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Understanding virtual world usage: A multipurpose model and empirical testing

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OBJECTS AND THEIR PARTICIPATION IN THE INTERDISCIPLINARY DESIGN AND DEVELOPMENT OF COMPUTER GAMES

Abstract

This paper investigates the role of boundary objects in the interdisciplinary collaborative processes found in computer games development. It draws on data from an in-depth case study in a computer games studio that explores boundary objects in relation to the compelling, sensory and entertainment-centred game-playing practices that inform computer games design and development. Sensory user experience and aesthetic considerations – of primary importance in computer games development – are becoming increasingly significant in the design and development of many other kinds of software and information systems. For this reason developments in the design and production of computer games have wider implications for other software and information systems settings and provide valuable insights into processes of collaboration that bridge cultural and aesthetic as well as technical forms of expertise. The paper seeks to provide insights into how objects contribute to such collaboration, with attention focusing especially on how game developers devise objects that span boundaries and draw on these in their collaboration. Through its focus on the material production and practices of computer games development, the research presented also seeks to contribute to the theoretical treatment of interdisciplinary collaborative working in software design and development via a critical assessment of the concept of boundary objects in the setting being studied.

Keywords: Boundary Objects, Computer Games, Design, Development, Aesthetics, Representation, Collaboration, Interdisciplinarity, Art, Programming, Practices.

1   INTRODUCTION

Most work is conducted by diverse collectives of people and things from different backgrounds and with varying levels and types of capabilities. Shared artefacts are seen by a number of studies from a range of literatures as playing a crucial role in the bridging of boundaries of human expertise and embodied skills involved in collaborative work (Gerson and Star 1986; Callon 1991; Henderson 1991; Fujimura 1992; Bowker and Star 1999; Carlile 2002; Bechky 2003; Carlile 2004; Bruni 2005; Engestrom and Blackler 2005; Levina 2005; Levina and Vaast 2005; Miettinen and Virkkunen 2005; Suchman 2005; Ewenstein and Whyte 2007; Luck 2007; Nicolini, Mengis et al. 2008). For example, a physical prototype (Carlile 2002; Bechky 2003) might help a designer communicate his/her vision to a production engineer and at the same time help the engineer understand the implications of that vision for production of that design in order to respond accordingly. Further examples from existing studies include design drawings (Bodker 1998) and engineering sketches (Henderson 1991; Bechky 1999).

More specifically, artefacts that exhibit a capacity to help different collaborating groups share representations with each other have been conceptualised by Star and Griesemer as boundary objects (Star and Griesemer 1989). Star and Griesemer's starting point for developing the concept of boundary objects is that for the success of collaborative work, cooperation and coordination need to be achieved across domains, and shared meanings and understandings established. For this to take place, information needs to "retain its integrity across time, space, and local contingencies" (Star and Griesemer 1989). This does not necessarily mean that for cooperation to take place consensus must be achieved. Instead, those involved in collaborative work have to "translate, negotiate, debate, triangulate, and simplify in order to work together" (Star and Griesemer 1989).

> "In conducting collective work, people coming together from different social worlds frequently have the experience of addressing an object that has a different meaning for each of them. Each social world has a partial jurisdiction over the resources represented by that object, and mismatches caused by the overlap become problems for negotiation. … Because more than one world or set of concerns is using and making the representation, it has to satisfy more than one set of concerns." (Star and Griesemer 1989)

According to Star and Griesemer boundary objects "both inhabit several intersecting social worlds ... and satisfy the informational requirements of each of them" (Star and Griesemer 1989). They are "both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites" (Star and Griesemer 1989).

> "These objects may be abstract or concrete. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation. The creation and management of boundary objects is a key process in developing and maintaining coherence across intersecting social worlds."

While a number of studies have made strong cases for the role specifically of boundary objects in collaboration (Gerson and Star 1986; Henderson 1991; Bowker and Star 1999; Carlile 2002; Carlile 2004; Levina 2005; Levina and Vaast 2005), most of these have been concerned with more conventional science, technology, and business settings where the forms of collaboration involved are functionally-based. There remains, however, a significant gap in the existing research regarding the role of boundary objects in relation to collaborative efforts that depend on linking technical forms of expertise with expertise in the areas of entertainment, culture, and aesthetics.

Computer games design and development, involves a highly diverse set of participants in multiple roles (Gershenfeld and Loparco 2003). Furthermore, because computer games are designed to be compelling on a sensory and entertainment level as well as to perform functionally, their development is an arena of techno-cultural production and differs from many other collaborative settings (Baba and Tschang 2001; Swartout and Lent 2003). For this reason computer games development was seen as a

good setting through which to investigate the importance of boundary objects in a situation of collaborative production characterised by a cultural and entertainment dynamic and to explore the forms of boundary objects being drawn upon. In particular, the research has sought to investigate what the role of boundary objects in the interdisciplinary collaborative processes found in computer games development is and whether the boundary objects involved reflect game-playing practices as compelling, sensory and entertainment-centred.

The article presents key boundaries and objects that span these boundaries identified so far in computer games development and describes the role of these objects in terms of how they contribute to collaboration. Attention focuses especially on how game developers devise boundary objects and draw on them in their collaboration. It also suggests ways such devised boundary objects might relate to specific performance outcomes and what the properties of boundary objects associated with successful projects might be.

2   RESEARCH APPROACH

As outlined, the study focused on boundaries of expertise encountered in an interdisciplinary computer game development setting and the use of boundary objects in the process of realising such an innovation outcome. To this end, an interpretive case study research approach was chosen (Walsham 1993) that focused on the work practices of game developers and the boundary objects they interact with during the development of these games. In particular, the research has aimed to acquire an in-depth understanding of the way in which the developers studied create, leverage, and alter boundary objects in this work and to access the meanings they create and attach to them (Ngwenyama and Lee 1997). This will ultimately form part of "thick descriptions" of the research phenomenon through engaged field experience that capture its distinctive complexity (Geertz 1973).

2.1   Data Collection

Through a combination of in-depth interviews and observations at computer games developer studios the research project presented is seeking to investigate the way the interdisciplinary collaboration involved in the development of computer games is performed by the humans and objects involved. This paper is based on interviews and some initial observations conducted at GamesDevCo, a pseudonym for a UK-based games development company, and the first of three planned case studies investigating the design and development of computer games at different development companies.

The researchers made a number of visits to the company's studios and headquarters between September and December 2008. During these visits a tour of the five divisions was undertaken. The various teams that comprise each division were encountered and informal and unstructured conversations with team members relating to their work, their interactions with other teams, the way they work within the team, and the importance of objects to this work took place. An in-depth formal interview with the company's director of development was also conducted and there were also a number of more informal discussions and interactions with the company's director of business development.

A range of artefacts involved in the design and development of past games titles also formed an important part of the evidential basis for the fieldwork. Finally, a significant amount of documentation generated from a part publicly funded joint commercial and academic international research project relating to the development of reusable multimedia objects was also accessed. This provided an in-depth view of the approaches the company was exploring in terms of re-using games 'assets' and how to enable those from an more creative background without expertise in computer technology and programming to interact directly with the technical components of games and input graphic elements and animations without the intervention of the technical experts.

Data collection also sought to pay attention to material entities, activities, schedules, hierarchies, routines and variations, significant events, participants' meanings, and social rules (Altheide and Johnson 1994).

While the use of other forms of evidence such as photographs of the studio and teams at work, pictures of the artefacts and objects studied, and screenshots of tools and objects used in collaboration was considered, that was not possible in this case study due to the strict non-disclosure conditions stipulated by GamesDevCo.

Interviews were recorded and transcribed, while observations were intended as a way of appreciating in greater depth and detail understandings garnered during the interviews.

2.2 Data Analysis

The analysis of the evidence has sought to counterpose theoretical formulations relating to boundary objects with the empirical data collected in order to develop an in-depth understand of how a variety of constructed boundary objects help shape, are shaped by, and represent shared meanings or interdisciplinary intersubjectivity.

From the data collected, the analysis first sets out to identify key objects used in the design and development of computer games at GamesDevCo and that were found to span the disciplinary boundaries in the company. Attention focused in particular on how these objects identified were involved in the collaboration across disciplines and what kind of interactions among the developers they were a part of.

Drawing from the original conceptualisation of boundary objects developed by Star and Griesemer (Star and Griesemer 1989), a mapping between the objects used in collaboration across disciplines in the empirical setting and the four key categories of boundary objects (repositories, ideal types, objects with coincident boundaries, standardized forms) proposed by Star and Griesemer was undertaken. On the comparison made possible by this, an analysis of conceptual concurrence and difference was undertaken, which formed the basis of the discussion that this paper presents.

3 CASE STUDY IN PROGRESS

Since its foundation in 1990 GamesDevCo has grown into a leading independent multi-platform developer employing around 250 people and comprising of five distinct divisions: family games; mature titles; serious games; downloadable games; and games technology. The company develops games under both its own brands as well as on behalf of external publishers and intellectual property rights holders.

3.1 Formal Structures and Disciplines

Formally, the various divisions of the company and the teams that comprise them are divided along the following three main disciplinary lines: art; design; and programming. The way the teams are structured in practice, however, can vary "as project needs ultimately dictate the structure and skills of the team and teams also vary in size as what [each] client needs is often very different".

The broad structure the company adheres to was described in the following way. A project director manages schedules and interacts with clients. Then, in most divisions there will be a manager for each of the disciplines involved, with, for example, a technical manager for the programmers, a design manager for design issues, and an art manager in charge of animators and concept artists.

This structure reflects the current company view of the key disciplines involved in the games development process. In practice, however, there appeared to be much more fluidity in the disciplinary boundaries that were likely to shift and be reconsidered. An example was given regarding the

introduction of an animations manager because the animation requirements for a project were considered so demanding and there were a large number of animators involved in the work. "It is something we are experimenting with" commented a senior development executive.

Below these discipline-specific managers each team in each discipline will have a "lead" or "senior" person "to help managers organise and lead their respective departments". These senior figures were described as "important to communications" and "senior in terms of what they have done", with 5-10 years of experience and having "done high-profile games, either previously at the company or at other companies". They were described as knowing "inside-out the company's technology, its games engine, and how to make games". Their job titles are along the lines of "lead programmer" or "lead designer", "lead artist", "lead animator" and so on.

Under this level are what were described as "general programmers, artists, designers, animators, and concept artists who do [technical design] concepts and visualisations". With bigger project teams of 50-60 people, specialisations might "go a lot further", especially with regards to art. For example, with regards to animation for large high-profile projects they now have people who are solely involved in "rigging" characters which involves "putting the skeletons on characters, but not actually animating them". "It is quite a big job and very critical with regard to the success of the project and the success of the animations". Similar developments are taking place with regard to 3D artists with the company now having environment artists, character artists, and "people … just dealing with lighting". Disciplines were described as "getting more and more specialised", with the example given of the introduction of "special effects-only artists".

"The bigger teams definitely have the ability to have people that are specialised in a certain skill and very much at the top of their game with regards to smaller parts of the game that make the difference. The smaller teams don't really have such needs, but that will also often depend on what the client needs", explained the company's development director.

The reason given for this specialisation and fragmentation of the three main disciplines were as follows:

> "The stakes are so much higher regarding the visual quality of the games, the complexity of the designs, and the technology we are using. Years ago … any decent artist could get away with doing special effects and knowing what to do, because it was very much dealing with 2D assets. These days, depending on the target hardware, what the [games] engine is capable of, and the technical requirements of the [games] engine a lot of special effects artists need to have a very good technical grasp of the technical aspects of the game in terms of coding and also for coders to have a very good understanding of how the rendering technology works with regards to that rather than just have a good knowledge of coding. You need to have extra knowledge on top."

The director of development talked about the necessity to "marry-up two different people" in one role creating "a 'technical artist' who knows a lot about hardware, about software, about good visualisation techniques, but also has a very intuitive mind in terms of experimenting with new and unusual ways of doing say a fire effect or a sparkling effect that goes in a totally different way than most others would do". Such a person would do "research stuff that instead of going down the normal route … could go in a completely opposite way" by talking with people and "figuring out that there may be a really cool alternative way of doing something".

Individuals from all the three disciplines are involved from the early stages of the origination of a game, with the creative side and designers taking a lead, but "senior technical guys and senior art guys" following them closely. "The industry is so tied together discipline-wise", explained the director of development, who went on to add:

> "Any change within an art specification could change the technical specification and the design specification definitely does [change] in terms of how many characters you can have on screen or how big the levels are and what the designer might want to do. The technical guys must look

at that and say: 'is that possible, how is it possible, how much would it cost if we did do it?' We try to involve those three sides of the disciplines – design, art, and technical sides – at a very early stage along with the manager. … Ultimately the project director will look at that from a costing and … scheduling point of view and say 'we have *x* amount of time to do this in and these resources we can bring, what are the major risks we need to be focusing on' and get a good estimate really of what kind of skills will be needed, what amount of people they are going to need and so."

In the case of GamesDevCo that works quite a lot with third party intellectual property rights holders, the GamesDevCo managers dealing with the interdisciplinary team from the client side also have to consider the specifications of a project strategically and technically in terms of what the studio wants to do with regards to its styles and "where [they] want to take the engine". "We work with that and make sure the pitch fits with what we want to do as well as meeting the clients' needs at the same time; we kind of marry those two up and then go in to further negotiations, explained a senior GamesDevCo executive.

As can be seen in this section, even at the level of concept origination for a game, a significant amount of interdisciplinary work is already involved. At the same time, while disciplines are recognised at the corporate and organisational level in the company, in the actual work practices of the teams developing a game the disciplinary boundaries are porous and flexible.

3.2   Concept Book

An important material nexus for this early-stage interdisciplinary work as the computer games move from conceptualisation to actualization was what was often referred to by the GameDevCo developers as the "concept book" and discussed as follows:

> "In the end [of the conceptualisation phase] we get to the point where we create a high-end specification document that looks great and [is presented] with good PowerPoints and videos and all sorts of madcap stuff. One thing we really have trouble doing in the industry is selling the vision of the game. … Trying to get that across is quite tough to do and quite expensive. Years ago we used to go through word documents and write stuff out and give lists and a bit of concept art here and there; nothing too major really. Now days we are dealing with producing videos and actual 3D assets which is probably the most expensive thing we do at the studio. Even [just] producing the documents you have seen takes a huge amount of resources and time to do."

The samples viewed were from past games. They were very professionally produced and aesthetically engaging documents, styled in accordance with the theme of the proposed game. For example, one for a very successful science fiction film series had covers made out of shiny metal that was shaped and indented in such a way as to look like one of the very characteristic spaceship doors in the film. Another for some medieval adventure had the look of an old and musty book.

The documents included text that described the game and its features to the reader, the thinking behind it as well as visual representations of the main characters of the game accompanied by what can be described as imaginary biographies for them outlining their roles in the game and what they could do. The documents often – though not always – also included outline budgets and cost projections for the proposed game. It was explained that the production of these documents was undertaken by a specialist "pre-development" team that included individuals from business development and marketing as well as individuals with skills in business analysis, project planning, desktop publishing, and writing and editing text. This core team would then draw from the expertise of the different developers involved in the project from the three formal disciplines acknowledged by the company of art, design, and programming.

3.3 Game Design Document

Once a more formal agreement to proceed with the development of a title has been reached, whether this is with an external publisher or in relation to internal approval procedures, a number of new objects that are crucial to the interdisciplinary collaboration involved are assembled, as the following passage describes:

> "The aim at the beginning of each project … is to create a 'game design document' an 'art design document' and a 'technical design document'. The game design document will contain everything that is in the game. It will classify all the characters, all their moves, all the mechanics, all the animations needed, all the pickups, all the weapons, all the locations, all the mechanics. That will grow to at least a couple of hundred pages for just that. … [The game design document] is also crucial to the relationship with the client [as well as in terms of] visibility for the collaboration. The same with the art and technology design documents and what they deal with. Everything is documented in terms of meeting notes. Everything visual is designed and we obviously design everything digitally or scan it in or drawn digitally. So we keep a record of that."

The *games design document* is not only a repository of all the elements that need to be assembled during the development of a game. Because the milestones agreed for the delivery of different parts of the game are also included, much of the scheduling of the tasks for a project and included in a "milestone schedule" will also flow from it.

These milestone schedules are a central coordinating device in the development process that span all the teams and disciplines involved in the project. They reach right down to the level of each individual, with printouts of graphical representations of the schedule observed fixed either side of their computer screens on to the wall or the separator screens on to which the desks of the developers abut.

The games design document is not a static high-level brief. It evolves and grows together with the games project, with minutes, drawings, and other relevant resources and assets added throughout the development process.

3.4 Drawing and Visual Representations

Drawings, within the context of both the concept book and the games design document, but also more generally in the games development process as a whole, were found to have a crucial boundary crossing role. Drawings – but also visual representations in general – were very much linked to one of the central preoccupations for a games development company: how to capture and communicate, both internally and externally, the "vision" for a game. The importance of drawings is captured in the following passage:

> "We try and draw a huge amount of stuff during the project because the cheapest way of getting any visualisations is by drawing. The [art specialists] are trained to draw extremely fast as well, so we spend a lot of time drawing out the environments, drawing out some of the character moves in regards to the animations cycles, drawing out all the characters' weapons, individually style anything else we need, sometimes just drawing with regards to diagrammatic things saying: 'I want this character to move like this', or, 'here is one of the character moves and I want it to look dynamic in this kind of way', or whatever. Some quite functional things like that. So, when we hit production we've got a huge amount of material there."

But it is not just the drawings that are so important in terms of the circulation of the vision for the game. Within the studio there was a wide-spread use of all sorts of sizes and types of models in the development process ranging from miniature mock-ups of landscapes made from the kind of modelling materials used by model railways enthusiasts, to small sculpted figures or portraits of

characters. Throughout the studio, props and objects from various well-known film and television titles could be seen on the desks of individuals and in areas occupied by different teams, but also all around the office space, giving a visually intense feel to the place.

Even external visual resources are utilised in order to convey to the individuals involved the elusive vision for the game, as illustrated in the passage below:

> "With everything we have created, even if it is 'true to original' there is always a movie, or a book in some cases, or another game possibly, that have done something similar or have done something diametrically opposite that we can say: 'this is really what we don't want, we really don't want this vision'. Or, 'what I am trying to get to is this', or 'here is a movie'. Everyone watches the movie and they then hopefully understand what you mean about the emotion of the game or the visual style of the game or whatever it might be. … Using those … references, to say, 'right we really want this', then … people come up with ideas and come up with visual styles [and] that's how [the vision] works; it kind of trickles down."

3.5   Other Objects

The development of computer games at GamesDevCo also depends on a number of tools and development methodologies that have knowledge, skills, expertise, and ways of viewing and knowing the processes involved in games development built into them.

These include computer programmes for the digital manipulation of artwork, for creating high-end 3D assets, development platforms for writing computer code, and project management applications. Of particular interest in relation to understandings of collaboration built into such tools was provided in this case study by the decision of GamesDevCo to abandon Microsoft Project in favour of a programme called Hansoft, which has been developed by a number of games developers who built a specialist project management software application.

4   ANALYSIS AND DISCUSSION

Our account of games development projects at GamesDevCo has focused on three of the objects that were found to play vital boundary crossing roles because of the important consequences for interdisciplinary collaboration they were found to have in this setting.

The *concept book* not only crosses the boundary between the games studio and the client, but also allows the developers from a number of areas of expertise to bring together in a common space their interpretations of the vision, concept, and ideas of the proposed game.

These interpretations are then, for the purpose of the concept book, expressed in text, textures, materials, drawings, photographs, tables, and spreadsheets that have been made combinable but also accessible by all those involved in the games development process and from different areas of expertise with different representational techniques. The co-production of shared representations is a central element in the conceptualisation of Star and Griesemer (Star and Griesemer 1989), as the following passage shows:

> "Because more than one world or set of concerns is using and making the representation, it has to satisfy more than one set of concerns. When participants in the intersecting worlds create representations together, their different commitments and perceptions are resolved into representations - in the sense that a fuzzy image is resolved by a microscope." (Star and Griesemer 1989)

The *game design document* is also crucial in this respect. It specifies a whole set of objects and relations among these objects that must come together in a game. It will specify, for example, the number of levels the game will have, what these levels will be, the storyline of the game and how that

relates the different levels to each other, who the characters are, what their role in the game is, where they can appear, how they can encounter each other, what the mechanics of their interactions are going to be, how they are going to move, what 'things' they can interact with or manipulate, and so on. These are all objects that whether an individual participating in the development process is a coder, an animator, a 3D artist, or an special effects or artificial intelligence specialist, will, during the trajectory of the game from concept to actualisation, continuously cross backwards and forward between individuals and groups of individuals with a particular expertise and way of working and interacting. As was explained during the research, this way, when for example the character artists come into the team, they can see straight away what characters are needed from the concept art already done in 2D and included in the document. Or a programmer can "look at the game design document, look at the pages which relate to character movement or even read the whole document with regard to how all that is going to feed into the mechanics and other stuff and then be able to think, 'OK I have got it'."

Furthermore, the dynamic nature of this documentation means that this a continuously expanding body of material of all kinds, both textual and visual, that tracks and accompanies the game through its development, recording but also making available back to them the interactions of all those involved in the project. It also provides an updatable representation of the game being developed itself, but in such a way that this representation is a shared representation that can be used by all the different disciplines for their own purposes.

This document also includes the crucial for every project, team, and individual team member "milestone schedule". The milestones themselves are more that just a project management device. It is through them that the performance of individuals, teams, and ultimately the company itself are judged, evaluated and rewarded, as the following passage from an interview illustrates:

> "The project director gets involved … to create a 'milestone schedule' with a list of deliverables for the duration of the project. [The milestones] are usually monthly and those deliverables contain certain parts of the game like an x amount of characters and an x amount of levels or whatever it might be. It is important that the teams are involved in whatever they are signing-up for as it is important that the milestones that are agreed on are met, as this is how we get paid monthly in arrears from our clients. We have to be aware that our milestones are judged by the fact that if we hit the milestone – which we luckily do mostly – then we get paid. That is how the visibility works."

Even conceptually, however, the notion of the schedule and the key stages in the lifecycle of every games project, regardless of the relative duration of each phase or the content of the work involved, shapes to a great extent the interactions of the developers with the project and with each other. They all know that there will be a pre-development phase, a production phase, and a finishing phase in every project and within these there will be certain inputs and contributions they will have to make. In turn, these broader phases are composed by other commonly understood and to a great degree inviolable key stages, like for example alpha testing, beta testing, console standardisation and certification, and the eventual graduation of the game from the "master version" to "gold master", which is effectively the game that is played by people "in their sitting rooms" and than one can find on the shelves of the shops.

While the concept book and game design document are much more clearly discernable as boundary objects in the way proposed by Star and Griesemer, it is the non-representational capabilities of the drawings and visual representations (models, sculptures, props, books, TV series, films, other games) that enable the circulation among the developers of the "vision and emotion" of the game being built that provide the most interesting insights from a theoretical perspective.

Although the research is still at a relatively early stage and the analysis presented here is based on a preliminary assessment of the evidence collected from only one of the three sites to be studied, some important theoretical points are raised from the first iteration in confronting the material collected with the literature relating to boundary objects and their importance in collaborative work.

The central role played by visual representations, not in terms of the representational work they do but in terms of circulating among the developers involved often intangible aspects of the game such as its "vision" and the emotional response it must produce, raises an important question for the notion of boundary objects. This is because the original conceptualisation of the boundary object as articulated by Star focused on rather narrow representational aspects of these objects and the systems of representation they are part of.

Furthermore, something that became quickly evident even during such an early phase of this research project was that while objects and artefacts clearly had very important roles to play in the collaboration involved in the design and development of the computer games, it was much more difficult to discern clear-cut boundaries between disciplines or particular social groups in the setting being investigated, despite the formal categorisation of art, design, and programming used by the company itself.

While Star acknowledges that "no representation ... is either complete or permanent", but rather that "any description is a snapshot of historical processes in which differing viewpoints, local contingencies and multiple interests have been temporarily reconciled" (Gerson and Star 1986), her formulation of boundary objects depends on a fairly stable view of roles, identities, and social groups. The notion of boundary objects depends on boundaries to have relevance, but the boundaries encountered in this research so far are not stable and 'given' but constantly shifting and changing. This critique of the original conceptualisation of boundary objects is made, if in a rather oblique way, by Fujimura (Fujimura 1992), who writes in a footnote:

> "I do not assume that social worlds, e.g. disciplines, are stable entities in nature or society … [and] that disciplinary boundaries are also constructed and therefore can be destabilized."

It is important to keep in mind – as Fujimura suggests – the location of Star's work in the field of "symbolic interactionism" and the interest of this field in how people act toward things based on the meaning those things have for them. From the way individuals interacted with these key objects identified in the case study presented we can say that social groups and disciplines are not pre-existing but formed and dynamically sustained out of the interactions of individuals and their embodied knowledge and skills through these important objects.

Finally, it is important to note that it was not just objects that were found to have an important role to play in spanning the shifting and fluid boundaries encountered in this setting. Individuals in the form of the "technical artists" mentioned by one of the interviewees when describing the experienced and senior 'leads' of the studio, had vital boundary spanning roles to perform. As the work on interdisciplinary collaboration in IS development by Levina (Levina 2005) suggests, participants' diverse backgrounds constitute powerful resources which help to shape the mode of collaborative actions and design.

5 CONCLUDING REMARKS

Drawing on data from a case study in a computer games studio we explored boundary objects in relation to the compelling, sensory and entertainment-centred game-playing practices that inform computer games design and development. Our analysis of this case study – the first of three such cases – highlights three set of objects found to have important boundary crossing roles in the design and development of computer games in this setting.

Paying particular attention to the importance of sensory and experiential characteristics in computer games and the need to bring together during their development diverse skills and expertise from art, design, and computer programming, the paper assessed the relevance of the notion of boundary objects in relation to the empirical evidence collected. While the importance of objects in the kind of collaborative work involved in the development of computer games was affirmed, the centrality given to the representational aspects of boundary objects in the original conceptualisation developed by Star

was found to be limiting (Nicolini, Mengis et al. 2008). In addition, the boundaries of social groups and the worlds they delineate were found to be fuzzy and shifting and far from stable in the way that the notion of a discipline would presume, with many individuals able to be part of more than one group and participate in more than one system of representations.

User experience and sensory and aesthetic considerations are increasingly taken into account in the design and development of software, hardware, and information systems (Bertelsen, Petersen et al. 2004; Fishwick 2006; Floyd, Jones et al. 2007), so acknowledging and understanding the multiplicity of roles that objects that participate in the interactions of social groups or even of the individuals involved in such forms of collaborative work is crucial. While the original notion of boundary objects developed by Star was important in terms of highlighting the role of objects in collaborative work and how common representational spaces are achieved in such situations, there is more than representation that these objects are involved in (Thrift 2007).

In a small way the games developers studied in this research and the importance to their collaboration of "the vision and emotion" of a game and how they deal with these elusive and difficult to represent entities in practice provide a glimpse of why the kind of research programme advocated by Ciborra (Ciborra and Willcocks 2006) "in which inner life is as important as surrounding circumstances, where the pre-theoretical is preserved by giving space to the moods, emotions and dispositions not linked to thinking", is of such relevance.

Following on from these findings from the first case study, investigative effort over the next case studies will be directed towards trying to understand the techniques through which intuitive and difficult to represent aspects of the objects being realised through such processes of design and development – such as, for example, their sensory, aesthetic, or emotional appeal – are accessed and shared by those involved in their production.

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