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EVOLUTIONS IN THE HUMAN TECHNOLOGY RELATIONSHIP: REJECTION, ACCEPTANCE AND TECHNOSYMBIOSIS

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ABSTRACT

Research on technology adoption has distinguished several models of the human relationship with technology as refusal or rejection, acceptance (Davis, 1985, 1989, etc) and symbiosis (Licklider, 1960; Brangier and Hammes-Adelé, 2011; etc). These models refer to the way that humans shape their cognitions and their interactions with technology; define their attitudes of rejection, acceptance or fusion; and whether they are in accordance with or in opposition to technology. This article seeks to show (1) that there are several models related to technology; (2) that these models are rejection, acceptance and symbiosis; (3) that these models are not stable but change over time; and (4) that individuals change their model from the contingent elements of their context of use and the characteristics of the technology they use. As an experiment, we investigated how the relationship of human to technology evolves over time. The methodology is based on both scenarios of the use of four technologies (internet, computer, digital camera, mobile phone) completed by verbalizations (verbal explanations of the chosen scenario) and a questionnaire. It was administered to a sample of 60 people (30 women, 30 men). The experiment was able to highlight types of technology use course. The results indicate (1) that individuals have three models of relationship to technology (rejection , acceptance, technosymbiosis); (2) that these models are not stable but change over time: the most common change is the transition from the acceptance to the symbiosis, which accounts for 38 % of observations; (3) that certain technologies are more conducive to the development of symbiosis (the mobile phone has particularly important symbiotic properties compared to other technologies studied) and (4) that in 42.8 % of cases it is a change in human activity which explains the transition from a model of one relationship of technology to another one. Finally, a general discussion provides a link between the three models: rejection, acceptance and technosymbiosis.

KEYWORDS

Human-technology symbiosis, technology acceptance, technosymbiosis

1. INTRODUCTION

Acceptance seems to be the main way of understanding the relationship between humans and technology. Publications quoting models such as TAM (Technology Acceptance Model, Davis, 1989) or its two bases TRA (Theory of Reasoned Action, Fishbein and Ajzen, 1975), and TPB (Theory of Planned Behavior, Ajzen, 1991) are common. This manner of conceptualizing the human-technology relationship is open to criticism for many reasons. First of all, the way we are using technologies and largely the type of relationship we are developing with those technologies questions that mainstream. In detail, to accept a technology means that the user makes the decision to uses it. This amounts to the consideration that technology is a foreign thing to humans. In reality, do humans accept or refuse technologies or are they living in a technological world? Do humans accept the television, the mobile phone or the GPS or do they live an embedded relationship with some technologies? In our point of view, the human-technology relationship does not only deal with accepting or refusing but more with living with, being transformed by, being dependant on, and being enhanced by. Technology is an extension of human cognitive, social, physical and perceptive capacities. Is our Smartphone just an information and communication technology or a part of us? It seems more to be a prolongation of our mind, of our social network or, more generally, of our capabilities to act and interact. It appears clearly that for many humans, the relationship with technology becomes close, personal, intimate and friendly. The IFOP survey carried out in January 2013 reported that 42% of French said they were dependent on their mobile phone, and 78% of those under 25 were in this case. It is now established that the ICT (Information and Communication Technologies) have become indispensable tools in our societies insofar as they contribute to the performance and the effectiveness of organizations and individuals. They significantly amplify our decision, informational and communicational abilities despite the risk of dependence or feelings of need. For this reason, a part of the relationship between humans and technology will take the form of a symbiosis. This notion, coming from natural science, has been used to describe the fact that humans and technologies are linked by a strong relation of mutual dependence; each of them getting from the other means to develop it or himself/herself.

More and more, humans are living in a technological world that shapes them, as well as human shape technology. Technology is anthropologically constituted and human is technologically shaped. From this point of view, there is a co-evolution between humans and technology. Thus to put in opposition human and technology is an error. Many researchers have developed this idea (Simondon, 1958; Stiegler, 1999). Licklider (1960) was the first to speak of “man-computer symbiosis”. As a precursor, he was forecasting the future evolution of computing that will be no longer a machine but a partner that would make it possible to overcome human limitations in a multitude of areas. To describe this intense relationship Licklider use the metaphor of symbiosis to qualify human-technology link.

This article has several objectives:

- Present and discuss the different models of studies of the human-technology relationship: In the first part of this article, the theories of functional and social acceptance will be detailed as well as the researches that use the concept of symbiosis. We will see their limitations and contributions. This part will be concluded in proposing three main forms of human-technology relationship extracted from existing theories: rejection, acceptance, symbiosis.

- Demonstrate experimentally the existence of these three kinds of relationships (rejection, acceptance and technosymbiosis) and their respective links. From this point of view, our goal is to study why and how humans are changing their relationship to technology. Those three main forms of the human-technology relationship have been used as a basis for experimentation about how the relationship evolves over time. Its results permit to explore how and why the human-technology relationship is variable.

2. THEORETICAL ORIENTATION

Overall, the human-technology relationship has been studied from three points of view: 1/the compatibility between the user's physiological and mental characteristics and the technology's physical and technical characteristics, also called functional or operational acceptance, 2/the perception of the user (attitudes, norms, perceived control, intentions, expectations…), also called social acceptance, 3/the hybridization between human and technology, also called symbiosis (Licklider, 1960; De Rosnay, 2000), neosymbiosis (Griffith, 2006) or technosymbiosis (Brangier and Hammes-Adelé, 2011).

2.1 Usability and Functional Acceptance

The appearance of more and more new technologies has gradually increased interaction tasks, which induces a large number of problems encountered by users. As mentioned previously, it focuses on the question of compatibility between hardware and software features of the technology and the physiological and mental characteristics of the human user. Thus, early studies have focused on the workload on screen identifying stress and strains related to the implementation of computerized tasks. At a less macro level, other studies have focused on the search for software compatibility with the ways of thinking of the user and, more generally, on the search for simplicity of use, or usability (Shneiderman, 1980). All this research is deeply rooted in the field of cognitive science and software ergonomics. "Software ergonomics is defined as the discipline studying the design, evaluation and use of human-computer interfaces, in order to ensure the best possible compatibility between operators, their tasks and the software to prevent failures of human-machine system and ensure a high level of performance and ease of use." (Brangier, Hammes-Adelé and Bastien, 2010: 130). It aims to design or modify all technologies with an interface so that they are suitable for human capabilities (physical, psychological, social), in order to avoid any undesired impact on personal and professional activities. The work of software ergonomics follows three objectives but finally the same goal: to reduce the distance between human and machine, and thus promote the functional acceptance of machines:

- The production of stabilized knowledge to design and evaluate human-machine interfaces. This stabilized knowledge takes the form of recommendations, criteria or norms on the content and form taken by the interaction. They are used as guides on how to design, specify and organize user's actions and tasks that respect the way human beings work. A recommendation is a rule wherein justification is based on experimental studies, theories, or practices where the effectiveness is proven. Sometimes those rules are differentiated by application context.

- The definition of human-machine interaction models (i.e. GOMS – Goal, Object, Method, Selection rules-; CLG -Common Language Grammar-; TAG -Task Action Grammar-)
- The development of methods and processes to ensure compatibility between the characteristics of users, their tasks and the tools they use. Those procedures aim to maximize usability and consequently the acceptance and use of these tools.

If the approaches focused on usability and human-technology compatibility have undeniable contribution to a better consideration of the human in the design and correction of technology, they are not free of limits. Thus, we can blame them for being decontextualized or detached from the socio-anthropological foundation of human activities. Moreover, as it is conceptualized, the human cognition is too assimilated to that of the machine. Usability is therefore not itself sufficient; it must be complemented by social dimensions of acceptance.

2.2 Social Acceptance

As it has been said in the introduction, the Technology Acceptance Model or TAM is the most famous reference for social acceptance perhaps because of its simplicity and understandability. Based on models from social psychology, the original model has been taken up and enriched over and over resulting in the loss of its original meaning. To sum up, the TAM is based on the idea that the acceptance depends on two factors: perceived ease of use and perceived usefulness; those two factors themselves influencing intention to use and usage behavior. Perceived ease of use is defined as the perception of a low degree of effort during the use of the technology whereas perceived usefulness is the perception that the use of the technology will increase its performance. In other words, to expect a low effort and a high performance will result in the construction of an intention to use, and then, in a use of the technology. It is user perception that leads to usage. To the best of our knowledge, the latest meta-analysis has been made by King and He (2006). The authors list the different types of factors added to the TAM:

- External precursors such as prior experience or personal computer self efficacy.
- Factors from other theories in order to increase TAM's predictive power: subjective norm, expectation, task-technology fit, risk, and trust.
- Contextual factors such as gender, culture, and technology characteristics.
- Consequence measures such as attitude, perceptual usage, and actual usage.

Very recently, the TAM has been used to understand the acceptance of systems such as telemedicine (Davis, 2013) or e-learning technology (Lee, Hsieh and Chen, 2013) and on different people such as elderly (Peng, Hong and Soar, 2013) or elementary school students (Cheng et al, 2013). Those studies are a continuation of a very long list of various others.

The theoretical base of the TAM is the TRA (Theory of Reasoned Action, Fishbein and Ajzen, 1975), and the TPB (Theory of Planned Behavior, Ajzen, 1991). For those two models, attitudes, subjective norms and perceived behavioral control are prerequisites for intention.

The TAM is the most used model to predict technology use, however it is also much criticized. There are two types of critics:

- Methodological and statistical: Critics have been made about the samples chosen (often students), the exclusive use of a questionnaire to study a complex reality, and the important variations in predictive power. Studies do not find a similar confirmatory factor analysis as in the original study (Février, Jamet and Rouxel, 2008). Finally, the strong correlation link

between intention an behavior is not validated by all studies (Davies, Foxall et Pallister, 2002; Webb and Sheeran, 2006; Zeithaml, 2000).

- Empirical and theoretical: Reproaches can be made about the important limitation of the number of factors studied, the absence of the context of the use of the technology which defines the user's purpose, and the model's low capacity of helping in technology implementation. In addition, the question of time is eluded. The use of technology has impacts on the user, on technology and on the context in which they are interacting. TAM does not deal with retroactions of use even though those retroactions change the human-technology relationship itself. Actually, TAM could be considered as adequate to understand the beginning of the human-technology relationship but not to study the multiplicity of forms taken by the relation over time. The last critic concerns the epistemological basis of the model. In the TAM, technology is viewed as a foreign or exterior thing to human being. In reality, technology does not exist separately to the human world. It is a social object with economical, sociological, cultural and psychological impacts. For Akrich, Callon and Latour (2006), a technology is not accepted but shaped by a group according to developed usages.

To go beyond limitations of the concept of acceptance, a symbiotic approach proposes to consider technologies as extensions of the human.

2.3 Human-machine Symbiosis or Technosymbiosis

In complement to acceptance, some studies have attempted to convey to technology, to the user and to the context an equivalent role in the forming of a special relationship, sometimes called coupling. They have focused on feedback and co-construction between the two interactive partners. The man-computer symbiosis notion (Licklider, 1960), inspired by biology, has been used as a starting point, from which the "symbionts", human and technology, benefit mutually from their close relationship. The aim of the relation is to mix the best of human and the best of technology to enhance human cognitive capacities. In her vision, each partner will have a role in cooperation. For Licklider, users will have a preference for symbiotic systems that will amplify their capacities.

In this approach, human is defined by and in relation with technology. Technology is not external to humans but an essential part of their life. From this point of view, it is not sufficient to design usable and useful technologies. They must also be capable of enhancing humans in an efficient way. The human-technology relationship will be considered differently. Humans will design technologies to help them by performing human tasks that are programmable. In return, human will be transformed by the usage of those technologies. Consequently, technologies and humans co-evolve.

The concept of symbiosis acquires meaning in many situations of our everyday life. For example, we use a mobile phone as an external memory to keep phone numbers. Gradually, we lost the capacity to memorize them. We also recompose the initial principle of this functionality in memorizing birthdays, passcodes, entry codes… This modification of the initial aim of a repertory has been perceived by product developers who propose in return new functionalities. These are examples of co-evolution.

Recently, many researchers have used this concept of symbiosis to metaphorically qualify a progressive dependence, an intimate link, a mutual influence (Bender, De Haan and Bennett, 1995; Brangier, 2002, 2003; De Rosnay, 2000; Griffith, 2006). This symbiosis has also been

measured by a questionnaire which aims to characterize the symbiotic nature of the relationship that humans develop with technology (Brangier and Hammes, 2006, 2007). With a survey of 482 people, this questionnaire permits to describe how humans experience symbiosis (Brangier and Hammes-Adelé, 2011; Hammes-Adelé and Brangier, 2011). Three factors (explaining 35% of variance in the use of technology) have been identified:

- Sense of control: people need to control their technological environment, to experience a feeling of mastery. This mastery has been developed over time.
- Perception of a benefit of mutual adaptation: that is the core idea of technosymbiosis. People perceive a benefit from adapting to technology and technology adapting to them.
- Perception of utility and efficiency: people must see a better performance in using technology.

In conclusion, human-technology symbiosis, by the idea of co-evolution and co-dependence, introduces the fact that this relationship is deeply phased and evolutionary. Let's explore this point in detail.

2.4 Integrative Model of Human-Technology Relationship

Each theoretical current provides undeniable contributions; however, they have never been integrated into the same model. Having said this, this research has brought forth three main forms of relationships with technology (Brangier, Hammes-Adelé and Bastien, 2010):

- The *rejection* model corresponds to various forms of resistance: The person has a globally negative opinion of technology; or, doesn't want to use this technology for instrumental reasons (uselessness) or non-instrumental (convictions…); or wants to use the technology but is unable to; or doesn't care of it.
- The *acceptance* model corresponds to chosen or forced use of the technology with regard to certain criteria: usefulness, ease of use, social presence… According to this model, the technology is used to carry out regular utilitarian tasks, with a conscious ease of use of the technology.
- The *technological symbiosis* model corresponds to a natural, intense, simple, and integrated use with no problem in using the technology. People use it as a matter of course. The user has no intention of going back to previous habits because the technology skillfully complements his/her capacities. Sometimes it is even dependence.

In literature, the existence of these three models seems to confirm the dynamic and intrinsically progressive character of human-technology relationship. Very few studies have actually looked into the changes which affect the relationship during the time that the technology is used. How do users develop their interactions? Do they change model? How do they shift from the rejection model to the acceptance one? Do they ever leave the technological symbiosis model to finally reject the technology?

Adopting a technology is neither static nor linear. Akrich, Callon and Latour (1988) consider that construction of usage and adoption are temporal, changing, and spiraling phenomena. They propose adoption in sequences: iterative loops of interest. This expression emphasizes the negotiated nature of the adoption between actors and technical devices, conditioning occurrences of a growing interest, as well as its sequential nature. Each loop represents a change, a redefinition of this innovation which leads to, in the best case, *« a reciprocal adaptation of supply and demand*» (Callon, 1994: 11).

Docq and Daele (2001) propose a definition of usage as «a set of practices, a special way of using something, a set of socially shared rules by a reference group and built over time». In the same vein, Morris (1996) challenges the linear character of the relationship with technology and postulates that it comes in a loop form, the quality of usage influencing retroactively the evaluation of Davis' two decisive factors (perceived usefulness and perceived usability) (1989). Furthermore, although he doesn't challenge the role of perceptions in the decision to use a new system, it seems risky to him if it is based solely on perceptual measures, as changes occur with the user over time (Dillon, 1987). Bhattacherjee (2001: 351-352) postulates that «While initial acceptance of information technologies is an important first step to insure the success of this technology, long term viability […] and its potential success […] depend more on continuous usage than initial usage».

In another vein, some emphasize the importance of the time factor, using terms such as « *Adoption trajectory*» or «*usage trajectory*». For Proulx (2002), these terms refer to «*the individual courses through the constellation of past, present, and emerging communication devices on offer, and which make up a privileged informational and cognitive environment for the individual to develop their communication and information practices*».

Finally these studies postulate that the relationship with technology is neither stable nor unimodal, but evolves over time, following particular dynamics and regulations. In this state of mind, the research which we are presenting seeks to define the course of the human-technology relationship. This means notably, understanding the way people choose their course and set out their arguments, resulting in the development of behavior and attitude patterns of rejection, acceptance or technological symbiosis.

3. PROBLEM AND METHOD

Drawn from works which have emphasized the existence of three models (rejection, acceptance, and technological symbiosis), we wish to test the evolution capacities of human-technology over time. How is the human-technology relationship changing? Does this change occur through adopting a new model or is it a marginal evolution of the same initial model? How does the transition occur from one model to another? Do evaluations of usage circumstances and personal or technological characteristics encourage the change in technological interaction towards adopting an increasingly symbiotic model? This study has an exploratory purpose; to better understand development of the human-technology relationship.

This study concerns a sample of 60 people, between 18 and 38, familiar with technologies and their use:

- 30 men with an average age of 26,2 (standard deviation = 4,72),
- 30 women with an average age of 26,2 (standard deviation = 5,38).

Approximately one-third of each of these groups comes from a student population and two thirds are employees. The respondents were requested to take part in an experiment to be carried out in three phases:

a) The respondents were asked to fill in a questionnaire concerning their ICT usage (frequency, time spent, length of experience), and more specifically concerning the technologies we chose for the study (mobile phone, computer, digital camera and internet).

They also had to define how they positioned themselves in relation to technologies in general in a «questionnaire on human-technology relationship», which was mentioned earlier.

b) We then examined four technologies (mobile phone, computer, digital camera and internet) and their usage at five chronological stages (Figure 1):

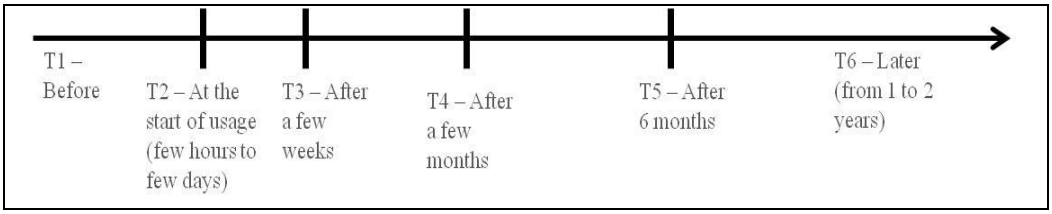

Figure 1. Chronological stages studied

Time periods T1 to T5 were imposed whereas T6 could be added if the subject so wished. For each time period, the respondent was asked to choose a scenario among the three below (Figure 2) and explain their choice (they could also create a new scenario, however none of the subjects did so).

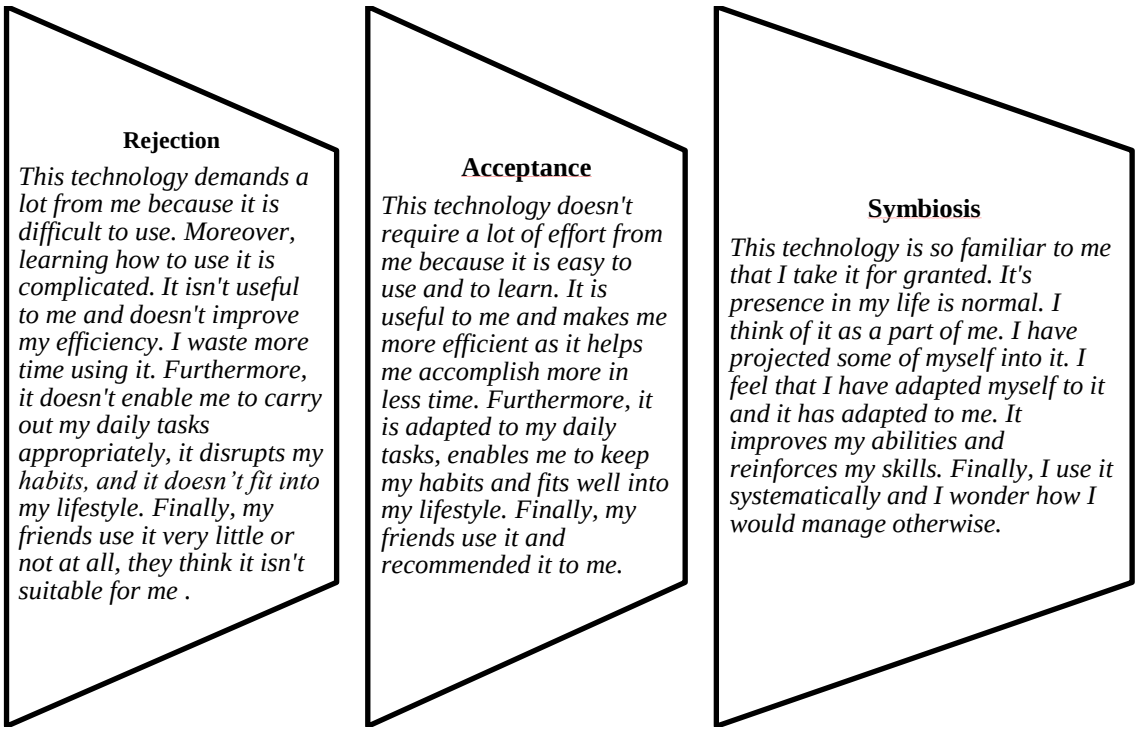

Figure 2. Three scenarios proposed to respondents for each chronological stage.

- They were also encouraged to talk about the reasons for a shift or non shift from one scenario to another. Those explanations were essential to catch the interconnection between human-technology relationship and the respondent's life. Without a longitudinal study, interview seems to be the best method to understand human activities in relation with technology. This technique allows to retrace the formation of the process of appropriation of an artifact without having to observe the activity on a potentially long period. It has always been successfully used to study the interaction of families with a technical system of energy management (Haué, 2003). Of course, this story is going through an interpretive filter and will be a reconstruction of history. But it provides a structure over the long term, defining key events and a priori stable periods that it is possible to specify and detail. This part of the experiment was recorded in agreement with the respondent in order to transcribe and analyze people's speech.

c) The third and final stage consisted of assessing the technologies studied in a questionnaire based on the eight technological symbiosis criteria (Brangier, Dufresne, and Hammes-Adelé, 2009). The respondents had to say, on a seven-point scale whether each technology:

- Amplified their intelligence: this technology enhances my capacity to produce information or knowledge.
- Reinforced their perceptual skills: this technology permits me to see and listen better.
- Handled or foresaw their mistakes: this technology corrects them efficiently for me.
- Balanced their emotional state: this technology contributes to my emotional stability.
- Expanded their potential for interaction: according to my needs, I can choose between many forms of interaction with this technology.
- Enabled them to gain knowledge from other users in real-time: this technology is permanently enriched by elements coming from other users.
- Decreased distractive elements: this technology prevents me from deviating from my objectives and intentions.
- Enabled continuity of information transfers with other technologies.

4. RESULTS

4.1 Scenario Choices

The scenarios, in which the respondents recognized themselves, differ according to time, as the figure below indicates (Figure 3). Time is therefore an important factor of change in attitude and behavior with regard to technologies. Moreover, the distinct profiles obtained through the technologies coupled to the qualitative data obtained, points to the important role of the technological features (rich functionalities, complexity of use) in the type of relationship developed by the users.

Each technology requires differentiated analyses. For example: The mobile phone provokes a low level of rejection and a high level of acceptance, this acceptance tends to become symbiosis after more than six months (T5). The computer and internet are initially rejected, this continues for the computer during early contact, then disappears rapidly as acceptance grows. Symbiosis appears later, it actually begins to appear after several months

(T4), becoming stronger after more than a year (T6). The computer and internet seem to differ in the speed of evolution of symbiosis, taking the form of a straight line for internet and a curve for the computer. The digital camera is more an accepted technology. To sum up the data, it could be said that the 4 technologies studied present 3 different «types» of relationships to technology:

- A growing and sustainable acceptance.
- Rapid symbiosis preceded by rapid acceptance.
- Slow symbiosis preceded by rejection followed by acceptance.

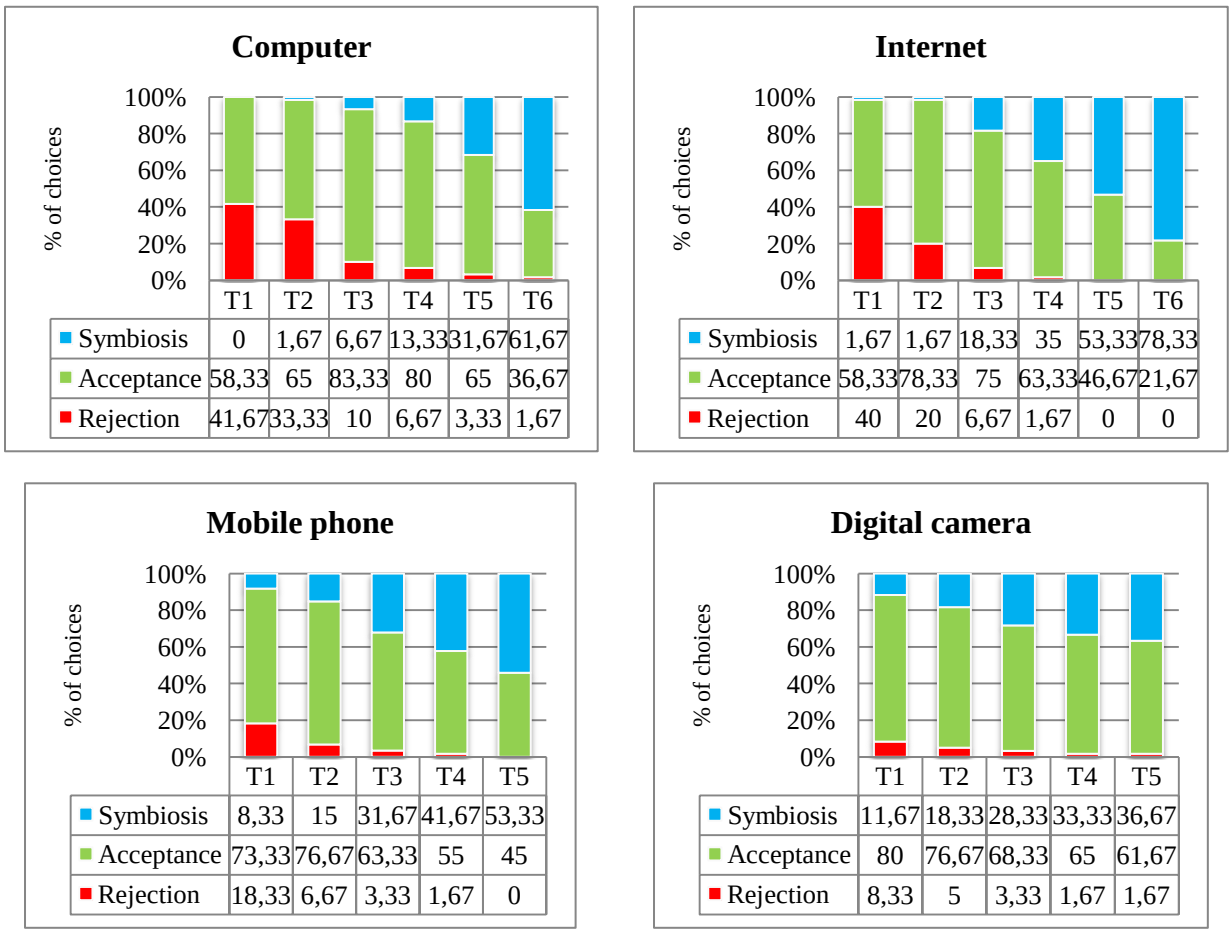

Figure 3. Percentage of choices of scenarios over time by technology (mobile phone, computer, internet, digital camera)

4.2 Changes in Technological Usages

For each temporal stage proposed, all the respondents positioned themselves easily in the three scenarios; they recognized themselves and verbalized the fluctuations in their relationship. The series of choices carried out can be considered as a technological relationship course. Firstly the results show that among the 189 possibilities of courses of relationships with technology (counting the number of possible combinations), only 12 were observed among our respondents. 7 include a backward motion, 4 of them being a back and forth shift from and to acceptance. Some courses include only one single model of the relationship to technology, acceptance being the most frequent. However, this unique model isn't equated to linearity since the qualitative data from the interviews suggest that all the interviewees indicate fluctuations, for example, in terms of perceived usefulness or perceived ease of use, which influence the relationship with technology. We can therefore confirm firstly that the technological relationship is dynamic, and secondly, none of the technological relationships models (rejection, acceptance, symbiosis) are stable, established or sustainable.

The most commonly observed courses are:

- Acceptance –> Symbiosis (38 % of all the courses)
- Acceptance only (25 %)
- Rejection–>Acceptance–> Symbiosis (15 %)
- Rejection –> Acceptance (10 %)

These results enable us to support two ideas: On one hand, the relationship to technology can be qualified by a limited number of courses, and on the other hand, these courses don't show a consistent linearity in the form: rejection, then acceptance, then symbiosis. They can also show backward shifts or changes in the same relationship model (figure 4).

4.3 Course Differentiation

Certain elements seem to influence the evolution of the relationship with technology. These concern the users and the technologies' characteristics and a link created between them through activity (as understood by ergonomics).

Depending on the way the users qualify their relationship with technologies in general, the scenario choices will be more or less directed towards symbiosis. More specifically the respondents with the highest symbiosis scores (measured by our questionnaire) choose the symbiosis scenario ($r = .46$; $p < .01$) more than the others. Furthermore the respondents recognizing their current state of relationship with technology in the symbiosis scenario consider, more than the others, that the technologies fulfill certain human ability amplification criteria. These criteria change partially, depending on the technology, mainly due to the specific features of each technology:

- For the mobile phone: intelligence amplification ($t = 2.10$; $p = .04$) and contextual knowledge management (gaining knowledge from other users) ($t = 1.99$; $p = .05$).
- For the computer: intelligence amplification ($t = 3.22$; $p = .01$), increase in perceptive abilities ($t = 3.36$; $p = .001$), contextual knowledge management ($t = 3.55$; $p = .001$) and multiplying operating efficiency (expand interaction potential) ($t = 1.96$; $p = .05$).
- For the digital camera: decrease in distractive elements ($t = 2.43$; $p = .01$).
- For internet: intelligence amplification ($t = 3.23$; $p < .01$).

The qualitative data derived from the interviews enable us to understand the courses followed by the respondents, especially the reasons for the transition to symbiosis. Overall, two main reasons were given by the participants:

- The growth of a close relationship with the technology (39.5% of reasons given). This closeness is revealed by high frequency of use, using the technology without thinking about for some tasks, and a feeling of co evolution with, and dependence on the technology.
- The intricate connection of activity and use of the technologies, (42.8 % of the reasons given for the change in scenario). A change in activity explains, very often, the break in the technology course. The respondents notice that the technologies play a facilitating role in their activity but also spark off the creation of new activities.

5. DISCUSSION / CONCLUSION

Our results show that it is possible to identify and qualify four main course types of relationships with technology (see Figure 4). These courses include up to three states of the human-technology relationship that is to say, rejection, acceptance (the most common) and technosymbiosis. These states can be considered as stages. These stages are not uniformly organized, but the most frequent courses show a progression which can culminate in symbiosis. The length of this progression depends on the complexity of the technology (from a few months for the mobile phone to more than a year for the computer and internet).

Depending on the technology, the most common course type varies. The «richest» technologies (i.e. the ones including a multitude of functionalities) such as the mobile phone, the computer and internet show more courses leading to symbiosis whereas the digital camera tends to remain in the acceptance stage.

Moreover, a clear distinction appears between Internet, the computer and the mobile phone, on the one hand, and the digital camera on the other hand. Regarding the latter, users care more about criteria relating to those proposed by Davis' TAM (1989), that is to say usefulness and ease of use; here the concept of acceptance would seem to have its full meaning. However, regarding more symbiotic technologies (where at least 50% of the course ends in symbiosis), other explanatory factors must be used.

Firstly, perception of the technological features comes into play. Each technology differs in its capacity to produce a symbiotic type relationship. The more the technology is perceived as skillfully completing human capacities, the more it will lead to symbiosis. Secondly, there's a strong link between the way the relationship to technology is globally assessed and the occurrence of symbiosis. The fact that the person feels able to (a) master the technologies (b) experience a better performance and (c) perceive the benefits of mutual adaptation of human and technology, increases their chances of achieving symbiosis. Thirdly, the circumstances and the way the user integrates technology to his activity facilitate symbiosis. Symbiotic subjects have an almost instinctive use of technology where the activity carried out takes precedence over the technological constraints. However, to achieve such a symbiotic relationship, a learning or adjustment period is needed. This adjustment phase will lead to the mastering of the technology, the perception of the benefits of a mutual adaptation between human and technology, and finally to a kind of coupling between user and technology. According to our results, this adaptation phase is needed in order for symbiosis to occur, but it

doesn't necessarily lead to it. This adaptation phase corresponds to Davis' meaning of technology acceptance. These results, derived from quantitative and qualitative data, have enabled us to consider more clearly the way a relationship to technology evolves over time. These evolutions take the shape of courses. Differences have been noticed between complex technologies such as the internet and computers, a communication dedicated technology such as the mobile phone and a basic one such as the digital camera.

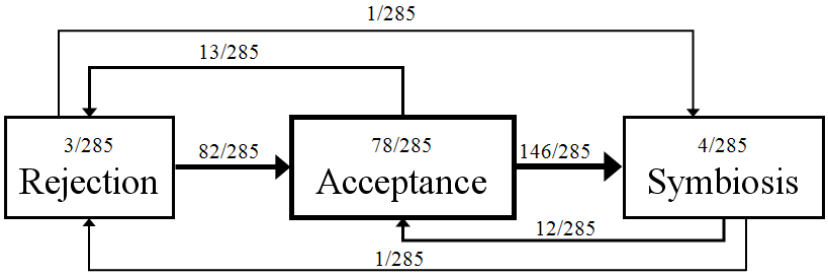

Figure 4. Developments and statements of probable courses (The number on arrows defines the number of transition from state A to state B. The number in the boxes set the number of courses containing only this state of the human-technology relationship).

So far, the human-technology relationship has mostly been studied in a static way, focused on a short lapse of time situated in the initial usage phase. Even so, the necessarily dynamic and constructed aspects of the relationship to technologies have been underlined (Dillon, 1987; Morris, 1996; Bhattacherjee, 2001). In this range of studies examining the importance of temporality in the development of the relationship with technology, our research shows that a short lapse of time is insufficient to be able to study the relationship which grows with technology since it is a process which takes place over a long period. Results show that this long temporality determines some of the attitudes towards technology. In the future, with the rapid turnover of technologies, the speed at which transitions occur between rejection, acceptance and symbiosis will increase even more, becoming volatile, thus causing a possible risk of over or under use?

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