

Design through exploration

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Design through Exploration

the REPAR
Project



Eindhoven University of Technology
Department of Industrial Design

The REPAR Project

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INTRODUCTION

the REPAR Project

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One of the tenets of User-centred design is that users should be involved as much as possible in the design process. Design practitioners acknowledge that involving users in the design process helps to create product innovations which meet the requirements of the users.

However, in practice it is often a challenge for companies to actively and advantageously involve end-users in the design process of their products. Main reasons are that users find it often difficult to understand the implications of the early ideas and concepts proposed by the designers and to imagine the future use of the product.

These tasks generally become easier when an explicit representation of the product concept as well as the use context can be shown, which is often only in later stages of the design process. As a result, users are often consulted at a later stage in the design process, after many design decisions have already been taken and considerable resources have already been invested. This paradox was addressed by the REPAR project, short for “Resolving the PARadox of User-centred Design through Flexible Prototyping”.

This booklet presents the outcome of the REPAR project. Chapters 1 and 2 introduce new ways of prototyping early product concepts. Chapter 1 presents a tool for creating animated sketches, providing support for designers to create rough 4D (dynamic) representations. Chapter 2 presents work on applying Virtual Reality technologies for creating in-context concept representations, supporting designers and users alike in the advantageous exploration of product concepts. Chapter 3 presents a method that aims to make it easier for the user to imagine future use situations as mediated by the concepts of the designer.

The REPAR project is a collaboration of Eindhoven University of Technology and the University of Twente, supported by the Innovation-Oriented Research Programme ‘Integral Product Creation and Realization (IOP IPCR)’ of the Netherlands Ministry of Economic Affairs, Agriculture and Innovation.

Jacques Terken
Jean-Bernard Martens
Mascha van der Voort

PROGRAM

Symposium Design through
Exploration June 2013

IN COOPERATION WITH
AND SUPPORTED BY:

PHILIPS

Rademaker



DAF
A PACOR COMPANY

10:00 **Arrival/Coffee**

10:30 **Welcome**

Introduction – Goals of the REPAR project

10:45 **Jo Geraedts** (OCe)

Maximizing the impact of usability
experience

11:10 **Freek Swaanen** (DAF)

User-centred design at DAF

11:35 **Roland Kals** (Rademaker)

(My vision on) future design

12:00 **Introductions in the REPAR
subprojects** (10 minutes each)

■ ID Animate:

A tool for Low-fi prototyping

■ Hi-fi prototyping through VR
techniques

■ Co-Constructing stories:

*Collecting feedback from users on radically
new concepts*

12:30 **Lunch**

13:30 **Workshops round 1**

■ Workshop 1: *ID Animate:*

A tool for Low-fi prototyping

■ Workshop 2:

Hi-fi prototyping through VR techniques

■ Workshop 3:

*Co-Constructing stories: Collecting
feedback from users on radically new
concepts*

14:45 **Break**

15:00 **Workshop round 2**

■ Workshop 1:

ID Animate: A tool for Low-fi prototyping

■ Workshop 2:

Hi-fi prototyping through VR techniques

■ Workshop 3:

*Co-Constructing stories: Collecting
feedback from users on radically new
concepts*

16:15 **Panel discussion**

Discussion with members of the REPAR
Industrial Advisory Board

16:45 **Closure/Drinks**

idAnimate

Creative expression and exploration of design ideas through animations

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Jean-Bernard Martens



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Introduction

What is idAnimate?

idAnimate is an application for iPad® devices that allows designers to rapidly sketch interactive products and services. Designers can describe by means of animations and storyboards how the product behaves over time and interacts with the user.

Background

In the early stages of the design process when ideas are vague and imprecise, designers usually work with paper sketches to explore their imagination and articulate their ideas. Reason for this is that sketches are easy, fast and cheap to create, while they provide a very flexible medium for expression. In general, sketches are used for:

- Exploring and expanding the space of alternative solutions
- Communicating design concepts
- Discussing and refining the core ideas behind the concepts with a team of stakeholders

Problem Statement

Product design has undergone a substantial change in the last decades due to the reduced size and low price of embedded microprocessors, communication devices,

and sensors and actuators. This has resulted in a growth of the interactive capabilities and sophistication of products and services, increasing the complexity of the design activities. This increase in design-complexity is making the limitations of paper sketches become more apparent.

Not surprisingly, sketches are not ideal for describing highly dynamic concepts. This is due to the fact that most of the behavior and time related aspects that are to be conveyed are either left implicit, or roughly described through arrows and annotations (*See Fig. 1*). This implies that the understanding of the information transported within the sketch heavily relies on the imagination of the interpreter (*See Fig. 2*).

Thus, sketches can give rise to misunderstandings and misconceptions, especially when they are used to express highly dynamic concepts.

Theories about creativity and design support the idea that the thoughts evoked by reflecting on the visual artifacts that are created during the creative process determine for a large part the quality of the outcome of this design process. In essence, the materials that are used during the creative activity enable, but also limit the creative capabilities of the practitioner. Consequently, working with static visualizations may not always help the designer foresee unexpected events, or more in general, enable the designer to adequately explore the space of solutions.

Thus, using static sketches to explore the space of solutions of highly dynamic concepts may lead to incomplete design solutions, while using them to communicate behavior and time-dependent ideas may lead to misunderstandings. As a result, sketches are normally only used for a limited time during the design process, generally only at early stages.

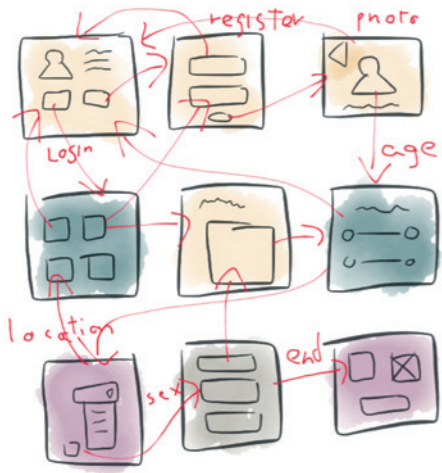


Figure 1 - Description of a web-based registration form using a static sketch



Figure 2 - The problem of miscommunication in the early-stages of the design process

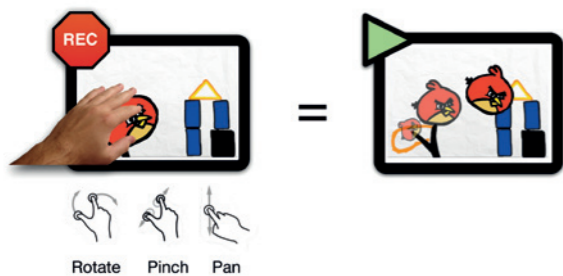


Figure 3 - Animating objects using hand gestures

Elaborating High fidelity prototypes can solve most of the aforementioned issues. However, creating such prototypes is not easy or cheap, requiring the investment of a substantial amount of time and resources. As a rule, high fidelity prototypes are therefore used at later stages of the design process, when a commitment to a particular solution has already been made.

Creating or modifying high fidelity prototypes usually requires a set of skills that is present only in a subset of the members in the design team, which limits the possibilities to provide input by other members of the team, as they do not possess the technical skills needed to modify or alter the prototype.

Thus, design teams increasingly find themselves in a situation where there is a need for tools that allow them to go beyond the expressive capabilities of paper sketches, i.e., by augmenting them. The cost and time involved in creating such new forms of visualizations can however not increase significantly, as the threshold for using them within early stages of the design process would otherwise be exceeded.

We propose that creating animations in a way that resembles sketching could be an interesting approach towards more effectively exploring and communicating the dynamic aspects of concepts. In order to investigate and test this idea more concretely, idAnimate was designed.

idAnimate

idAnimate enables designers to more interactively explore and communicate design solutions by increasing the capabilities of a conventional sketchbook, allowing them to create meaningful animations in a sketch-like way without having to spend large amounts of time in doing so.

How does it work?

idAnimate is inspired by the metaphor of a digital sketchbook animator.

Users start by sketching or bringing graphical objects on the sheet of digital paper. It is possible to interact with the objects using multi-touch gestures that transform the object by panning, pinching and rotating them. While the user moves and transforms an object on the digital paper (acting out the interactions and behavior), the system records what happens creating an animation, being able to replay it at a later stage (See Fig. 3). In essence, with idAnimate the user generates animations by interacting with digital objects in a natural way.

Supporting the early stages of the design process with idAnimate

idAnimate is designed to complement paper sketches by giving the designer the ability to introduce time-related events. Since these visualizations convey additional information, it makes it easier for multiple stakeholders to be involved in rapidly visualizing and/or modifying the ideas, effectively discussing dynamic concepts. Thus, idAnimate is ideal for:

- Increasing the information conveyed in the design artifacts exchanged at a conceptual stage
- Increasing the awareness and shared understanding of the design proposals
- Supporting participatory design in workshops and brainstorming

- Allowing designers to more easily communicate and discuss early-stage concepts with a broad range of stakeholders such as marketing people and end users
- Collecting insights and feedback already at a stage where no high-fidelity prototypes are available yet

To understand how idAnimate can be used for the aforementioned purposes, we will follow an example utilizing it to generate design solutions for an exemplary design brief.

A practical example: A smartphone payment system for gas stations

Suppose an assignment about a gas station payment system for mobile devices has been provided, which includes the following requirements:

- Payments are conducted using a mobile device (smartphone)
- Payment initialization relies on proximity, i.e., bringing the mobile device close to the payment artifact
- The selection of the type of product (type of gas), amount to fill (volume or money) is accomplished on the smartphone
- Payments need to be confirmed on both the gas pumping device, and the smartphone.

Preparation

Collecting Material

Animations and storyboards are generally composed of three core elements: (1) The Place or setting where the situation occurs, (2) the Object(s) involved, and (3) the Actor(s) who carry out the interactions (usually, as some form of dialogue).

Users are recommended to start by creating a collection of images related to the design brief.

This can be done in multiple ways: by sketching on

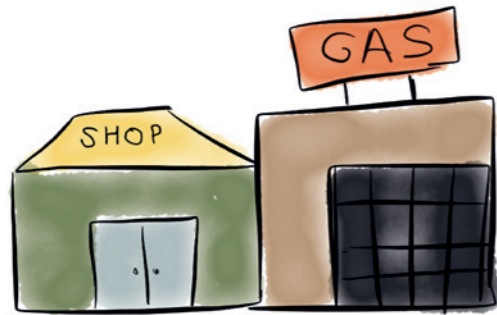


Figure 4 - A sketchy looking gas station scenario



Figure 5 - A hand (actor) interacting with a mobile device (prop)



Figure 6 - Gas pump screen

the built-in sketchpad, by preparing collections of PNG images in a computer, by taking pictures with the iPads® built-in camera, or by pulling images from internet sources.

In our particular example we combine a specific sketching application for the iPad® (Paper by FiftyThree) with idAnimate in order to create the visual elements.

Places

Places constitute the setting and context for the product, the user and the interactions. While it is an optional element in an animation, situating the interaction in a specific place usually helps to better understand how and why things happen (see Fig. 4).

Object(s)

Props are the objects that have relevance in the story; mainly those that the actor will interact with. For our particular example the selected props are a smartphone, the gas pump and the screen of the gas pump, as well as a collection of user interface elements for the application on the mobile device. (see Fig. 5 and 6)

Actor(s)

The actor interacts with the environment and the props, providing them with an essential role in the animation. The actors will carry out the interactions with the objects, triggering the product behaviors and responses. In our example the actor is a hand of the user of the smartphone device (Fig. 5).

Setting up the scene

Casting the objects

The first step to set up a scene is to cast the elements previously created. Since the images of our example were sketched with a different application, we will bring them into idAnimate by exporting and importing them to/from the device's gallery of images, which is shared across the two applications.

In order to do so, we select the "create a new object" inside idAnimate, and import the desired sketch into it by selecting the import button.

Placing the objects

On the left side of the screen we can find the object selector (See left side of Fig. 7), which allows the user to choose which object to move, scale or rotate at any specific time on the digital paper. Doing this repeatedly for every object allows the user to define the initial placement of all the elements in the animation. Additionally, the user can define the layered order of the objects by swapping their position inside the object selector.

Defining the motions

Everything is prepared to start defining how the action develops, which is achieved by animating the objects. The approach to follow is simple: First we select the desired object to animate from the object selector, and then we tap on the Record button (See Fig. 7).

A countdown will be displayed, giving us time to prepare for acting out the motion. After this, whatever movements and transformation are carried out on the object will be recorded as part of the animation until the user decides to stop recording. This can be repeated for each of the objects in the animation, making it possible to record new motions while others are being replayed, allowing the user to synchronize the movement of different objects.

In our example, the interaction starts by bringing the mobile phone close to the gas pump screen. When both elements are sufficiently close, the screen of the phone shows the interface for selecting the product and amount to refill, while the gas pump turns on an orange light (see the defining visual appearances of objects ahead for more details). Once we have recorded the motion of the device, we can start defining how the actor interacts with the user interface, selecting the type of gas and the product. Having done this, we can act out the gas pump to show what happens while the gas is being pumped into the car's deposit, until completion.

Defining multiple visual appearances

Objects may have multiple visual appearances, that is, multiple images that can represent their visual state. Think of visual appearances as different outfits, which can be changed for instance to show two stages of a light bulb (On or Off), or two different facial expressions of a character. As shown in figure 9, the sketch editor helps the user create these distinct appearances in a way that resembles using an onionskin notebook.

In the animation editor, the user can seek for a particular moment in time and select the desired visual appearance to display from that moment on. This selection is done using the object inspector as shown in figure 9. Users may hide and show objects during the course of an animation by switching between visual appearances with content and visual appearances with empty content.

Creating Alternative Scenarios

Once we have an initial animation it is easy to make small variations to show alternative scenarios or use cases. What happens when the user pulls the nozzle before the gas has been fully loaded? What happens if the tank is full earlier than expected? How does the system display errors or react to different



Figure 7 - Animation editor of idAnimate. Exploring solutions for the gas station payment system with idAnimate

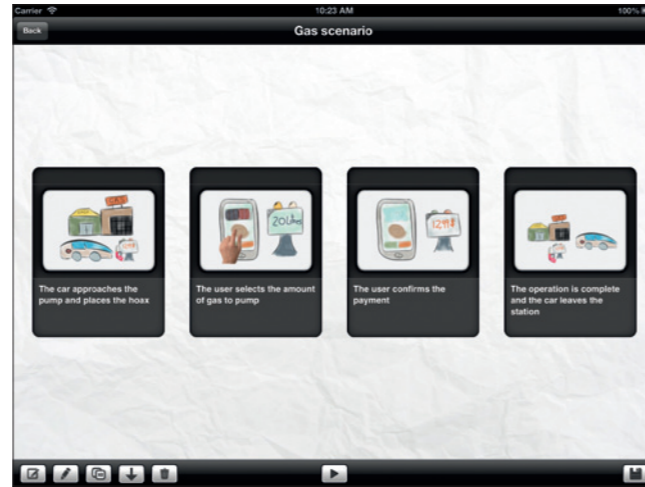


Figure 10 - A storyboard showing the different steps of the gas pump scenario in detail



Figure 8 - Example of sketching multiple visual appearances of a character



Figure 9 - The object inspector allows the user to select the visual appearance to be displayed from a particular moment in time



Figure 11

circumstances? To show this, users can duplicate a project and then rapidly make the appropriate changes to it.

Storyboards

idAnimate's storyboards are composed of sequential collection of animations with textual captions. Storyboards can be used to illustrate a story with multiple scenarios, or to show a particular element in more detail.

In our specific example, the screen becomes cluttered when introducing all the elements. We can improve this by separating the story in four different animations. The first one shows the car arriving to the gas station, placing the gas hoax inside the car's deposit, and the first reaction of the gas pump screen. The second and third storyboards show the interaction between the user and the displays of the smartphone and the gas pump to select the amount of gas to fill, and to confirm the payment. Finally, the last animation shows the car leaving the gas station.

Similarly to animations, storyboards can be duplicated to create modifications describing alternative scenarios.

Sharing and discussing animations

Once the animations or storyboards have been created, they can be easily shared amongst the team members. Other members cannot only watch them, but can also propose modifications to the ideas, quickly creating and sharing alternatives of the concept of scenario.

In addition, it is possible to export movie clips to embed them in a Powerpoint presentation, or share them on Facebook (See Fig. 8).

Conclusion

Sketches show clear limitations for exploring and communicating design solutions of highly dynamic products and services in the early stages of the design process. In this chapter we have presented a (research) low-fi animation and prototyping tool that aims to enhance paper sketches, to support designers to rapidly articulate such concepts. In addition, we have presented a use case scenario describing how to achieve the desired results with the tool.

Where to find more information?

idAnimate can be downloaded for free from the Apple® App Store™. To do so, you can use the following link, or simply search for "idAnimate" in the Apple® App Store™ with your iPad® device.

In the idAnimate website you can find a collection of resources such as tutorials, library packs and examples to help you learn and master the tool in a very short time.

www.idanimate.net
itunes.apple.com/app/idanimate-r/id614254835

FACILITATING USER CENTRED DESIGN THROUGH VIRTUAL REALITY



Jos Thalen



Mascha van der Voort

Mascha van der Voort is an associate professor at the Laboratory of Design, Production and Management of the University of Twente. She is leading the research group on Use Anticipation in Product Design. This group aims at supporting designers in anticipating use within product design processes in order to improve user – product interaction. This aim is pursued by means of the development of new design approaches and tools focusing on eliciting and sharing knowledge of product use. Concurrently, Mascha is partner and consultant of Invoke v.o.f., together with Jos Thalen.
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As a designer you might be familiar with various forms of concept representations, such as sketches, storyboards or physical prototypes. These representations can facilitate communication with stakeholders such as end-users. Involving end-users in the early stages of the design process allows you to ask what end-users think of a product concept, see how end-users would use a product concept or even ask end-users to assist in the definition of a product concept.

However, when developing new, complex or interactive products, these concept representations sometimes fail to fully convey the product, interactions or use context. Presenting a product concept in a concrete use context or use situation makes it easier for end-users and other stakeholders to understand the product concept. The current research proposes to use Virtual Reality (VR) technologies to create realistic representations of future products, user-product interactions and use contexts.

Opportunities for Virtual Reality

VR technologies create an alternative reality in which worlds, objects and characters can be experienced that may not yet be available in reality. By deploying these technologies in the early stages of a User Centred Design process, VR can:

- Provide an interactive and realistic confrontation with future use situations
- Make complex situations and information accessible to all stakeholders
- Support early stage concept generation, presentation and evaluation

Together these opportunities help with eliciting more profound insights and feedback from end-users in the early stages of the design process, and consequently contribute to creating products that suit end-user needs and expectations.

Research Objective

In practice VR applications are only relevant if you are able to realise them through an effort that is proportional to the benefits you get in return. Especially for VR techniques, which are traditionally considered complex, expensive and time consuming to deploy, this is a relevant aspect for the research to investigate.

The research presented in this chapter therefore featured two primary objectives:

1. Identify advantageous applications of VR in the early stages of a User Centred Design process
 2. Determine the boundary conditions for designers to realise these VR applications themselves
- Both objectives were first addressed in a specific design context by conducting three industrial case

Case study applications



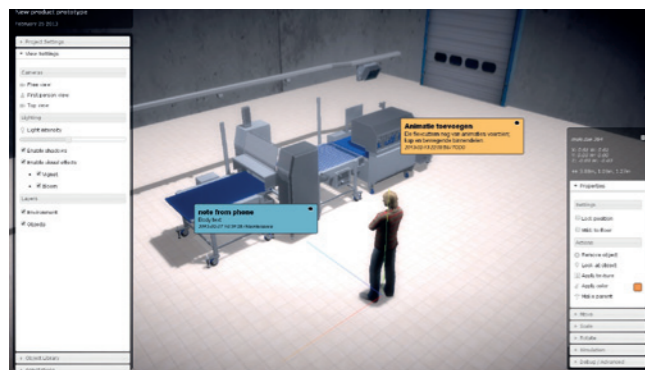
Virtual Printshop

The Virtual Printshop improves the realism of product evaluations in the early stages of the development process. In usability evaluations the product's use context can play an important role in triggering feedback from either end-users involved in the evaluation, or from designers themselves. The Virtual Printshop provides a realistic and interactive virtual environment in which virtual product models can be experienced, for instance by acting out workflows or specific use scenarios.



Virtual Personas

Virtual Personas are virtual user representatives that can be used to create and visualise future use scenarios. Virtual Personas enable designers to act out virtual scenarios in a very early stage of the design process. The virtual personas used in these scenarios represent specific user groups that can be used to review a new product concept from these specific points of view.



Virtual Annotation

The Virtual Annotation application enables multidisciplinary design teams to collaboratively review and annotate product concepts in a very early stage of the development process. The visualisation of the product and its use context can help with identifying, evaluating or validating initial product requirements, but also with brainstorming about new product functionality.

Table 1 - The VR applications developed during three industrial case studies

studies. Table 1 lists the three VR applications that were developed during these case studies. By evaluating the case study results across various design contexts, insights were gained into the effectiveness of VR applications in different design domains, as well as the boundary conditions that different designers have with respect to the realisation of these applications.

Based on these insights a structured approach for the realisation of VR applications for User Centred Design was developed. This chapter presents the approach and illustrates each step using examples from the case studies.

Getting started with VR

The key to successfully deploying VR in early stage User Centred Design activities is to be able to select the right tools for preparing and executing a desired VR application, as illustrated in figure 1.

- The VR application describes the design activity in which VR is applied. The application involves designers and internal and/or external stakeholders, who have a shared goal that is to be achieved through an activity (e.g. concept generation, usability evaluation or a design review).
- The execution tools provide the required hardware and/or software to run the application. For example, if the application involves a workflow evaluation in an office environment, the execution tool could be a 3D game engine that provides an interactive walk-through in which workflows can be acted out and evaluated.
- Preparation tools are used to prepare the VR application, and could for instance involve the creation of 3D models or virtual object behaviour. Depending on what is to be prepared, the preparation can be carried out by designers themselves, or by experts in other fields (e.g. programming).

Establishing a clear definition of the VR application was found to be one of the most challenging steps of each case study (see table 2). It turns out to be quite difficult to describe why and how VR could facilitate a User Centred Design process. This is partly due to a lack of awareness; as VR technologies are relatively unknown and change rapidly most of us do not have a complete or accurate view on what VR is, or how it could facilitate User Centred Design activities. A more important factor however is that the application often is (or becomes) technology driven; instead of asking "how can we use (a specific type of) VR in our design process?" the question should be "how can we improve our design process (possibly using VR)?"

Once a desired VR application has been established, the selection of execution and preparation tools is fairly straightforward, as the application also defines boundary conditions for these tools. For example, if the application requires 3D models of a particular product concept, one of the preparation tools will be a 3D modelling application. Other boundary conditions, such as the skills and tools already available within the company, can also be taken into account in this selection process.

Insights from practice

The primary challenge of using VR lies not in the realisation of the VR application, but rather in the definition of the application itself. Before thinking about required tools or techniques, describe what the VR application should achieve with respect to your design process:

- What is the primary purpose of the VR application?
- When in the design process can the VR application be used?
- Who are involved in using this VR application?
- Which resources are required for preparing or executing the VR application?

Table 2 - Clearly describe the VR application prior to selecting tools or techniques

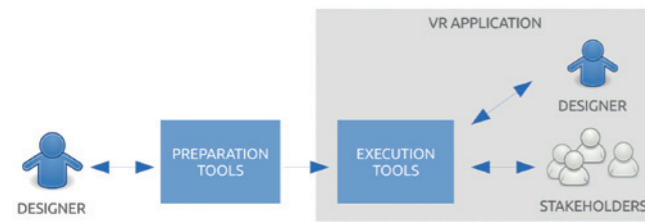


Figure 1

Approach

The research resulted in an approach that guides designers through the process of identifying and realising advantageous applications of VR in a User Centred Design process, consisting of the following steps.

1. **Exploration** – Become aware of what VR is, and define a VR application that is beneficial to your design process
2. **Specification** – Determine boundary conditions for the VR application, and derive requirements for its realisation
3. **Realisation** – Acquire the appropriate means to realise the desired VR application

The approach has been used to conduct three industrial case studies and resulted in the applications presented in table 1. These applications can be used as a starting point. If you are interested in using either the Virtual Printshop, Virtual Personas or the Virtual Annotation application, a first step would be to contact the researcher for an in-depth demonstration of these applications. This will help with identifying application elements that need to be changed for your particular design context, and with identifying boundary conditions for preparation and execution tools.

However, although the case study applications have been translated to various other design domains successfully, chances are that you want to explore new or additional opportunities for your particular design context. In this case it is recommended to involve an expert to facilitate the exploration of VR applications for your design context and the selection of tools, according to the approach outlined here.

Exploration

In order to assess whether or not VR is a valuable addition to your design process, you need to know what VR is, and what it has to offer. A problem with VR is that there is no clear definition of what VR is and is not; it ranges from very strict definitions (e.g. it has to provide a certain level of realism, immersion or interaction) to very broad ones (e.g. anything related to computer generated visualisation). In the case studies it was found that the designers' perception of VR is primarily based on high-end examples such as 3d CAVES, haptic gloves and head-mounted displays.

It is important to also become aware of low-end (off the shelf) hardware and software that enable the creation of effective VR applications without significant investments. The case studies for instance used the Microsoft Kinect to control virtual personas, regular web cameras for augmented reality applications and multi-touch displays for capturing input during collaborative sessions. As most of these technologies are available on the consumer market, they include proper documentation and support, which reduces the threshold for using such technologies in design practice.

Another important aim of the exploration phase is to determine which design task is to be facilitated by VR technologies. When brainstorming about VR it is quite tempting to think of all the possibilities the technology offers, without reflecting on why you would use it. The case studies have shown that the more a VR application is defined in terms of what design activity is supported (e.g. "the application should support our usability evaluations", or "the application should help us with conducting design reviews"), the easier it is to identify tools that realise this application.

Howto?

You can conduct the exploration yourself, for instance by conducting desk research involving academic and industrial resources to establish an overview of available VR technologies. These technologies can be matched to specific challenges or bottlenecks in the design process that you would like to address.

In the case studies a workshop approach was used. This 3 hour workshop, which is facilitated by a VR expert, involves a multidisciplinary group of about 10 people involved in the design process. Using visual storyboards, the participants first identify bottlenecks and challenges in the design process that could be addressed by VR technologies (see table 3). Having identified these opportunities, they use storyboards to visualise their desired VR applications by indicating what kind of technology could be used, why and when it would be used (e.g. what design activity is facilitated) and who would be involved in using it.

The main advantage of the workshop approach is that the company does not have to invest time in getting to know the current state of the art in the field of VR. Furthermore, the expertise of the workshop facilitator can be deployed to assess the matches between specific design challenges and VR technologies.

Specification

Especially when there are questions about the technical characteristics of the desired application, the creation of demonstrators or prototypes (see table 5) is a vital step towards establishing a focus on the final VR application;

- It will give insight into the validity of the desired application (e.g. does the VR application indeed contribute to a particular User Centred Design activity?)
- It will tell you whether or not you should invest in e.g. creating high-fidelity 3D models or buying new hardware or software (see table 6)

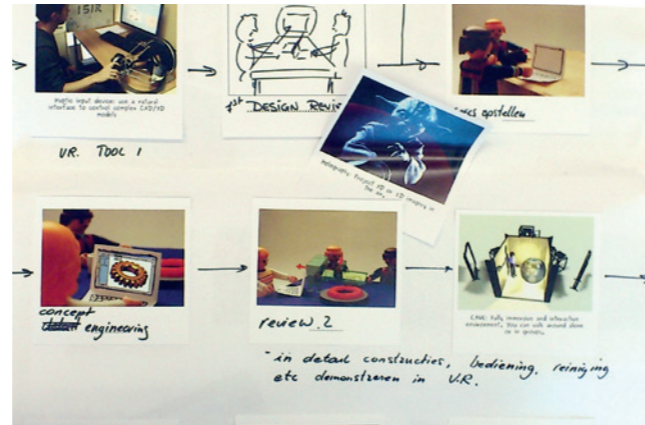
VR Exploration Workshop

The workshop is a three hour session involving a multidisciplinary group of about 10 participants related to the design process of the company, and is structured as follows.

- **Introductory presentation** - This presentation explains the purpose of the session and briefly introduces VR by presenting several examples of technologies.
- **Presentation of example storyboards** - The facilitator presents four animated storyboards that were prepared earlier. The storyboards visualise different applications of VR in the company's design process.
- **Individual storyboard** - After showing the example storyboards, participants are asked to generate their own storyboards by modifying the example storyboards.
- **Group storyboard** - After discussing the individual storyboards, groups of three to four participants are formed based on similarities in storyboard themes. The groups merge their storyboards into a group storyboard.
- **Wrap-up** - During the wrap-up group storyboards are presented to the entire group. The aim of these presentations is to share and discuss the group storyboards, and to reach consensus about which of the group storyboard presents the most interesting storyboard for further development.



Workshop participants creating storyboards



An example of an individual storyboard describing the use of several forms of VR in the design process

Table 3 - The VR exploration workshop

The use of demonstrators is most effective when there is a balance between the investments made to create the demonstrators and the resulting feedback and insights. While the demonstrators need to have sufficient 'depth' to properly experience a specific functionality (e.g. motion tracking), it should be kept in mind that they are still (disposable) demonstrators.

Howto

There are several off the shelf options available for demonstrating specific VR technologies, such as BuildAR for demonstrating augmented reality applications, Microsoft's Kinect SDK (Software Development Kit) for creating gesture recognition applications and the Surface SDK for creating multi-touch applications. These tools typically provide restricted yet user friendly access to the core functions of a specific technology, which makes them quite suitable for developing demonstrators. Furthermore, most SDK's provide a collection of examples that can often be used as a starting point for a more tailored demonstrator.

More advanced development environments and programming interfaces such as Blender, WebGL and Artoolkit provide more versatile platforms for developing demonstrators, but also required additional skills (e.g. programming and/or 3D modelling).

Realisation

The final step of the approach is to select appropriate preparation and execution tools. The selection of preparation and execution tools is affected by several factors

- **Consider your current tool chain**
 - Companies involved in product development often already possess the tools and skills required for the preparation of 3D assets (e.g. CAD software)

- Modern CAD applications also provide support for executing VR applications. Sometimes the functions are built-in (e.g. an interactive walk-through function), while plugins can also help with providing specific functionality (e.g. model annotations)
- If your VR application requires integration with other tools such as simulation software (e.g. Matlab), it is recommended to focus on larger tool suites. These suites generally provide more interfaces to external tools and data formats than smaller task specific tools.
- **Consider your resources**
 - Design and engineering departments use stripped-down versions of CAD models for making quick renders or to share with clients. These "light weight" models can also be used for VR applications (also see table 7).
 - Model repositories such as Google 3d warehouse provide a good source of 3D assets that can be used to support the preparation of the VR applications. The repositories provide generic models such as furniture, vehicles, humans and scenery objects.
- **Consider the desired scope of VR applications**
 - If you only intend to realise a single VR application, task specific tools such as BuildAR or SweetHome3D are sufficiently capable and easy to use without extensive training.
 - Tool suites such as 3DVIA, Blender or NX provide an integrated solution for the preparation and execution of the application, but require more extensive training. They do however support a wider range of VR applications than task specific tools (also see table 8).

Insights from practice

Even without expert guidance or support it is possible to create simple demonstrators or to explore new VR technologies. Throughout the research project, the designers involved in the case studies experimented with various software tools themselves to explore possibilities of VR. Sometimes these experiments were triggered by initial demonstrations shown in the first stages of the project (e.g. one company continued augmented reality experiments using BuildAR), while others were triggered by the case studies.

Table 4 - Creating low-tech demonstrators

Application demonstrators



Several VR application demonstrators were created during the case studies to investigate the effects of various parameters, such as the level of realism or the interaction modality used in the applications, and to assess the added value of the application to the intended User Centred Design activity.

Table 5 - Application demonstrators created during the case studies

Case study examples

The following findings are examples of the results that were obtained by reviewing the application demonstrators with designers.

- Visualisation quality – Detailed models are not always required to give external stakeholders such as end-users an impression of an integrated and realistic product and use context. In early stages of the design process the models should be recognisable rather than realistic.



The Virtual Printshop demonstrator showed low (left) and high (right) levels of visual quality in order to determine how this affects the experience of the virtual environment.

- Interaction modalities – Using motion tracking to control virtual personas (represented by 3D avatars) turned out to be less effective than expected. The designers preferred regular mouse and keyboard controls because it allows for a more detailed control of the avatar's movements.



The demonstrator for the Virtual Persona application showed that designers preferred manual control of the avatars (on the right) instead of motion tracking (on the left).

Table 6 - Application demonstrators can be used to investigate specific application characteristics, such as the required level of realism or the required interaction modality

Insights from practice

In spite of the similarities that the example applications have with traditional CAD applications, it should be noted that there is a difference between VR and CAD, particularly when applying it in the early stages of the design process.

- Detailed CAD models are not required to give external stakeholders an impression of an integrated and realistic product concept and use context. In this early stage of the design process the models should be recognisable rather than realistic.
- When the design process involves platform based or incremental innovation oriented products, it can be useful to use CAD models and CAD software in early stage collaborative design reviews to allow for minor modifications or improvements to the model. However, it is expected to be mainly relevant for internal stakeholders (e.g. engineers) rather than external stakeholders who might lose the 'bigger picture'.

Table 7 - Integration of VR with CAD is feasible but not always necessary

Insights from practice

The use of a versatile VR development environment such as 3DVIA, NX or Blender is not recommended unless there is a definition of one or more VR application(s). Without a clear definition of the application that is to be realised, the number of functions and features these environments offer make it difficult to determine where to start.

Table 8 - Complex tools require a clear application focus

Conclusion

The three case studies presented in this chapter illustrate how VR can facilitate various User Centred Design activities in the early stages of the design process, addressing communication between designers and end-users (for instance by improving the realism of a usability test environment) as well as communication within a design team (for instance by facilitating concept annotation tasks).

Based on the experiences gained during the case studies in which the above applications were developed, it was found that the threshold for the realisation of VR applications can be reduced by

- Using low-end and/or off the shelf VR hardware and software
- Re-using tools and skills already available in the design process

The approach presented in this chapter guides you through the process of identifying advantageous applications of VR in a User Centred Design process, of further specifying this application and with the realisation of the application by selecting appropriate tools. Although the approach typically involves a VR expert to facilitate e.g. workshops or the development of demonstrators, the actual deployment and use of the VR applications during User Centred Design activities does not require external resources.

More information

More information about this research can be found on <http://www.repar-project.com>. This website includes links to the VR application demonstrators that were developed during the project. For additional support or expertise regarding the deployment of VR in your user centred design process, feel free to contact the authors.

THE CO-CONSTRUCTING STORIES METHOD



Jacques Terken



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Introduction

The Co-Constructing Stories (CCS) method aims to collect feedback from end-users on ideas and concepts in the early phases of the design process. The primary goal is to assist the designer(s) in the decision on whether an idea or concept will be useful by people. The method resembles in-depth interviews, in the sense that the designer has a conversation with an end user lasting about 45 minutes to an hour. It differs from interviews in its view on how to facilitate users to give feedback. In interviews the focus is on collecting more general insights about users and use contexts, and on eliciting direct feedback on the concept. In the Co-Constructing Stories method people are first encouraged to talk about their past experiences concerning a particular context or activity. Next, the past experiences serve as a basis for discussing a new concept, again focusing on experiences: the user is invited to imagine future experiences mediated by the concept. This way, the focus is on reflecting on future experiences, and feedback about whether or not the concept is considered valuable is collected in an indirect way.

Motivation

When designing, designers do not only create products or services. They also create a story explaining why this product or service is likely to be useful and valuable for people. The Co-Constructing Stories method is intended to collect information from users, enabling the designer to enrich the story and make it more convincing and credible.

The development of the method was motivated by two observations. First, our previous research pointed out that in the early phases of the design process, designers prefer feedback that is contextualized and grounded in concrete real-life situations. The real-life stories of users are considered valuable, by virtue of being trustworthy, informative and inspiring. Second, when designing, designers need to envision the future context of use, to understand how future use situations will be affected by the concept. Existing methods focus on helping designers to envision future use and on establishing empathy with users. The Co-Constructing Stories method offers designers the possibility to involve users in this process, and helping users to imagine themselves in future use situations and come to a judgement on whether and how the concept may bring added value to their life.

How does it work?

A Co-Constructing Stories session consists of two phases: sensitization and envisioning. (see Fig. 1)

The sensitization phase helps participants to revive their past experiences, making the relevant use situations more concrete, so that in the envisioning phase they can better envision the future. The sensitization phase starts by a sensitizing story presented by the designer. It aims to set the stage for

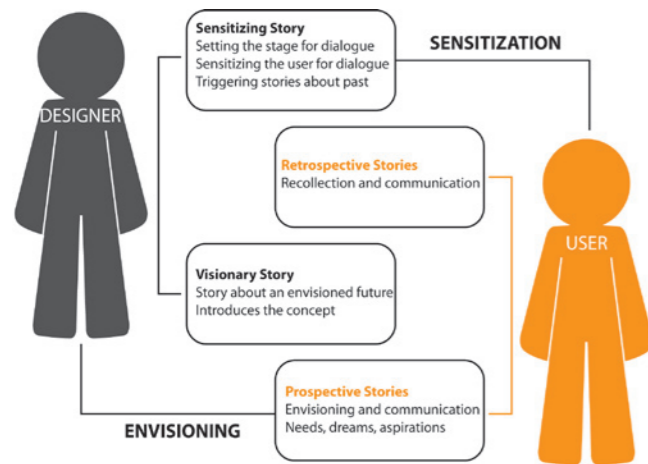


Figure 1 - The protocol of the Co-Constructing Stories Method

dialogue and introduces the context of interest. After the story ends, the designer asks the user whether he recognizes the story, why or why not, and invites him to continue the story by telling about his past experiences. Non-directive questions should encourage the user to tell a few stories about relevant past experiences. Sketches of a relevant context of use are made available to the user to help him organize his thoughts and communicate them to the designer. The sensitization phase should provide user stories revealing past experiences, enriching the designer's understanding of the current context of use.

The second phase starts with the visionary story told by the designer that introduces the concept in an envisioned context. When the story ends the designer elicits first impressions of the user about the concept by asking what the user liked and disliked in the story. Then, the designer asks the user to envision himself as the user of the concept. The user is invited to retell the stories that he told in the sensitizing phase by asking: what would this story be like if you had the concept back then? What would still be the same and what would be different? How would you feel about it? The user is given prompt materials, such as sketching templates, pictures, maps, etc., which help him to communicate the situations he envisions. The designer facilitates this envisioning process with non-directive questions. With these questions, the designer encourages the user to supplement the basic story about the concept with contents representing anticipated future experiences, based on the needs, dreams and aspirations of the user.

Towards the end of the session, participants are invited to compare the current and future situations and to discuss positive and negative points of both situations. The envisioning phase provides the designer with stories containing envisioned experiences that enable him to enrich the story about why the concept will be valuable to people. The whole session lasts about 45 minutes to an hour.

Preparing the Session

Making the aim of the study and the design space it concerns explicit

The first step is to make explicit who are the target end users and what benefits the concept is expected to provide to these users. Also, the designer makes explicit what are relevant use situations for the concept. This results in the initial concept story (or stories).

Preparing Storyboards

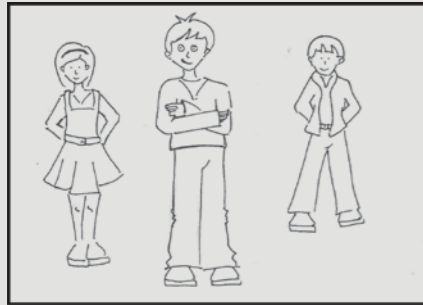
Next the designer starts preparing the materials needed for the session: two storyboards and associated prompt materials (see Fig. 2). One storyboard presents the sensitizing story and aims (1) to set the stage for dialogue, (2) to introduce the context of interest and (3) to elicit past experiences of the participant concerning that context. It presents realistic character(s), situation(s) and experience (s) that the participant can easily identify with. Also, it is open-ended: the participant is asked whether he has been in such a situation and how the story continued in his case; the participant is encouraged to tell his past experiences (see Fig. 3). The second storyboard presents the visionary story. It is a possible continuation of the first storyboard, including the

new concept. It is important that the participant understands the story and empathizes with the presented situation, but he should not be overwhelmed by it: the participant should still feel encouraged to be critical.

The designer should choose a medium which is suited to communicate the storyboards. We recommend presenting them on a screen like a simple flipchart animation, so that the participant is not put under pressure while he is reading the storyboard and the designer is waiting for him to finish. Moreover, looking together at a screen puts the participant and the designer in equal positions. Among REPAR tools idAnimate, represented in the first chapter of this booklet, can be used to create the storyboard.

Preparing Prompt Materials

We found it useful to provide the participants with prompt materials, such as templates for sketching, to be used by the user when he is telling the stories representing past or envisioned experiences (see Fig. 4). The prompt materials appear to help participants to organize their thoughts. Some users find it convenient to use them for clarifying and illustrating their stories by sketching (see Fig. 5). Also, they create a point of attention for gazing, so that the user is not forced to gaze at the designer all the time. The materials should be prepared per case. They can be low-fidelity mock-ups of spaces, blue print maps, pictures, templates for sketching, etc. The prompt materials may help to trigger the imagination of the people.



Jasper is a second year bachelor student in the department of industrial design. This year he chooses a design project about the design of a TV remote control for elderly. He is doing the same design project with his fellow students Esther and Paul.



He has been busy with his design project for three weeks already. He has done lots of research and he has generated some basic ideas but they are far from being concrete. There are only three weeks left for the interim exhibition. In these three weeks he should choose a concept, design it and build a prototype. So he needs to be quick!



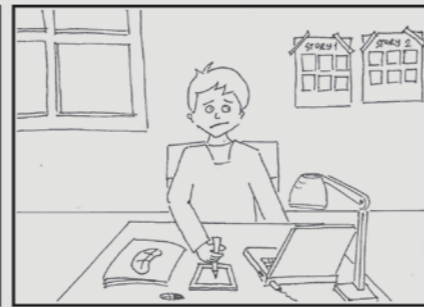
However, he is quite stuck with his concepts. He has three basic concepts and he does not know which direction to go.



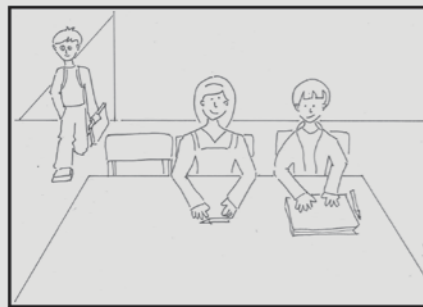
Every time he is intended to detail one of his concepts and build a simple mock-up of it, he is distracted by his other ideas. The more he is circling around his basic concepts the more they start to seem very boring to him.



He is getting extra stressed because tomorrow there is the group meeting. He will be meeting with Esther and Paul and he does not have a concrete concept to show.

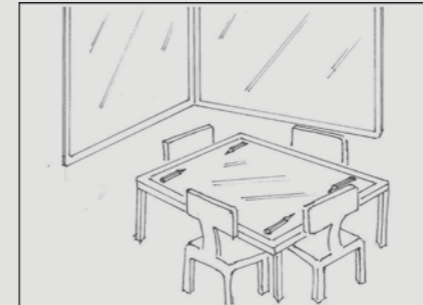


After some thinking, he manages to relieve himself by thinking "We meet to discuss and help each other." He quickly prepares some storyboards and sketches of his concepts to discuss the day after.

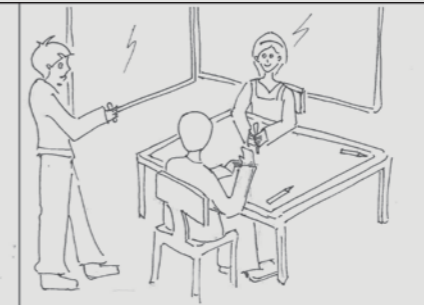


When Jasper arrives to the student space, Esther and Paul are already sitting in a table and waiting for him.

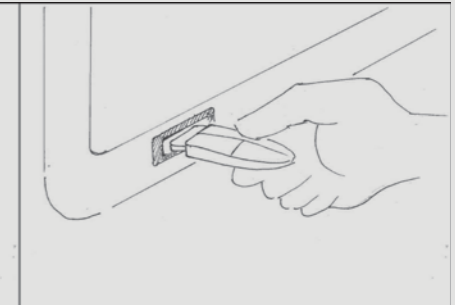
Figure 2 - Impression of a sensitizing story



Jasper put all his drawings in a USB and walked to the meeting room. The meeting room was equipped with a large multi touch table and two interactive wall displays.



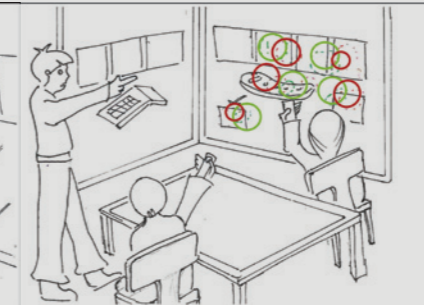
When he arrived, Esther and Paul were already in the meeting room waiting for him. They asked him to start showing his concepts.



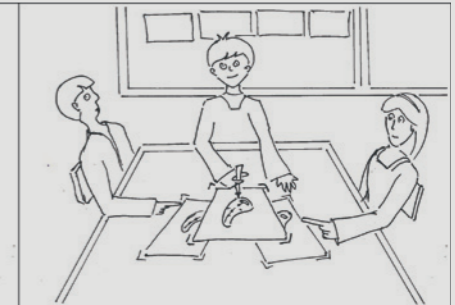
He copied all his storyboards and sketches in the system.



He started presenting his storyboards to the rest. While he is presenting Esther and Paul were marking the things that they liked in the storyboard with a digital, colored marker.



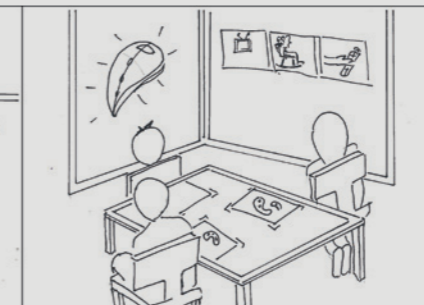
After the storyboards, he presented his concepts. During the presentation Esther and Paul started to make some comments on the concepts. They were marking things on his concepts with digital markers and his drawings were becoming unreadable. Jasper started to get really confused with all the comments and the markings made on his original sketches.



Jasper decided to move the concepts to the multi touch table so that everybody could do his/her drawings. After a quick table discussion both Esther and Paul thought that one of the concepts had more potential than the others. They decided to concentrate on that idea. Jasper, Esther and Paul made their personal copies by double tapping on the original sketches of Jasper.



They started to make individual changes on the original sketches and communicate it with the rest. While they were discussing they were referring to the storyboards which were still on the interactive wall. At the end everybody put their sketches in the middle of the table. Jasper thought some aspects in Esther's sketches and some other aspects in Paul's sketches could contribute to his original idea. He extracted these aspects from the sketches of his friends and combined it with his sketch.



He put his final sketch on the interactive wall. Everybody looked at the final sketch and decided that it is going towards the right direction. Jasper needed to detail it further and made some prototypes. Then it was time for Esther to present her ideas.

Figure 3 - Impression of a visionary story

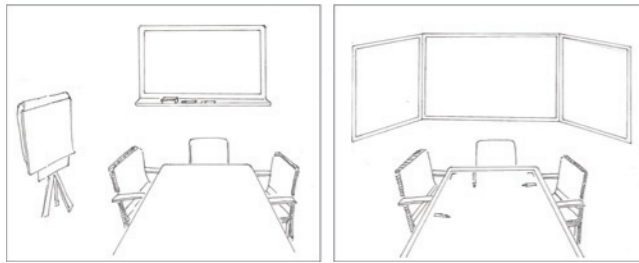


Figure 4 - An impression of sketching templates used as prompt materials. Left for sensitizing phase (current situation). Right for Envisioning phase (Future situation).

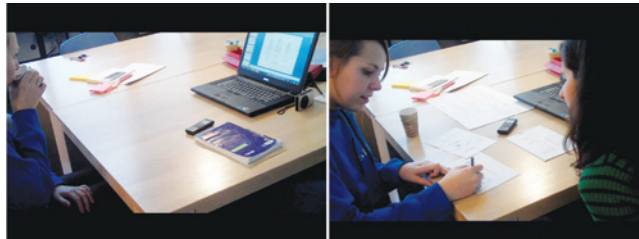


Figure 5 - An impression of the session

Choosing the Setting

Before conducting the session the designer should also decide where he will meet with the participant. He should create a relaxing atmosphere, so that the participant feels comfortable. The designer should also decide how he will capture the sessions. We recommend recording the session with video camera so that the conversation is not interrupted by the need to take notes and so that the visual and gestural information can be captured.

Analyzing the Results

The method elicits stories of past and anticipated future experiences. These stories can be used in different ways depending on the case and the needs and interests of the designer. One possibility is to use the raw materials for inspiration during the further design process. In this case the designer immerses himself in the stories told by the users to gain empathy and get inspired. A second possibility is to use the feedback and suggestions to give direction to concrete design decisions. A third possibility is to use the stories told by the users to learn what matters to users: as the stories are about past (real) and future (envisioned) experiences, they typically provide information about how the concept might give rise to valuable experiences. A structured method to extract this information is to apply thematic analysis. Taylor-Powell and Renner (2003) provide guidelines for conducting thematic analysis: <http://learningstore.uwex.edu/assets/pdfs/g3658-12.pdf>. Thematic analysis requires considerable time, however, and not all designers may want/need to conduct such a thorough analysis. In all cases, the stories told by the users should enable the designer to enrich the concept story.

Reflections

The Co-Constructing Stories method is intended to provide information about whether or not the ideas and concepts emerging from the early stages of the design process may provide value to users in their everyday life. Although the method can be used for improving existing products, we believe that the main added value of the method is to elicit feedback on radically new concepts. It is often argued that end users are poorly equipped to provide meaningful feedback on the value of a radically new product. However, we believe that it is mainly a matter of facilitating users to provide valuable feedback. The Co-Constructing Stories method aims to achieve this by three mechanisms: (1) sensitizing users to the relevant use situations by having them recollect and revive past experiences; (2) using these real-life experiences as a point of departure for reflecting upon future experiences; (3) encouraging the users to present these experiences as stories.

Although the Co-Constructing stories is developed for the early phases of the design process, when there is no detailed concept for evaluation available yet, the procedure may also be used in later phases. The sensitizing phase could still be arranged in the same way, but when more advanced prototypes are available, they could be used for exploration of the concept in the envisioning phase (see the chapter on Virtual Reality).

More information

More information about the Co-Constructing Stories method can be found on <http://www.repar-project.com>. For additional support or expertise regarding the deployment of the method in your user-centred design process, feel free to contact the authors.

APPENDIX 1

Practical Guidelines for applying the Co-Constructing Stories method

The Preparation

While preparing the scenarios, keep in mind that users can comment on any detail you put in the scenarios, thus avoid the details unless user feedback on these details is welcome.

Prepare storyboards such that the users can empathize with the story and be drawn in the story space. Incorporating the known traits and attitudes of the user group and the general emotions associated with the context helps users to empathize with the stories.

Prepare prompt materials such that it is not hard for users to work with them. Playing with loose materials can be easier for people than sketching certain situations.

The Sensitization Phase

After your participant reads/watches the first storyboard you created, ask him if he recognizes the situation and which aspects in the story make the situation recognizable for him.

Elicit concrete real-life experiences. Make him concentrate on specific situations by asking about the last time he experienced such a situation or the first time, or about when he felt most frustrated or happy.

Help your participants explain the situation to you vividly, by asking questions such as where he was, what was the context, whom was he with, what was he doing, why was he so frustrated, why was he happy (and some other details that you might be interested to learn), etc.

Elicit more than one experience. The first experience your participant remembers may not be the most interesting one, as he is also getting used to the process. In addition, talking about one situation may make him remember further situations which might be more interesting for you.

Ask your participants the things he liked and disliked regarding each situation. Elicit his emotions and the underlying reasons for the emotions.

Note the experiences that your participants told you about and also the things he said. You will need this information at the end of the session when comparing the past experiences with envisioned ones. If needed, write down keywords as mnemonics for the experiences, but avoid interrupting the conversation by taking extensive notes.

The Envisioning Phase

After your participant watched the second storyboard, ask him how he found the story. Is it recognizable to him? What does he think about the concept? What does he like about the concept and what not?

Ask your participants to imagine what the situation would look like if he had the concept in the situations he told about in the sensitization phase. Ask how things would be different (for good or bad).

Repeat the situation for every single situation he told you during the first phase.

Note the situations that your participant told you and also the things he said. You will need this information while comparing the past and envisioned experiences. Ask your participant to compare his past and envisioned experiences. Ask him about the things he appreciates in each situation. What are the things he is concerned about or does not like in each situation? What would be the added value of either situation over the other? What are the down sides of each situation if compared to the other? Overall which situation he would prefer and why? Or maybe in which kind of situations would prefer to have the concept and in which situations he would see no value?

If the user produced sketches, you can put the past and envisioned situations next to each other to facilitate the discussion of the past and envisioned situations, as they are placeholders for the stories that your participants told you. If no such materials were produced, you can use your notes to help your participants. You can remind him the things he said like “you also talked about xxx while you were telling this story to me.”

End the session by thanking your participant.

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DESIGN UNITED

Design United 'platform for Dutch Research in Design', is an initiative of the departments of Industrial Design of the three Technical Universities in the Netherlands. This initiative aims to increase the academic power of the field of Industrial Design and strengthen the innovative force of the Dutch industry.

Industrial Design integrates knowledge from different disciplines and puts the user in a central position in the design process. It focuses both on the quality of the interface between user and product, and on the development of more complex systems incorporating multiple products and services. Within the context of increasingly complex societal issues, Industrial Designers have started to play a larger role in innovation processes. This requires knowledge, methodology, tools and new concepts concerning users, technology and business aspects.

By addressing social issues and involving industry in a diversity of projects, design research is better attuned to the needs of existing and future companies. Two-way communication between universities and industry will also strongly contribute to the opening-up of existing and new knowledge and methodologies.



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