AGILE DEVELOPMENT OF INTERACTIVE INSTALLATIONS
Two Case Studies

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Abstract: We argue that agile methods can be particularly effective when designing and developing interactive installations, as long as the agile methods are correctly tailored to this application domain. Based on significant experience, which was built upon ethnographic observation and participation in about a dozen industrial projects related to interactive installations' design and development, we present agile strategies which proved effective when dealing with the industry's typical tight production schedules, and we also provide the data from two case studies, discussions and conclusions. Using real world case studies such as these, researchers can obtain more insight into best practices that could be useful for promoting innovation during the agile process.

1 INTRODUCTION

Agile Software Development (ASD) is a software engineering approach that has come to an age of relative maturity, while keeping itself open to integration or cross-pollination among approaches that previously represented sharply opposing postures (Ergdomus, 2007).

On the other hand, the principles underlying the ASD movement, firstly advocated by a set of several practitioners, are based on concrete best practices, which were outlined through a large body of knowledge. That body of knowledge included essentially a vast amount of success and failure case studies and experiences with many software projects, in many different application domains. While each practitioner has an individual perspective about how to successfully approach software development, there were key factors, which seemed common to each and every project. These included tight collaboration between developers and business managers, face-to-face, informal collaborations as opposed to bureaucratic production of project documentation and formal modelling, frequent iterations and rapid deliveries of functional prototypes, embracing requirements' change as opposed to well-defined, fixed requirements right at the start of a project, as well as other principles that have become widely known by the general software engineering community (Fowler and Highsmith, 2001).

Since the early Agile Manifesto days, there has been a growing number of research papers around this theme, some of them focusing on the success factors brought by the agile practices, such as customer commitment derived from early and continuous delivery of valuable software, decision time, likely made within short timeframes, corporate culture (agile methodologies are not appropriate to bureaucratic organizations (Cockburn, 2002)), and dynamism and uncertainty, i.e. being able to handle dynamism and the uncertainty built in it.

There are also many tailored approaches and variants of agile development. The most popular ones include Extreme Programming (XP) (Hedin et al., 2003), SCRUM (Schwaber, 2004) and Crystal Methodologies (Cockburn, 2002).

However, there is currently a lack of agile strategies to designing a novel kind of software: software built to support interactive installations such as interactive floors, walls, multi-touch tables and - in general - software for novel interaction paradigms. This new kind of software is quite different from the traditional GUI-oriented software, which is essentially based in WIMP (Windows, Icons, Menus and Pointing Devices) (Want and Pering, 2005) user interfaces.

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built upon ethnographic observations and participation in about a dozen industrial projects related to interactive installations' design and development, we present agile strategies which proved effective when dealing with the industry's typical tight production schedules, and we also provide the data from two case studies, discussions and conclusions.

Our contribution is two-fold: (i) we present the results from applied case studies, following the spirit of the agile movement - which was itself based on a practical experience body of knowledge - in a novel software development context that is becoming increas-ingly important: multimodal user interfaces (Klein and Myers, 2005) sometimes also referred to as ubiquitous computing (Latoschik, 2005); and (ii) we describe a novel set of agile strategies aimed at supporting this development context in the tourism market. Both of these contributions are, to our knowledge, original, although several researchers have applied similar research methods to similar domains.

2 BACKGROUND

2.1 Agile Methods

Agile methodologies fit nicely into the context of small software development companies, since they evolved as a reaction against the so-called 'heavy-weight' methods, which are regarded as bureaucratic and slow, like the waterfall model. The main idea advocated by agile practitioners, is that short iterations turn the methods more responsive to changes in the environment - this is especially useful in the application domain this paper is focused on. In particular, artists and interior designers, who were stakeholders in the projects we will describe, have a particular work style, which is based on constant change as a way to create better results. It's a cultural and professional issue that clashes against the more formal and compartmented software engineering process.

The agile approach quickly became mainstream in the software industry. The agile community is defined by a core set of beliefs and practices, in a "practice what you preach" philosophy. The Manifesto for Agile Software Development, the most well-known conjugation of agile principles and beliefs, states:

"(...) we have come to value:

- individuals and interactions over processes and tools
- working software over comprehensive documentation
- customer collaboration over contract negotiation
- responding to change over following a plan"

Agile methods pay significant attention to users and their needs. They bring users to the development process from the early stages, when the requirements are discovered, and give them an opportunity to speak up and say what they really need and want.

There are some studies, such as (Mitra and Gupta, 2005), regarding how innovation can be brought to the XP and Agile processes. However, little research is based on extensive experience and observations from real world case studies. Innovation and agility are essential factors to supporting the creation of value in a fast-paced global knowledge economy.

2.2 Novel Interaction Paradigms

Interactive installations based on novel interaction paradigms; such as gesture recognition or multi-touch surfaces are typically designed through User-Centred approaches, the so-called UCD methods (Vredenburg et al., 2002). There are, however, many similarities between the XP practices and UCD. What XP argues as iterations, small increments, UCD advocates as prototyping. The XP "Planning game" is very similar to the UCD concept of "Focus Groups", which are essentially, focused discussions where a moderator leads a group of participants through a set of questions on a particular topic (Dix et al., 2004). XP's story cards, task cards and user stories are very alike to UCD's scenarios, user roles and task models. The XP practice of having an on-site customer representative is analogous to the UCD notion of user-centred design, or user participation. The UCD equivalent of XP's tests (or test stories) is the evaluation session or usability inspections. And finally, XP's metaphors correspond to UCD's conceptual and mental models (Vredenburg et al., 2002).

2.3 Innovation Processes

Creativity support tools have the power to accelerate discovery and innovation (Shneiderman, 2007). The question is posed in terms of how can designers of programming interfaces, interactive tools, and rich social environments enable more people to be more creative more often (Shneiderman, 2007).

Ben Shneiderman, one of the most prominent leaders of the human-computer interaction field, advocates that Leonardo da Vinci could help as an

inspirational muse for the new computing (Shneiderman, 2005). Shneiderman says his example could push designers to improve quality through scientific study and more elegant visual design. Leonardo's example can guide us to the new computing, which emphasizes empowerment, creativity, and collaboration.

Shneiderman (2000) also proposes a four-stage framework for creativity that can assist designers in producing the right tools their users: (1) Collect: learn from previous works stored in libraries, the Web, etc.; (2) Relate, consult with peers and mentors at early, middle, and late stages; (3) Create: explore, compose, evaluate possible solutions; and (4) Donate: disseminate the results and contribute to the libraries. He also emphasizes that "Education could expand from acquiring facts, studying existing knowledge, and developing critical thinking, to include more emphasis on creating novel artefacts, insights, or performances." (Shneiderman, 2000).

Some successful examples of creativity and innovation processes come from universities, especially examples where cross-disciplinary design research is involved. Ellen Yi-Luen Do and Mark Gross (2007) engaged their students in this line of action and describe parameters and principles that they found helpful in organizing and conducting this kind of work. A variety of projects that have been developed in their group illustrated their parameters and principles. The focus is on making and they have come to see creativity as grounded in the ability to make things.

3 METHOD

This research was mainly carried out in the company WowSystems, while the case studies we focus on happened at the World Expo Zaragoza 2008 (Spain), and at a Cultural Exhibition in Madeira (Portugal). WowSystems is specialized in new digital media, novel interaction paradigms and interactive installations. Because of the very nature of its core business, innovation and agility are main concerns of the company.

We followed an interpretive research approach (Walsham, 1995). Interpretive case studies can make a valuable contribution to Information System (IS) theory and practice and the volume and range of such studies are limited. Some researchers (Hedin et al., 2003) agree that there is a need for more interpretive stances in the future in the IS field and software engineering as well.

This means that the analysis of data was based "on understanding a complex whole from preconceptions of about the independent meanings of its parts and their interrelationships" (Klein and Myers, 1999). We also followed in some way the spirit of ethnographic research, taking field observations and tracking artefacts such as post-it notes, desktop items, whiteboard collaborative writing sessions and similar ones. Ethnographic analysis is derived from anthropology. Field observations are taken at a site of a possible user. These observations also gather the sequence of work and interruptions that determine the user's typical day.

Our method included the gathering of data related to (i) participant observations, in an ethnographic study manner, over the course of the projects; (ii) semi-structured interviews to stakeholders and (iii) informal meetings and discussions. The following are the time periods and projects the author participated, in order to conduct the research following the previously mentioned method:

- Cultural Interactive Exhibition: January to April 2008;
- Portuguese Pavilion in Expo Zaragoza, Spain: April to September 2008;

The meetings involved a large assortment of professions: programmers, visual de-signers, project managers, interior architects, artists, government persons, marketing personnel and researchers. We took notes during the observation sessions, and audio-recorded some of the interviews. Photos were taken at relevant and/or interesting moments throughout the development. The authors were also able to participate in informal meetings.

Following the ethnographic research spirit, we also conducted several in-depth structured interviews with developers and engineers, project managers, and customer representatives, which included the professions mentioned before.

4 CASE STUDIES

WowSystems had chosen to follow agile development methods in all projects developed by the company, since it fitted very well into the tight schedules the clients demanded. There were, however, two major concerns expressed by the developers: how to achieve innovative solutions and how to deal with the communication issues. These communication issues were derived not only from the background differences between artists and engineers but also from the very nature of interactive installations as "physical pieces" of software, sometimes even cal-

led as tangible user interfaces (Ishii, 2008).

We will begin by analysing the Cultural Interactive Exhibition, and afterwards we will describe the Tourism Information Office case study. At the end of each subsection, we provide a detailed discussion organized around the main challenges and processes; in particular we outline how agile processes should be tailored in order to be more effective when designing interactive installations like these.

4.1 Cultural Interactive Exhibition

In April 2008, WowSystems designed a set of sensor-based installations in a cultural exhibition organized by the Direction of Cultural Affairs, which aimed at showing the visitor the cultural richness that formed the streets of Funchal (Portugal). The concepts of the exhibition revolved around promoting awareness about, and foster a better understanding of, the cultural tourism that can be performed by simply walking through strategic streets and watching certain buildings, sites, and heritage. To better complement the exhibition's traditional large-format printed panels, the organizers wanted to have the interactive factor as a means to add value to the visitor's experience.

The final set of installations included: (i) a virtual encyclopaedia that could be browsed by simple page-flipping gestures performed in mid-air; (ii) an interactive floor that illustrated the evolution of the transportation means along the years; (iii) an interactive timeline using a touch-screen and (iv) a panel with projected images that would change through waving. These installations are shown in Fig. 1.

Figure 1: Innovation examples for cultural heritage and museums: the installations and interaction styles employed throughout the 2008 "Cultural Tourism" exhibition (clockwise from top left): page-flipping, walking over, touching and waving.

The use of sensor-based interactive installations, in particular installations involving infrared motion sensors as well as cameras coupled with real time video processing algorithms, have been receiving considerable interest both from industry and academia (Hornecker and Stifter, 2006) During the design and evaluation of interactive exhibitions, much can be learned about interaction design for public settings like these.

An important principle, upon which the agile methodologies are based, is the close relations between developers and users or customers. Being agile means giving priority to customer's satisfaction through early and continuous delivery of software where changes are appreciated. The main customers for this Culture Interactive Exhibition were architects, artists and designers who were interested in conceiving the best possible ways to provide an interesting exhibition. The design and development processes were therefore a collaborative effort between WowSystems' team and these user groups.

"*Change was constant - and communication was a true challenge, since it was difficult for them to communicate us the whole point of. And when we moved from the laptop to an actual kiosk or projection, we noticed how different their opinion was regarding every aspect of the design and development*" (Developer/Designer, WowSystems).

Another interesting observation was:

"*They were completely focused on the MS PowerPoint model - they thought kiosks and interactive installations had to be designed as if they were PowerPoint presentations*" (Developer, WowSystems).

The experience of designing and evaluating an interactive exhibition featured four different interaction styles to control digital contents: touching, walking over, waving and page-flipping. The design approach was based on tailoring the interaction styles to the exhibition's contents and making a creative use of sensor-based technology, with the explicit goal of reducing the distance between visitors and cultural heritage.

While some of the more than fifty interactive installations already deployed were solely created as experiential activities, providing an increase in the level of learning by adding facts to an already well-formed conceptual model, others were designed to enact a reflective activity, thus supporting a restructuring learning where new conceptual frameworks need to be built. Another issue that drives the development team is the observation of the visitors' and users' behaviours, particularly finding out how col-

laborative activities can be supported as feedback mechanisms to enhance engagement and learning motivation.

Generally, the observations were focused around four issues: (i) usability, how easy and intuitive it is to interact with the products? (ii) interaction model, i.e. how did the interaction model was learned and reapplied, (iii) social interaction, which types of inter-action triggered more collaborative activity and how did this activity affect the performance of the interaction and finally (iv) learning effectiveness, did visitors actually learn anything? Whether it's for a museum, tourism or a brand, all these issues apply. If we're designing for a brand, the visitor should learn all about it and memorize it. If we're designing for tourism then the destination itself is the brand. And if we're designing for a museum or a science park, learning is one of the most important goals to be attained by the product's usage.

Particularly important for designing for innovation is the interaction model and how it is learned and reapplied. If the interactive product is too innovative, then it could be difficult to learn at first hand. On the other hand, conventional, well-established models of interaction (e.g. touch-screen kiosk) aren't innovative and therefore we can conclude that there is, naturally, a dichotomy between the learning curve and innovation degree of an interactive product.

4.2 Tourism Booth, Expo Zaragoza'08

Another similar innovation case study was the installation at the Portuguese Pavilion in Expo Zaragoza, Spain, in 2008. WowSystems was commissioned by the Tourism Board to design, develop and install an interactive floor of 5x2m at Expo Zaragoza, the world's largest exhibition, dedicated to "Water and sustainable development". The installation was a recreation of the famous Madeira "Levadas", the name given to watercourses built by man in order to carry the water from the mountains down to the villages.

Figure 2 illustrates the final product: we can see a picture of a visitor walking over an interactive recreation – an interactive floor – that reacted to the user's steps or gestures. Innovation was once again present, and the team wanted to achieve something more significant, but very rapidly and in an agile way. Since the idea was to recreate the environment, and since that idea influenced the design process, the team added the true sounds of the forest's bird species, and even added a "scent projector" that spread the scents and aromas of the forest as well. This way, the visitor could really immerse herself into the scenery, in a multi-sensorial experience.

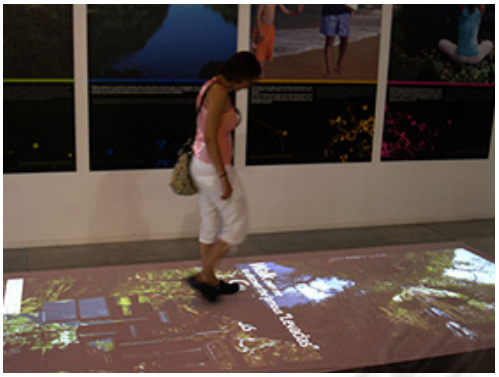

Figure 2: The virtual walkway.

The innovation process followed in this project was similar to the previous one. Like the previous project, one of the innovative ideas that were put into practice was the alignment of the interaction style to the message being conveyed by the product: In this case, visitors of the pavilion get to know the "levadas" the same way they would as if they were visiting the real ones - by walking over the interactive "levada". However, some significant differences occurred because the goal was to bring a little bit of life to the pavilion. The innovation process that was undertook in this case, was to brainstorm about how to recreate a touristic site using technology. After two sessions, one member of the design team proposed to add sounds and scents to the installation, and this turned out to be an aspect that the end users and the client both appreciated, much more than expected.

5 CONCLUSIONS

In this paper, we focused on describing the innovation aspects that occur using an agile development approach, when creating software products that employ novel user interaction paradigms. Using real world case studies such as these, one can obtain more insight into best practices that could be useful for promoting innovation during the agile process. Incubators, applied research centres, company's R&D departments, and innovation centres in general: All these can benefit from learning other companies' experiences and projects.

Interactive, Digital Media projects are often conducted by multi-disciplinary teams that usually include programmers, software engineers, project managers, interior designers, architects, graphical artists, and a high-level of client involvement.

A great difficulty arises when the final product is actually deployed: interactive installations are difficult to prototype and many aspects are impossible to model and test by means of early prototypes. This doesn't happen with, e.g. mobile applications, where the designer has full access to the end product look & feel anytime and anywhere. Since innovative products are much harder to propose to clients than conventional products, this difference between early prototypes and final product is a significant challenge for small companies, since it involves a large degree of imagination to describe.

Finally, many governmental programs, which are aimed at sparking innovative companies and supporting creative entrepreneurs, entail a large degree of bureaucratic forms, laws, regulations and similar "red tape" that are easy creativity-killers. This is a major difficulty should be addressed. Facilitating or diminishing the amount of red tape in incentives programs doesn't necessarily diminishes the credibility and transparency of the program.

One of the limitations of a study like this is related to measuring results: it is not easy, in a business context, to effectively measure innovation processes or even to explain exactly what went well and what went wrong during the agile process. Much of the practitioners' knowledge is tacit, in the sense that they don't know themselves how they accomplish their everyday tasks. Only through extensive observation in situ can researchers obtain a clearer picture on the innovation processes that companies and research institutes follow and consequently how can software developers take appropriate measures in order to improve their competitiveness and efficiency. This is, however, a first step towards that goal.

Another limitation of our experience is that it considers only the perspective of an interactive digital media company. It would be very interesting to compare this experience to other businesses and to other research fields, since some conclusions can be transversal to the research field.

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