Research through provocation: a structured prototyping tool using interaction attributes of time, space and information.

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Abstract: New technologies are bringing unexpected possibilities to improve our daily lives beyond the traditional focus of task efficiency and work environments. Some academics propose that these new technologies generate new types of interactions that go beyond a form of information processing and should be studied as a form of meaning making. This change encourages designers to evolve the role of traditional prototypes that have validated a concept at the final stages of a project to new approaches that use provocative prototypes - termed, "provotypes," that can be used at the beginning of design research to unveil hidden assumptions. We propose a structured way to study these phenomena using three subjective scales to measure interaction attributes represented as continua for time; from scarcity to abundance, space; intimate to public and information; tailored to generic. Three different projects in the fields of health, management and policy engagement are presented to validate the tool.

Keywords: provocation, meaning creation, prototyping, design methods
1. Introduction

The study of time and space has been associated traditionally with the natural sciences and philosophy as anchors for our understanding of reality and the workings of the universe. Some of the more famous theoretical physicists like Einstein and Newton, and philosophers like Kant made their careers by changing the models about how nature operates in terms of time and space (Kronz, 1997). By contrast, people inside newer disciplines such as Design have not yet made deep explorations about these two phenomena. For example, a common concept like time in the study of Human Computer Interaction (HCI) has not received enough attention in design research (Huan & Stolterman, 2011). Therefore, design practitioners rely more commonly on alternative methods to deal with projects related to time and space. However, many of the concepts that we use in design such as user experience, embodiment and situated action are highly related to people’s behavior with time and space as variables. This contrasts with the natural sciences and their standards for objectivity; design methods are more connected to subjective approaches and seek to learn how people understand their reality through experience.

Some academics propose to treat interaction not as a form of information processing but rather as a form of meaning making in which the artifact and its context at all levels are mutually defined and subject to multiple interpretations by the embodied actor (Harrison, Sengers, & Tatar, 2011). Under this change, the role of Design that is introduced at the end of design project to provide affordances for the users, could be reframed more broadly as part of the entire project and with a more participative role of humanizing the technology with a multiple set of theoretical methods and tools.

In a well-cited paper in the design community “When second wave meets third wave challenges” (Bødker, 2006), Bødker presents a future scenario involving technology, moving from the traditional work-task analysis of work related issues to multiple possibilities in our homes and everyday lives (a most appropriate instance for the study of behaviors related to health and wellness). In this sense, the methods of validation such as situated action, distributed cognition and activity theory are still valid and evolving to solve some of the context issues that are important topics of inquiry. However new explorations are emerging to understand more deeply the levels of emotion, culture and experience.

Bødker proposes some changes for the communities that are interested in this third wave, which advocates changing prototyping beyond the operational interaction and further exploring a controlled process of reflexivity that includes studies of tailored and integrated situations from multiple areas of life. In this sense, other authors are exploring frameworks and strategies for this change. In the article “a practical framework for supporting third wave Interaction,” Odom states that meaning emerges in the dynamic interplay between reflection and concrete interaction that could be mediated by artifacts (Odom & Lim, n.d.).

2. Design as a facilitator of meaning creation

Meaning has an important role for design; some authors relate this idea as the main responsibility for designers and their effort about understanding how people make sense of products and services. The need to have some mediation and understanding between how people create meaning and the design possibilities has different forms. About this mediation Paul Dourish presents the concept of coupling defined as “…an Intentional connection that arises during interaction, so while designers might suggest a coupling, they cannot actually make one. Only the user can do that, because coupling only happens in use.” (Dourish, 2004, p. 172)

Another approach about how people create meaning is in the concept of interpreters (ex: design
consultancies) as an intermediary about how people can give meaning to things or situations, some of them based in possible scenarios that never occur. (Verganti, 2009, p. 11) In this concept, some companies study how the context in which people live is evolving using two perspectives, first the cultural factor, why people buy things. Second the technical view, how technology shapes the context and how people at the end, don’t buy products but buy meaning.

Other perspective about meaning could be understood from the categories of tacit knowledge proposed by Polanyi: Functional, phenomenal and semantic. In these categories, the perceptual stage (being aware of something) is the first step to begin an interaction but just after we connect this process with our own understanding of the situation we create meaning by adding a new category called the ontological aspect. As the notion of tacit knowledge implies, this type of information is highly subjective and involves the experience of people in specific situations.

For all three authors, meaning arises from:

1. The possibility of people interacting under the constraints of time and space.
2. The role of perception as a trigger to create meaning.
3. The connection with pre-established cultural values to add meaning to a situation.

If the possibility to create meaning happens when one interacts under the constraints of time and space through not only pre-established archetypes of information but through the provocation of new experiences that are not yet available then it opens the possibility to alternative ways of provocation.

3. Provocation in Design

Provocation in Design advocates the use of prototypes to study a reflexivity process experienced by the user. However, using early low fidelity prototypes to encourage user participation present new possibilities and should be explained. While traditional prototypes are created to validate a concept at the final stages of a project, new approaches to prototyping suggest that provocative prototypes (termed, "provotypes") non finito products (Seok, Woo, & Lim, 2014), critical design (Bardzell, Bardzell, Forlizzi, Zimmerman, & Antanitis, 2012) and ethnography as design provocation (Buur & Sitorus, 2007) can be used at the beginning of design research as a method of provocation, to understand interactions, constraints, and activities as described by the user. Early low fidelity prototyping combine the power of traditional prototyping (Boer & Donovan, 2012) with participatory design methodology (Dourish, 2004). This method is appropriate to unveil assumptions taken for granted at the beginning of the project.

4. Interaction Variables

We propose building on the concept of early prototyping by examining pre-defined elements that can facilitate a structured approach. Of interest is the work of Youn-kyung Lim entitled “Interaction Gestalt and the Design of Aesthetic Interactions” (Lim, Stolterman, Jung, & Donaldson, 2007) that presents a set of interaction attributes based in three key elements of interaction: time, space and information.
4.1 Time

A traditional overview of time from natural sciences is often described as a duality between two notions: a reversible, homogeneous parameter time (Relativity Theory and Quantum Mechanics) and an irreversible, directed time (Thermodynamics). Both concepts differ on what we define implicitly as the past and the future and especially on the concept of now (Franck, 1994). Even for Einstein the concept of now was just an illusion that was real for its possessor or the mind possessed by it. Some measurements rely on the notion of now as the moment that we feel a specific sensation, lasting as long 30 milliseconds, but this is merely a simplified way to understand the present framed in terms of our limited senses.

To frame the study of time in a more holistic way, an interdisciplinary approach is provided in the collection of essays in *Time, Temporality, Now. Experiencing time and concepts of time in an interdisciplinary perspective* particularly the chapter entitled *Theory and Experience of Time: philosophical aspects* from Frederick Kronz. In this essay the author makes an overview of six different major figures: Aristotle, Newton, Leibniz, Hume, Kant and Mach to show a variety of perspectives based in the breadth and depth of their points of view (Kronz, 1997).

The review begins with the initial notions of time in the ancient periods before the philosophical thinkers with the humanization of time as Chronos (substitution of Kronos father of Zeus). This perception was gradually changed to a more mathematical understanding of time. The most important vision of this period were the studies of Aristotle that presented rational thinking in three types of cases: empirical, ontological and mathematical. This philosophy was the predominant system for centuries; Galileo and Descartes presented some alternatives but Newton was the first that made an explicit contribution to the perception of time as an empiricist. His perspective includes the notion of absolute time (mathematical) and relational time (empirical). In contrast Leibniz, contemporary of Newton, maintained a closer connection with the Aristotle tradition connecting time and motion but also including the notion of perception.

The Newtonian understanding of time was the prevalent mindset for the 18th century; empiricism was the predominant philosophy at that moment. In contrast, David Hume contributed to our understanding of time embracing a more subjective point of view without trying to explain the experience of time as an objective truth. This would be emphasized by Kant presenting the duality of time as a subjective intuition but at the same time as a *priori* event making arithmetic knowledge possible by the chance of counting. Finally, Mach presented a clear distinction between two types of time, the physiological time, including phenomenological characterization, evolutionary-biological accounts and psychochemical conjectures, and physical time.

According to more scholarly perspectives about the study of society related to time, the perspective of a cyclical society with seasonal rhythms was replaced with linear systems that are associated with the invention of the clock. Recent views explain how people experience time in different ways, however the way we organized time depends in different modalities that are both culturally and idiosyncratically determined. Moreover, the neoliberal perspective of production related to time – efficiency can create an agency “time is also, as Das remind us, a matter of how we experience the world as having an impact on us. To extent that time is conceptualized as an agentive force, it limits our ability to play with, and deform, conventions.” (Herzfeld, 2009)

Another point of view from the relation between time and space can be made from the influence that media and communication technologies play a role in changing the conceptions of time and space or at least in the subjective experience of them (Tsatsou, 2009) and could be considered to mediate, creating a multilayered significance of how these two concepts are experienced today, moving from the objective view of time to a complex perception of *internet of time*. 
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Under this review we can understand the evolution about the notion of time from objective perspectives like time as “Truth”, returning to more subjective approaches that includes a multidimensional experience of time for each person and even recognizing how time can play a role in society with agency or as a mediator of our experiences with technology.

Today different subjective ways to measure time include phenomenological perspectives (Varela, 2009), satisfaction over pragmatic aspects (Karapanos, Hassenzahi, & Martens, 2008) among others. Special interest is the idea of scarcity of time (Shah, Mullainathan, & Shafir, 2012) when a continua is presented from the perception of lack of time to abundance.

4.2 Space

The study of time is related with space in a way that some philosophers and scientists cannot separate the two concepts. To experience space, it is necessary to have time and vice versa. However, the tradition in Design is to have professional roles that emphasize the study of space from different perspectives, from the conventional graphic user interface to new approaches that rely in the study of space through the embodiment of technology.

A traditional perspective about the use of space in graphic user interfaces is shown by the classic WIMP interface (WIMP: Windows, icons, menu and pointers) where the screen can be classified according to users’ space management styles and relationship to window space types: Maximizers maximize all windows, near maximizers use multiple windows but save space for one or two small windows usually for instant message or computer status indicator, and careful coordinators employ multiple windows where none of them are maximized. (Hutchings & Stasko, 2004).

In the other extreme we can study how the space around people can react and provide information tailored to the location and user profile, a location based scenario that can provide specific types of interaction. This approach would benefit people that are not familiar with a space providing a sense of freedom and an immersive experience between physical and digital environments (Mokey, Nalbandian, & Keefe, 2013).

The new possibilities beyond the tradition of desktop interaction and post-pc era open the options to new technologies like touch, gesture-based, physical and bodily-based interaction (Benyon, Hook, & Nigay, 2010). These new technologies are fundamentally embodied and can be divided into information spaces, interaction trajectories, and navigation information. The intersection of these concepts generates the term “navigation of information space”.

Other categories that focus the attention in tangible interaction are tangible manipulation, spatial interaction, embodied facilitation and expressive representation. The category directly related to space (spatial interaction) has the next themes: Inhabited space, configurable materials, non-fragmented visibility, full body interaction and performative action. (Hornecker & Buur, 2006).

A more classic perspective that involves the complexity of multimedia design presents four different categories of space: physical space, perceptual space, conceptual space and behavioral space (Trumbo, 1997). Four categories of reality-based interaction (RBI): naïve physics, bodily awareness and skills, environment awareness and skills, social awareness and skills (Jacob et al., 2008)

As we discussed early in the paper, the notion of time and space are highly linked, and the perspective about space influenced by media and communication technologies can change the
perception of space, creating electronic spaces with different meaning and different notions of place (Tsatsou, 2009)

The most recent approach is the concept of proxemics interactions (Porcheron et al., 2016) that study how space influences social interactions including cultural factors (using ethnographic methods) to generate deep insights about relevant experiences including individual users or groups of people, proposing a continua from intimate use of space (portable personal devices) to public (large digital surfaces).

An attempt to organize these different perspectives is shown in Figure 1. The authors, when arranged chronologically, reveal the change from studying UGI and media possibilities to more complex concerns about how new technologies are blurring the boundaries of digital and real, allowing new experiences that are mediated by how people and technology interact in relations with the space.

4.3 Information

Information is a broad topic of study. While some of the traditions in design rely on the study of visualizations and how people interact with information, there is a lack of theories of interaction for visual analytics that just show the possibilities that are still open for exploration (Mcewan, Igoniderigha, & Benyon, 2014)

Interaction models and mental images cannot be separated in the analysis or evaluation of a solution since both are part of the information visualization experience. Based on this, there is no right or wrong use of mental images because people make sense of them only when they interact with the information. The way to have a complete understanding and evaluation of information visualizations
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is to study the whole experience and capture data beyond the tradition of just time. This implies moving to a more holistic perspective of capturing the use of physical activities (Faisal, Cairns, & Blandford, 2007).

The field of information architecture is not unaware of the changes that are happening with the arrival of new technologies and interactions that are reshaping the traditions of information architectures. The possibilities of including a holistic approach to design digital – physical human information interactions in the way of ubiquitous ecologies create new possibilities. Resmini and Rosati propose a manifesto with seven points to deal with this change: from information architectures becoming ecosystems to experiences becoming cross-media experiences. (Resmini & Rosati, 2009). A subjective approach about how information is selected, processed and delivered is the use of the continua (tailored to generic) (White, Clark, & Moore, 2010) common in conversation models and intonation.

5. A new framework, Time Space and Information in a new perspective

Combining research from previously mentioned scholars describing how time, space, and information relate to GUI, embodied interaction, and meaning creation we can add new intersections between the variables.

The complexity of this type of prototyping (including the option of early provocations – provotyping) under the possibility to facilitate meaning creation by people needs subjective scales to measure interaction attributes. From the section before we used the subjective scales for time (from scarcity to abundance), space (intimate to public) and information (tailored to...
Mapping how people experience technology under this scheme provides a way to control the process of prototyping and decide what attributes the designer should change to provoke controlled experiences.

Using the continua presented for each interaction attribute, a structured controlled reflexivity prototyping involves four steps:

1. Mapping the most common interaction that is present in the context (this will work as a control group).
2. Select the parameters in the scale that cannot be change in the project and will affect the other variables.
3. Generate low fidelity prototyping in the attributes that can be change, the more extreme the change the more chance to provoke and unveil hidden assumptions (Provotype – Experiment)
4. Guide the prototyping process with the findings (Final prototype)
6. Case studies

6.1 Visual workflows for design project knowledge management

This project explores an interactive prototype to generate a digital learning knowledge management tool that uses an interactive surface to manipulate a design project in multiple stages. The research aim was to understand how designers might replace the traditional model of one device per person and use digital space as an alternative for analysing data collaboratively. (Rivera, Abouhazim, Mattis, Ruecker, & Wang, 2014)

6.2 Bridging the communication gap, a new touchpoint for pediatric asthma education in emergency departments

This design service addresses the communication of complex discharge instructions to pediatric asthma patients and their families in the emergency room following an asthma attack. Asthma is a deadly condition—disproportionately so in minority populations. The ER discharge experience and accompanying patient education tools are critical to the child’s well-being. (Erwin et al., 2016).
6.3 Skywords: an engagement machine at Chicago City Hall

When governments enact new policies they often have limited methods for engaging the public and gathering opinions. As a result, policy-making is not always inclusive and too often important decisions are made by just a few. SkyWords is a site-specific installation or “civic engagement machine” — that addressed this problem head on. Installed on the ground floor of Chicago City Hall for ten days, SkyWords leveraged technology, interaction design and the universal appeal of play to give hundreds of people the opportunity to participate in government. (Braun et al., 2013) The final installation allowed participants to play a game (inflate and destroy balloons) through answering questions about the cultural preferences for the city.
7. Discussion

With the development of new technologies and the possibilities of the internet of things where information can be available in multiple devices and environments, we need new methods that can go beyond the tradition of understanding the current situation, where most of the research resources are spent designing prototypes that fit the current behaviors. Provocation will play an increasing important role to keep the pace of design and collect behavioral information from people exploring new technologies in the early stages of the design project.

The prototyping tool presented has been developed using the literature review discussed in the first section of this paper and applying some of these models to the projects presented, in an iterative process until the scale fit the interaction attributes of each project. The tool is still under construction and will change in the way that some projects do not fit and will require new continua to fit their constraints.

The concept of provotype is not new in the field of design, however until now there is not a structured method to guide the process about how to provoke using new technologies, the tool presented is an attempt to provide a starting point in the project when there is still time to reframe and redirect the project using information from participatory methods. The tool can be used to understand different cultures based in their values associated to the subjective experience of the interaction variables presented.

Initial insights from the tool show how under the perception of scarcity of time that generic information is more useful. In contrast, with abundance of time then tailored information from a specific user is easy to digest since it requires more cognition to make sense. An exception of the latter case is when you carry the information all the time with you like a wearable device.

Creating scales to measure interaction from a subjective perspective can open the possibilities to include quantitative analysis, the next steps in the use of this scale is to correlate the interaction attributes variables with models of cognitive science for behavior change. The result of connecting the variables can provide better strategies about how can we design technologies to facilitate positive behavior change.

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