knowledge categories to be attended to. Normally, it is supposed that students define their own design goals [25]. The teacher defined the design settings and students followed it to start the project (Fig 1). Creativity is not taught at best it can be identified, encouraged and supported [25].

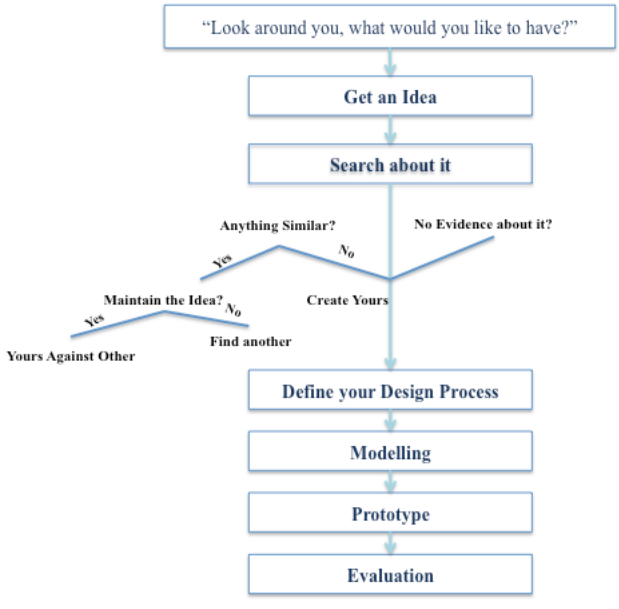

Fig. 1 Design Process

Each team came with an idea and they search about other artifact's developments related with the idea. Then, they defined the design process of the proposal to be created. Finally, they had to present sketches, diagrams, scenarios, prototypes and its heuristic's evaluation. This paper presents, as example, only one of the results.

4 Results and Discussion

The first output of the presented case was a redefined design process based on the one given to students (figure 1) and the observed experience (figure 2). Author consider it as a model of creativity, which was composed with the design phases carried on by students: Searching to get the idea, searching literature and digital sources to be inspired; Debating data results to understand and find relationships; Collaborating

with colleagues and teacher for support of their knowledge; Thinking to get combination of ideas and argument to explain the chosen option; Exploring solutions either making use of technology as a tool or developing its own tools; developing artifacts step by step; presenting the results in an engaged way.

The first stage of the creative design process was the problem definition. They defined the idea to be developed. In the second stage, students got information to understand contexts, the existence, or not, of the proposed interactive artifact; they searched, sketched, they took photographs, they interviewed colleagues and other people about the relevance of the proposal. Then, in the analysis stage they did diagrams and other sketches and they searched about technologies to be used for the prototype development. They listed the limits on the design according the available resources and constraints. At the development stage, students created solutions to share with other students, and they discussed ways to solve the problem each team had. Then, they started the technology integration on the design idea. Finally, the prototype was examined, evaluated and the constraints were clearly identified (if they existed) to produce the final artifact.

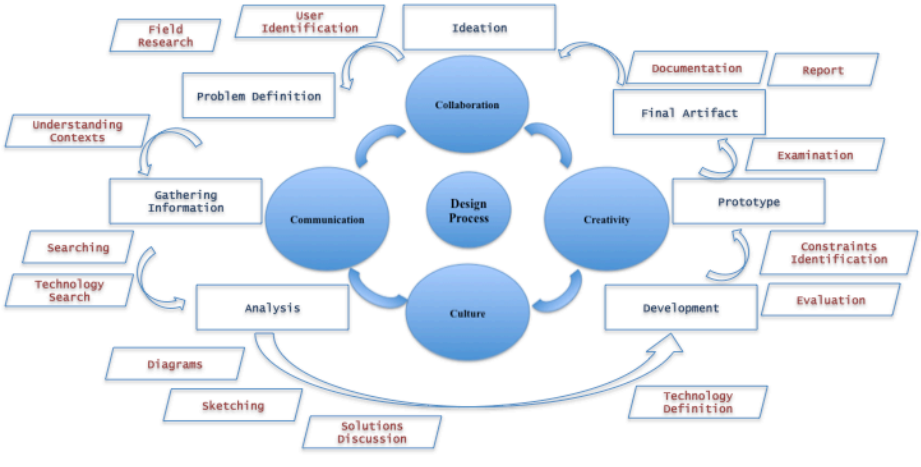

Fig. 2 Creative Design Process – [27]

Moreover, they completed each of the previous steps and they documented their work, in a report format; they presented the state-of-the-art about each of the subjects related with its main idea; they described the similar interactive artifacts on the market; they made the conceptual design research carried on their work; they presented the arguments about the technological choices and decisions about the materials used. A section with the description of the design process was integrated and the whole sketches and draws were included. Finally, they revised the work, they stated the identified problems and, they described the proposed solutions.

The four Cs (collaboration, creativity, culture, communication) in the design process came from the first impressions gathered from the observation of students doing their work [26]. Each concept could be attached to one of the stages but it could also make part of other stages. Examining them using communication as a means of sharing knowledge and ideas; watching their preoccupation on building artifacts carrying messages of their own cultural backgrounds; observing the students collaborative environments where each task was executed by sharing interests; examining their common values, meanings and feelings which were a constant

influence among the teams participants. The phases of the creative design process were derived either during the design brief or the data analysis. The data were analyzed based on the final report submitted by students and also on the group discussion during the artifact presentation.

Figure 3 shows the HWID framework designed to present the data gathered and to delineate the artifact.

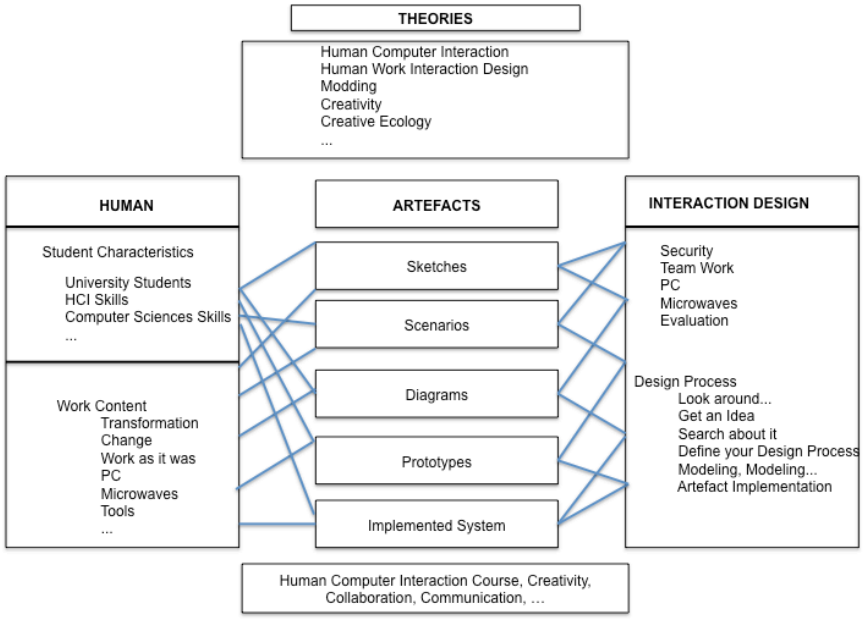

Fig. 3. HWID Framework

The development stages comprised several steps: the microwave box was designed on paper in order to spatially organize the components. Then, the original microwave box was removed, removing everything that was housed inside. With the lid of a damaged source a support was made to support the weight of the source, which supports the microwave. The slots grid has been positioned mill metrically so that boards could be added to the motherboard. Then, all the components to be inserted in the microwave were arranged for the computer to work. Figure 4 shows some of these stages.

The second main finding of the presented case is a Central Process Unit (CPU), inserted on a microwave. The main idea is the concept of reuse and of 'modding' applied to computers, the reuse of unused appliances. The students were concerned with environment and sustainability in the way they inserted each component on the microwave box for example, they introduced fans on the top of the microwave cover for refrigeration and thus, to enable better hardware performance.

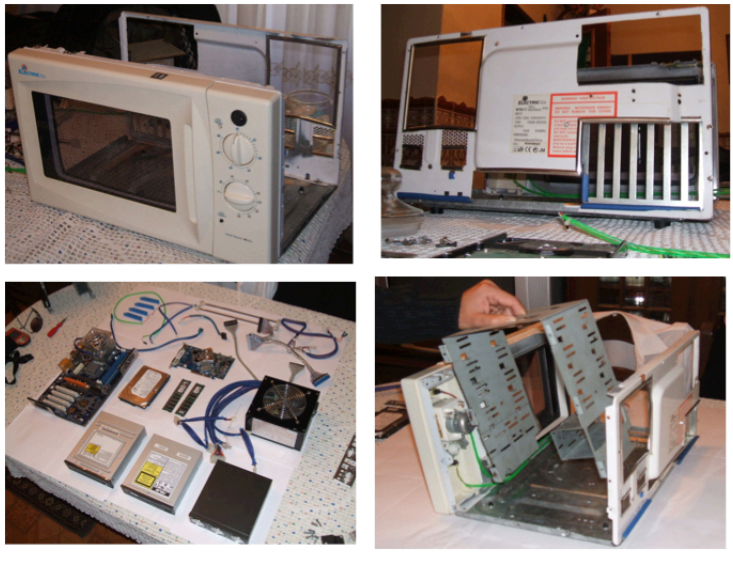

Fig. 4. Development Stages

This project corroborates the fact that our society has become a more technological, which leads to a more creative society. As a result, the routine tasks that used to take up a lot of our time and effort have become automated. Technology increases our potential to engage in the types of experiences that lead to greater creativity. Creativity is the essence of technology we have today, without technology one would be without the most basic of equipment in our modern day lives. It would be difficult to imagine a life without cars, computers, and even houses. Technology does not control creativity technology enhances creativity by the way users dealt with it. They are to be appropriately applied as set of tools in the creative process.

Figure 5 presents the final artifact, the computer components working inside the microwaves. This is a creative and innovative way to reuse damaged appliances, which was the case of the microwaves.

Fig. 5. Final Output

The theories of creativity are predominantly psychological [28]. Creativity does not result from the talents of a few individuals, but, on the contrary, nourishes itself from the repeated exchanges among a variety of heterogeneous entities that all contribute in their own way to foster the development of new ideas [29]. These entities were students' cultural background, skills in computer science, motivation, among others. Creativity is referred, on the study, in a contextualized way, place and circumstance. Students were encouraged to use and develop their creativity in an academic context. They were challenged to create a product using their technological skills.

There was an ecological perspective concerning the way students learned and adapted or changed something in a different way. The idea of learning ecologies is discussed by Brown; Staron and Land [30, 21, 32]. The ecological concept of the creative process is that it is the emergence in action of a novel relational product, growing out of the uniqueness of the individual on the one hand, and the materials, events, people, or circumstances of his life on the other [33]. A framework designed by Jackson (figure 6) explains the learning and practice as an ecological phenomenon to characterize a particular problem solving process in a practice setting and reveal the ecological relationships and interactions [34].

Fig. 6. Exploring Learning Ecologies (Jackson 2016)

The value of the ecological perspective to the teacher was the way the process in a holistic way, was respected, this means, the way how students used their own learning in the developed project.

The challenge succeeded. A new methodology was proposed to the students. They were at the center of the process, asking for their creativity skills, finding a team common idea, developing it, applying the theories and concepts learned on HCI course, level I, and coming back with an output. This challenge was very interesting, since the results shown student more engaged on the process and even working for completion aiming with colleagues. This study is a starting point of our knowledge acquisition and understanding of the situations that worried us. The study convinced us that this method should be continued with other teams looking at the creative process, the creative person and the creative product.

5. Conclusions

This paper summarizes the background definitions of Human Computer Interaction along the years, and presents a case study example of a creative artifact design using modding approach. The space for the study was laboratory classes in Human Computer Interaction field at a Polytechnic Institution. The work goals were based on something that surrounded the students, an event, an artifact, a problem someone had to sort, and was developed in groups. Each group had three elements. They should do design research applying their creative practices to present an output.

The case study goals were described to the undergraduate students. They were challenged to develop a creative artifact. In the presented example, students used the concept of mooding to develop the artifact. The aesthetics was observed on the storage of computer components and cables management inside a microwave.

These studies teach all of us several lessons. Beside the observed students' creativity and output novelty, it was found that they were engaged on a deep process of collaboration and free communication among the students. They designed interactive products to support the way people communicate and interact in their everyday and working lives using reutilization interface design concept.

Human work interaction design framework was used as a tool to help to organize the design process. Students developed several activities to support creativity and exploit the features of digital technologies: developing new ideas, making connections, creating and making, collaborating, communicating and doing analysis and evaluation.

The research methods, observation and interviews permitted to understand the students 'motivation, engagement and feeling about the pleasure and less good moments during an artifact development.

The most striking result of this process was, when freedom to choose a solution for a problem is given to students, they show greater levels of creativity, engage more with the task at hand, and they learn more with the mistakes they make throughout the course of their work. On the other hand, the concept of re-use has allowed them to become more interested in the environment that surrounds them and with the saving of materials and equipment.

Acknowledgements. We want to thanks the team student that developed the presented artifact: David Morgado, Joao Lourenço and Pedro Batista.

References

[1] Grudin, J. (2012). A Moving Target — The Evolution of Human-Computer Interaction. In J. Jackson (Ed.), *Human-Computer Interaction Handbook* (3rd ed., p. 40). Taylor & Francis.Walt Scacchi, Modding as a basis for developing game systems, GAS '11: Proceedings of the 1st International Workshop on Games and Software Engineering, ACM May 2011

[2] Grudin, J. (2005). Three Faces of Human-Computer interaction. *IEEE Transactions*, 2–18.

[3] Sanders, L., & Stappers, P. J. (2014). Designing to co-designing to collective dreaming: Three slices in time. *ACM Interactions*, *21*(6), 24–33.

[4] Kostakos, V. (2015). The big hole in HCI research. *Interactions 22*, 2 48–51.

[5] Reeves, S. (2015). Human-computer interaction as science. *Proc. 5th Decennial Aarhus Conference (Critical Alternatives)*. ACM Press.

[6] Rogers, Y. (2012). HCI theory: Classical, modern and contemporary. *Synthesis Lectures on Human-Centered Informatics 5*, 2, 1–129.

[7] Kim, S. (1990). Interdisciplinary cooperation. In The Art of Human-Computer Interface. Ed. B. Laurel. Reading, MA:Addison-Wesley.

[8] Pan, Y., Roedl, D., Thomas, J. C., & Blevis, E. (2015). Fashion thinking: Fashion practices and sustainable interaction design. *International Journal of Design, 9*(1), 53-66.

[9] Pan, Y., Roedl, D., Blevis, E., and Thomas, J. (2012). Re-conceptualizing fashion in sustainable HCI. *Proc. of the DIS'12.* ACM, 813–815.

[10] P. Campos, T. Clemmensen, J. Abdelnour-Nocera, D. Katre, A. Lopes, R. Ørngreen e (Eds), (2012) Human Work Interaction Design – Work Analysis in HCI. IFIP AICT 407, Springer.

[11] Gonçalves, F., Campos, P., & Clemmensen, T. (2015). Human Work Interaction Design: An Overview. In J. Nocera, B. Barricelli, A. Lopes, P. Campos, & T. Clemmensen (Eds.), *Human Work Interaction Design. Work Analysis and Interaction Design Methods for Pervasive and Smart Workplaces : 4th IFIP 13.6 Working Conference, HWID 2015, London, UK, June 25-26, 2015* (pp. 3-19). Berlin: Springer. IFIP AICT - Advances in Information and Communication technology, Vol.. 468, DOI: 10.1007/978-3-319-27048-7_1

[12] Clemmensen, T. (2011). Designing a simple folder structure for a complex domain. *Human Technology* 7, 3: 216-249.

[13] Clemmensen, T., Campos, P., Orngreen, R., Pejtersen, A. M., & Wong, W. (Eds.). (2006). *Human work interaction design: Designing for human work*. Springer.

[14] Newell, W. H. (1994). Designing interdisciplinary courses. In J. T. Klein & W. Doty (Eds.), Interdisciplinary studies today: Vol. 58. New Directions for Teaching and Learning (pp. 35–51). San Francisco: Jossey Bass.

[15] Bowden, M., (1994). The Dimensions of Creativity, MIT Press Cambridge, London.

[16] Mayer, R. E. (1999). Fifty years of Creativity Research. In R.J. Sternberg (ed.). Handbook of Creativity, pp. 449-460. London: Cambridge University Press.

[17] Eysenck, HJ. (1994). "The Measurement of Creativity". in Boden, M.A. (ed). Dimensions of Creativity. The MIT Press. 199-242.

[18] Franken, r. (2006). Human Motivation. Cengage Learning. 6th Edition.

[19] Walt Scacchi, (2011). Modding as a basis for developing game systems, GAS '11: Proceedings of the 1st International Workshop on Games and Software Engineering, ACM.

[20] Lev Poretski, Ofer Arazy, (2017). Placing Value on Community Co-creations: A Study of a Video Game 'Modding' Community CSCW '17: Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing, ACM.

[21] Tapajit Dey, Jacob Logan Massengill, Audris Mockus, (2016). Analysis of Popularity of Game Mods: A Case Study, CHI PLAY Companion '16: Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play Companion Extended Abstracts, ACM.

[22] Jin Ha Lee, Jacob Jett, Andrew Perti, (2015). The Problem of "Additional Content" in Video Games, JCDL '15: Proceedings of the 15th ACM/IEEE-CS Joint Conference on Digital Libraries, ACM.

[23] Burnett, M., Cook, C., Rothermel, G., (2004). End-User Software Engineering, Communications ACM, 47(9), 53-58.

[24] Magy Seif El-Nasr, Brian K. Smith, (2006). Learning through game modding, Computers in Entertainment (CIE) - Theoretical and Practical Computer Applications in Entertainment: Volume 4 Issue 1, ACM.

[25] Goldschmidt, G., Hochman, H., & Dafni, I. (2010). The design studio 'crit': Teacher-student communication. Artificial Intelligence for Engineering Design, Analysis and Manufacture 24 285-302.

[26] Lopes A.G. (2018). Creative Activity Mediated by Technology – Artifacts, Technology and Ideas that Could Shape Our Lives. In: Nunes I. (eds) Advances in Human Factors and Systems Interaction. AHFE 2017. Advances in Intelligent Systems and Computing, vol 592. Springer, Cham.

[27] Lopes, A., (2009). Design as Dialogue: Encouraging and Facilitating Interdisciplinary Collaboration, Publisher: VDM Verlag Dr. Muller, USA, UK, ISBN: 978-3-639-11713-4 Springer

[28] Sternberg, R. J. (1985). Beyond IQ: A Triarchic Theory of Human Intelligence. Cambridge University Press. New York.

[29] Patrick Cohendet, David Grandadam & Laurent Simon. (2009). Economics and the ecology of creativity: evidence from the popular music industry. International Review of Applied Economics Vol. 23, Iss. 6.

[30] Brown, J.S. (2000). Growing up digital: How the web changes work, education, and the ways people learn. Change Magazine, March/April, pp. 11-20.

[31] Staron, M. (2011). Connecting and integrating life based and lifewide learning. In N:J: Jackson (ed) Learning for a complex world: A lifewide concept of learning, education and personal development, Authorhouse, 137-159

[32] Land, R., Rattray, J. & Vivian, P. (2014). Learning in the liminal space: as semiotic approach to threshold concepts. Higher Education, 67, 199-217.

[33] Rogers, C.R. (1954). Towards a theory of Creativity. ETC: A Review of General Semantocs 11, pp. 249-260; In Rogers (1961)

[34] Jackson, N. (2016). Exploring Learninf Ecologies. Puvlisher Chelk Mountain, Amazon, ISBN – 10:0993575900