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smoke & mirrors

Diminishing the barrier between physical and virtual objects

The Bottomless Bag

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Additional Litteratur:

[1] Buxton, W. "Sketching User Experiences - Getting the Design Right and the Right Design", Morgan Kaufmann - Elsevier, San Francisco, March 2007 - **(448 Sider)**

[2] Norman, D. "The Design of Everyday Things", Basic Books, New York, 2002 - **(288 Sider)**

[3] Nørager, Rune "Low level cognition in user interfaces", Department of Psychology, University of Aarhus, 2009. **(30 Sider)**

[4] Buxton, W. "TechTalk: NUI: What's in a Name? by Bill Buxton", Principal Researcher Microsoft Research - MDCC in Vedbæk, October 2010. - **(1 time og 30 minutters lyd)**

[5] Pederson, T. "Physical-Virtual instead of Physical or Virtual — Designing Artefacts for Future Knowledge Work Environments", Proceedings of HCI International'99, Lawrence Erlbaum, 1070-1074, 1999 - (**4 Sider)**

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[8] Silverman, D.. "Doing Qualitative Research", Third Edition, Goldsmiths, University of London, UK, 117 - 135, 2010 (**18 sider)**

[9] Creswell, J. "Qualitative inquiry & Research Design - Choosing among five approaches", Second Edition, Sage, pp. 59-68, 2007 **(9 sider)**

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ABSTRACT

A survey was conducted in order to map out what types of objects people carried around, and whether the participants actually used all of these objects. 60% of the participants did not use the items they carried with them. The survey sheds light on the motivation for creating a design solution which diminishes the barrier between physical and virtual objects. This paper proposes a design solution where objects transfer between the virtual and physical environments, thereby giving the means to use both physical and virtual objects, with the help of an augmented reality overlay. By developing such a device, people will be able to carry all the objects they want, but without carry weight or space consumption. Through our research we find what issues in the user-agents mental model may arise, when designing in mixed environments..

KEYWORDS

Physical, Virtual, PVA, Technology, Illusion, Bottomless bag

1.INTRODUCTION

In recent years we have seen technologies around data storage becoming more ubiquitous and mobile. Dropbox and iCloud, to mention a few, is now ordinary and popular applications which makes our files and documents become available from anywhere. This combined with computer technology continually getting smarter, more powerful and more compact, gives us the means to design and develop solutions where one can carry items digitally in an extremely light weight solution. Today you can bring vast amounts of pictures, music, movies and documents on your smartphone. All digitally stored and non-space consuming. A physical book can with current technology, be brought with you in a digitally stored version.

Most factories within the mass production industry are controlled electronically, and most of the products are created from digital blueprints. This be in the layout phase of a book, home appliances or even the blueprints to a standard house made in AutoCAD, ideally this data is available.

With emerging technology like Google Goggles and the fact that every smartphone have cameras, the ability to digitally identify a significant portion of physical artefacts in the real world is now a technology, where we will be able to utilize the objects virtually.

Current research within the field of augmented reality done by Matt Hodges and Bo Brinkman from ARLab[1] demonstrates how we can monitor the real world and via an augmented reality overlay interact with artefacts. They successfully created a changing room where the agent can try on clothes, virtually. Inspired from their achievements within the fields of mixed environments we believe that all the above mentioned technologies could be united into a design solution utilizing the strengths from both the physical and virtual environments.

The concept proposed in this paper allows users to have both physical and virtual objects in their possession and accessible at all times. The bottomless bag gives the user an almost unlimited virtual space, where one can capture objects, and then place them within a virtual storage, resembling a handbag. Our design proposal, is a solution which breaks the barrier between the physical and virtual environments, where on can switch between using objects in both environments.

1.1 RESEARCH QUESTION

What issues might arise in an agent's mental model when designing a concept that uses Physical-Virtual Artefacts?

2.RELATED WORK

Every artefact has several properties that describe how to interact with it. Norman refers to this as affordance, feedback and constraints of the artefact or embodied knowledge which determine how it can be used. When user-agents interact with an artefact or system, they rely on their previous knowledge and their ability to perceive new knowledge about how to use it, as well as their cognitive understanding of the cultural and social context in which they are situated [1]. This embodied knowledge is defined as the user-agent's mental model [2]. They develop a mental model of how to use an artefact through the interaction with it or interaction with similar artefacts. Thus, if appropriate mental

[1] http://www.arlab.nl

models are supplied through the design, the user-agent can immediately interact with the artefact thereby reducing the cognitive load [2]. While talking about design psychology, one needs to mention Nørager's cognitive pyramid [3] as well. The pyramid describes the human effort needed for certain actions, and gives the means of pinpointing the cognitive load.

Thomas Pederson's research on virtual/physical environments [5] and PVA's or physical/virtual artefact's [6] suggests that designers need to start thinking the physical and virtual environments as equally important. He argues the PVAs as "*instantiated in both the physical and virtual environment, where these instantiations to a large extent utilize the unique affordances and constraints that the two different environments facilitate...*"[6]

With the release of "Google Goggles", which enables Google searches through images, we are now allowing extensive tangible searches, hereby broadening the scope of how we understand to seek information. The mobility of this technology may permit us to evolve within the field of regular file storage and not only store files from our computer to a file service, but include our physical surroundings with the backstage of information from the Internet.

Contemporary input devices are getting more and more innovative. Gaze tracking has become immensely precise, used in military, medical instances etc. Displays that are projected on any given surface, enabling the user to control chosen devices from the palm of the hand. An example of this is the Microsoft Kinect that combines advanced camera technology with microphones and infrared laser, software recognizes you when you enter the room - through gestures and spoken commands, you can control everything.

3.METHOD AND ANALYSIS

This paper focuses on literature reviews and related work within the field of virtual-physical artefacts. We have chosen a phenomenological approach due to Creswells' and Moustakas argument of phenomenology as "*best suited to understand several individuals' common or shared experiences*" [9]. They define the approach in steps:

1. Ask 1-2 broad question(s).

2. Observations, depth interviews, surveys, journals ect.

3. Find significant statements. (Moustakas term: horizonalization)

4. Clusters of meaning.

5. Bring in own experiences.

To clarify and investigate which sort of areas or situations a concept within this field could become helpful, we chose to focus on the fact that virtual objects does not take up space. As defined in Moustakas step 1-2 we have asked the question "what does take up space for the common man?". To answer this we conducted a small qualitative survey based on the approach from Boolsen [7]. Asking 170 participants within the age of 21-45 to look into their briefcase, bags, pockets etc. and through a small form write down all the things that they where transporting. Our quantitative survey revealed that 59 % carried around objects regarding reading, but more importantly almost 60 % did not use the majority of the objects transported.

As mentioned in the related work chapter and as argued by Silverman and Moustakas step 3-4, we needed preliminary studies early in our process [8], in our case on how agents understand objects that exist in multiple environments. Inspired by Young, we did a small scale contextual investigation on mental models within the field of the most common carried objects, according to our survey - reading materials. In our study we found a gap between how agents understand a physical object and its virtual representation. Objects that have been passed through to a digital environment are treated differently due to primarily two reasons:

1. Extended features are possible when passing the object to another environment

2. The physical properties have changed hereby at some degree forcing a changed mental model

Step 5 in Moustakas phenomenological approach is found within our design, which is based on our discoveries, own experiences, several sketching iterations and before mentioned technologies.

3.CONCEPT DESCRIPTION

The Bottomless Bag is essentially a mobile application, which facilitates a virtual representation of a bag. The bag has the ability to store an large quantities of physical/virtual artefacts through augmented reality. We facilitate the augmented layer by using mobile devices such as smartphones or tablets with built-in cameras paired with software such as Google Goggles, that can recognize and identify physical artefacts. When an artefact (e.g. a book) is identified, the user-agent can store the object in a virtual copy, hereby accessing it anytime, anywhere. The level of interaction with the object is bound by the affordances and constraints of the mobile device, along with the available digital information about the object. In the book example, if a digital copy of the book is available, it permits the user-agent to read, annotate, create bookmarks etc. in the virtual copy. Later, if any physical copy of the book is identified, all of the user-created alterations would still be available for the user-agent through an augmented reality layer facilitated on his/her mobile device.

The above mentioned description focuses on the implementation or development as of today. The constant evolving technology within this field, along with the development of before mentioned technologies, might provide for a system built into a pair of glasses. With a technology like VRD[2], the system would be able to project an overlay onto your eyes, usable whenever, wherever. The augmented reality overlay would follow eye gaze and the image projected, would be just as natural to the eye as looking at the real world. With this type of overlay, along with hand gestures, we would be able to produce, a solution with the ability to scan objects, texts, images. With the help from image recognition, the development within this system, our concept, will be able to scan objects and directly transfer info, images etc. to the system. This is of course not within the next 1-3 years, but we believe it possible within a foreseeable future.

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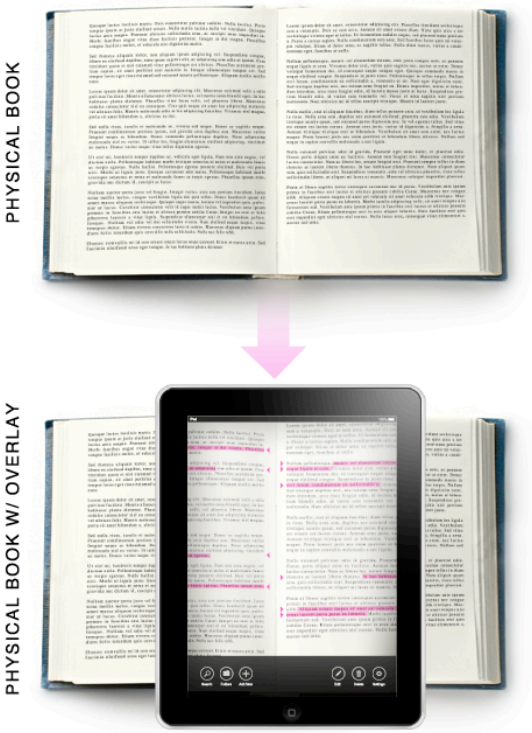
2 Virtual Retina Display



All of the before mentioned examples are centered around text related objects, that are easily manipulated in both physical and virtual environments. If we look at how we handle books in the physical world we however must acknowledge, that not all interaction is about reading or marking up. What if we wanted to staple together a collection of pages. In the virtual environment the problem could be handled by holding a couple of documents together while making a stabling motion, thus making one document, but what about the real world. We propose that a solution to this kind of interaction, would be a virtual guide to the nearest stapling machine, printer or what ever could be the solution to the problem at hand.

According to Nørager we should try to design our artefact in a way that embraces as much from the bottom half of the pyramid in order for the cognitive load to be kept at a minimum [3]. If we want to be innovative we should at least try to support well known mental models to minimize the cognitive load. By reducing the features available in the concept, and by keeping a very strict eye on the affordances of the physical artefact, the product will be easily understood and easily adaptable by the agents. On the other hand, if the focus falls on the affordances of the technology, the agents will potentially be exposed to a product that consumes a lot of effort to decode.

4.IMPLEMENTATION APPROACHES

When taking Normans arguments regarding agents' cognition of artefacts into account, designing systems where artefacts exist in both virtual and physical environments, we as designers need be specially aware of what consequences the manipulation in one of these environments could, should or might have in the other. Our concept and method clarifies that we see two approaches for design within this field:

1. The conceptual model is the same in both environments

2. The conceptual model is extended in the virtual environment

A Homogeneous approach requires that designers uphold the conceptual model from the physical environment; when virtualizing an artefact e.g. a book and highlighting a sentence, designers could support this functionality in the virtual version. We suggest to limit the actions / changes to what regularly is used in the physical environment due to the risk of breaking what the agents might think is possible according to their mental model. We believe this approach could - if succeeding in transferring the mental model fully or at some significant degree - create a more seamless transition between the environments, reducing the cognitive load of the agent but at the same time gaining the logistical advantages. We as designers can never predict how the users approach our concepts and bearing that in mind, a truly homogeneous concept becomes unattainable [2].

A Heterogeneous approach however separates the virtual and the physical conceptual model by extending the physical allowed actions in the virtual environment - but still inheriting the basic understanding of the artefact from the agents mental model. The core issue when extending an artefacts affordances, the designer allows for actions that could not regularly be associated with the artefact. when including affordences from different conceptual models, the design needs to use extensive feedback in order to guide the agent through this mix of models and environments. The human brain is an impressive tool for perception and understanding complex connections but as Stigel argues, if there is not a clear indication of how we should interpretate the artefact, then the mind will fill in the "blanks" [10]. Filling in the blanks in design could become "worst case scenario" hereby loosing the agents ability to understand the interaction with the artefact.

If current technology only supports the visual properties of a physical-virtual artefact, the question is whether or not the full mental model of the physical artefacts is still valid in the virtual environment. We believe that, if the full mental model of the artefact is in fact transferrable to a virtual environment, we will be able to merge virtual and physical affordances of the artefact e.g. weight reduction, space consumption and replication without adding to the cognitive load [3]. But currently the technology in simulating these non visual aspects is still in its embryological stage.

3.CONCLUSION

Through our research we have designed a possible concept for creating a transition between a virtual and physical environment. Our research suggest that one should think PVA design within two areas (1) Homogeneous (2) Heterogeneous - whether or not one wants to uphold the conceptual model as defined by Norman or use the VR environment for the purpose of extending the physical tools. If choosing the second approach we suggest including a clear indication that this interaction moves between two conceptual models; one of the virtual environment and one of the physical.

4.

5.REFERENCES

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