

Selected Readings

of the 7th Information Design International Conference

Edited by
Virgínia T. Souto
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The Brazilian Society
of Information Design

Selected Readings
of the 7th Information Design
International Conference

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Virgínia Tiradentes Souto, Carla Galvão Spinillo,
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Foreword

Information Design is a discipline that converges different areas, such as art, education and technology. This may be one of the reasons why the CIDI 2015 - 7th Information Design International Conference - attracted over 4000 people (among registered participants and general public) for the four days of the event held in Brasilia in September of 2015. This book brings together a selection of papers that illustrate some of the research topics discussed at the conference.

The Selected Readings book is composed of twelve chapters by three keynote speakers and the presenters at the conference. Papers that were originally published at the Proceedings of the 7th Information Design International Conference (Editora Blucher, 2015) were adapted for publication in this book. It is mainly intended to support an academic audience (e.g. lecturers, researchers, and graduate and postgraduate students). The chapters are gathered into three main themes: “Digital media design”, “Design education”, and “Methods, theories and new design approaches”.

The initial section concerns digital media design. Chapter 1, “Understanding animated and interactive journalistic health infographics”, by Rafael Andrade and Carla Spinillo, investigates the effects of animation, interaction and text display mode on understanding health infographics in online journalism vehicles. The empirical research observed five experimental conditions, involving 50 participants, and took into account both the graphics and informational aspects of the content. The second chapter of this section is entitled “Social interaction guidelines for Brazilian digital television: the example of “Tererês” TV program” and is authored by Taygoara Sousa and Paulo Souza. They investigate social interaction guidelines within the Brazilian model of TV and, as a result, they present a model of organizing and projecting design interfaces for digital TV. “Doulas, mothers, and cell phones: Storytelling and a supportive doula approach for mothers at risk for postpartum depression”, Chapter 3, by Judith Moldenhauer et al., explores the use of a cell phone app with a focus on storytelling. In particular, they investigate the use of a cell phone application developed in the USA for postpartum doulas to help mothers identify postpartum depression symptoms and how this app could be adapted for use in developing countries. Chapter 4, “Design and interactive bilingual literature”, by Rita Couto et al. concludes this first section; it describes the design process of an interactive book in bilingual digital format with a focus on deaf children. Their investigation encompasses relationships between Design, Education and Technology.

The chapters concerning design education were gathered together in Section 2. “Pictograms in teaching drawing to the visually impaired: a case study of a teenager’s drawing of a bird”, Chapter 5, by Mari Piekas, investigates teaching drawing to visually impaired children and teenagers. She proposes a method for teaching drawing from Pictographic vocabulary. “Collaborative learning process through co-creation of graphic representations for synthesis (GRS)”. Chapter 6, by Juliana Bueno and Stephanie Padovani, investigates learning in theoretical classes in Design post-graduation.

They present a study on the production process of GRS developed collaboratively by students during the classes of User-Centered Design in a Brazilian postgraduate course. Chapter 7, “Pioneering disciplines of History of Design in Brazil: the place of graphic design”, by the keynote speaker Marcos Braga, reviews the first disciplines that dealt with the history of design in undergraduate design courses in Brazil. He also shows an analysis of the place of the history of graphic design within these courses. The final chapter of this section, Chapter 8, is entitled “From Mapping to Data Visualisation: Re-evaluating Design Education at the Royal College of Art” and is authored by the keynote speaker Teal Triggs. She explores some of the key themes related to design education and its future, and how people are engaging with new ways of thinking about design education. She carried out these explorations through examples from MA and PhD students of the RCA’s School of Communication.

The last section is about methods, theories and new information design approaches. The first chapter of this section, Chapter 9, is entitled “Semiotics and information design. <metabolisme. design> an interactive tool for designers”, and is authored by the keynote speaker Bernard Darras. He presents a semiotic tool, called Metabolisme, which is “intended to accompany the follow-up of changing distributed meaning”. He also discusses the impact of information design on the development of this tool. Chapter 10, “Methods and practices of Brazilian designers on digital projects” by Paula Farias and Virginia Souto, investigates methods and practices of design processes in digital projects used by designers in Brazil. They present a study on design processes and methodologies, a survey with Brazilian designers of digital projects, and discuss design processes and methodologies used by them. “Basic ID-theories”, Chapter 11, by Rune Pettersson, presents seven theories applied to information design. The author classifies design into six families and presents many important information design definitions. He also explains that only one of the seven theories is considered internal (i.e. based on research within information design). The final chapter of this book is “Using new media art and multisensory design for information and data representation”, Chapter 12, and is authored by Patricia Search. She presents a study on multisensory design elements that augment traditional approaches to information design. Her chapter includes visual design examples from an interactive art project that illustrate “how new media design and multisensory information can create engaging experiences that expand our perception of multimedia and spatiotemporal relationships”.

We hope you have pleasant reading and can feel a bit of the experience of the 7th Information Design International Conference. Other papers from the conference are online available at <http://www.proceedings.blucher.com.br/article-list/cidi2015-255/list/#articles>.

Brasília, April 2016
The editors

Jury procedure for selecting the papers

The selection procedure for this publication was conducted by a jury composed of the editors of this book, with the mission of ensuring the quality of the publication.

The process started with the designation of the papers that gained the highest scores from the referees of the 7th Information Design International Conference. Then the editors who were to make the final choice of papers reviewed the material. As a result, 9 out of 132 papers approved for presentation at the conference were selected for this publication, together with those by three out of the four keynote speakers, Bernard Darras, Marcos Braga and Teal Triggs.

Editorial acknowledgments

We would like to express our thanks to the authors for their contributions, to the referees of the 7th Information Design International Conference, to the people who helped in the organization of the Conference and of this book, and also to the sponsors of the Conference, specially to The Brazilian Society of Information Design - SBDI, University of Brasilia - UnB, Coordination for the Improvement of Higher Education Personnel - CAPES, National Council for Scientific and Technological Development - CNPq and Research Support Foundation of the Federal District - FAP-DF. Special thanks to CNPq for sponsoring this book.

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Section 1

Digital media design

Chapter 1

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Chapter 1

Understanding animated and interactive journalistic health infographics

Rafael de Castro Andrade, Carla Galvão Spinillo

keywords: infographics, understanding, experiment, health

This paper presents an experimental study to evaluate the effects of animation, interaction and text display mode in understanding health infographics in online journalism vehicles. Five experimental conditions were observed: 1) Interactive Animated (IA); 2) Animated (A); 3) Animated with narration (AN); 4) Animated with narration without text (ANWT) and 5) Static Interactive (SI). The experiment was split in two stages: In the first stage, participants were invited to observe an infographic and in the second to answer questions about the content. Fifty adult participants (over 18) were voluntarily recruited and distributed in five groups of ten, which observed/interacted with a version of the infographic. The results were analyzed qualitatively and have indicated that the way animation and interaction were used together did not benefit understanding and did not promote the content properly.

1 Introduction

Informational Graphics, or Infographics, is a form of representing information, widely used in news media such as newspapers, magazines and websites. Characterized by the relationship between image and text (DE PABLOS, 1999; LIMA, 2009; TEIXEIRA, 2010), information disposed in layers (SANCHO, 2001; FASSINA, 2011; MIRANDA, 2013) and diagrammatic layout, infographics generally allows a non-linear reading (LIMA et al., 2014). Infographics have been used in journalism since the fourteenth century (PELTZER, 1991; SANCHO, 2001), but became popular in the late 1980's. From a technological perspective, Moraes (1998) holds that the modernization brought about by the introduction of computers in newsrooms and print-shops in the late 1980s brought infographics to public knowledge. At the beginning of the 2000's, with the spread of internet use and with emerging of news websites, online infographics became popular (RIBAS, 2005; SCHMITT, 2006; RODRIGUES, 2009; AMARAL, 2010).

Annually, the Presidency's Secretariat of Social Communication discloses the Brazilian Media Research, and over the years it has been possible to observe a gradual growth in information consumption in online vehicles. In 2015 about 14% of the consulted population consumed information via online newspapers. The easy access to the news, made possible by internet, is an interesting way to communicate certain content, such as health, which is of public interest. However, this issue also requires greater attention to the content. An inefficient communication about health can lead to a misunderstanding and affect the welfare of individuals. For example, it may induce self-medication and even generate unnecessary concern in the population (CASTIEL, 2003; RANGEL, 2003; LUIZ, 2007).

On the other hand, it is common to observe online vehicles using animated and interactive infographics in their health sections in order to make more attractive and interesting explanations of medical procedures, like stages of diseases, functioning of the body and others. The animation and interaction are common features of digital media and authors like Tversky et al. (2002) and Betrancourt (2005) indicate that this could promote a better understanding of information. Nonetheless, some studies like Spinillo et al. (2010), suggest that the initial notion, which considered these resources more efficient and beneficial to understanding, could be wrong, especially if they do not consider aspects of the graphic representation of information. For example, the way that the information is represented in an animation can influence and compromise a satisfactory understanding of the material.

Materials using text and image combined with animated and interactive features are objects of study in educational psychology, which observes the cognitive process in order to formulate strategies to promote more effective learning. In this context, the studies of the North American psychologist Richard E. Mayer contributed to the area with the Cognitive Theory of Multimedia Learning (CTML). This theory lists principles that look to reduce the cognitive effort and promote a higher level of understanding of educational material. One way for this is a better use of input channels to receive verbal information, giving preference for narrations rather than written text.

Based on this assumption, this paper presents an experiment where the influence of interaction, animation and presentation of the text in understanding health news infographics was observed, taking into account graphic and informational aspects of the content.

2 Research Methods

The study takes an experimental approach, involving handling of interaction, animation and text display mode was also included because it is a recurring point in CTML. For Mayer (2005), there is deeper learning when using animations together with narration, even when compared with the use of animation and text on screen (i.e. Modality Principle) or with the use of animation, screen text and simultaneous narration (i.e. Redundancy Principle).

Manipulation generated five experimental conditions: interactive animated (IA); animated (A); animated, narrated and with supporting text (AN); animated, narrated without supporting text (ANWT) and static interactive (SI). In the conditions IA, A and IS the presence/absence of animation and interaction were controlled. In AN and ANWT the presentation of the infographic supporting text was controlled.

Finally, to evaluate the effects of interaction, animation and understanding in the text display mode an interview was carried out guided by a questionnaire.

Participants

Fifty (50) participants were recruited voluntarily via internet (social networks) and banners displayed in the Design Department of the Federal University of Parana. The participants who applied were: twenty-three (n = 23) female and twenty-seven male (n = 27). Most participants (n = 40) were in the range of 18-25 years. Thirty-nine had not completed higher education (n = 39) and eleven had completed higher education (n = 11).

Tested Materials

To meet each of the experimental conditions, five versions of an infographic were developed, based on the infographic “*Os efeitos da Sibutramina no organismo* (The effects of sibutramine)” (Figure 1)

published in *Zero Hora* newspaper's website. This infographic was chosen because it is representative of a sample from a graphical analysis in a previous work (ANDRADE & SPINILLO, 2013). This infographic seeks to explain the action, effects and restrictions of sibutramine, a controlled drug used in the treatment of obesity.

Figure 1: Infographic “Os efeitos da Sibutramina no organismo (The effects of sibutramine on the body)” extracted from Zero Hora newspaper. Source: [http://zerohora.clicrbs.com.br/rs/vida-e-estilo/bem-est](http://zerohora.clicrbs.com.br/rs/vida-e-estilo/bem-estar/infografico/os-efeitos-da-sibutramina-no-organismo-35311.html)



To adjust the infographic to experimental conditions some interventions were made in each of the versions of the infographic, such as inserting title and subtitle, and depending on the version, some text and unnecessary interface elements were hidden (e.g. semantic markers and interaction of objects in the animated version, which did not allow interaction).

The infographic after the adaptations can be seen in Figure 2 and was composed as follows: a brief introduction to the drug and four stages, the first (1) locates the reader in the human body where the drug acts; (2) shows the relation of substances and neurons without the drug; (3) shows the changes in the system with the use of sibutramine and (4) concludes the explanation showing the sensations that are extended with the drug.

Figure 2: Infographic “Os efeitos da sibutramina (The effects of sibutramine)” adapted for the experiment



Information Content

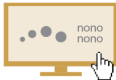
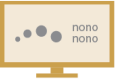
The infographic shows that when a person ingests food the hypothalamus region is activated, where neurotransmitters responsible for controlling appetite and satiety are captured by neurons. If more neurotransmitters are available in body, the feeling of hunger is lower and the satiety is higher. As these neurotransmitters are absorbed by neurons their levels are reduced and the person feels hungry. In this case, sibutramine acts on neurons as a blockade, preventing the reception of the neurotransmitters, leaving the substances for longer in the body. Thus, it decreases the feeling of hunger and prolongs the feeling of satiety.

For each experimental condition a version of the infographic was derived as detailed below:

- **Interactive Animated** – Original characteristics were maintained;
- **Animated** – Original was converted into a video and interaction objects (arrows) were omitted. As a criterion of time for advancement to next stage, a slow time for reading the texts and observing the animation was considered. The same time of reading was used in narrated versions;
- **Animated with Narration** – Original was converted into a video, interaction objects (arrows) were omitted and narration was added with the reading of the text present in the infographic;
- **Animated Narrated Without Text** – Original was converted into a video, interaction objects (arrows) were omitted and the text was substituted by the narration;
- **Static Interactive** – The basic operation of the original infographic remained, but animations were removed, leaving only significant moments;

In Table 1 the differences between each version are shown. In the first column elements and variations are shown. In other columns the infographic versions are shown and in each line the element present in the release is identified.

Table 1: Characteristics of each version of infographic

	IA  Interactive Animated	A  Animated	AN  Animated with Narration	ANWT  Animated Narrated without Text	SI  Static Interactive
Animations	•	•	•	•	
Interactive Objects	•				•
Narration			•	•	
Support text	•	•	•		•
Subtitles	•	•	•	•	•

Interview Protocol

For the interview a protocol was used, composed of twelve questions. The protocol was organized in three parts: 1) information gender, age and education of participants; 2) number of visualizations of the infographic and spontaneous participant demonstrations during the visualization, following the model proposed by Tulis and Albert (2008); and 3) questions about infographic understanding, covering content, suggestions, difficulties and ease of dealing with the material.

Procedures

The participants were randomly grouped in five groups of 10. Each group viewed a version of the infographic. Before the experiment, the participants were asked if they knew the action of the drug (sibutramine). If the answer was negative, the participant was considered able. So, an appointment for the experiment was scheduled, which was conducted individually.

On the day of the experiment, the participant was oriented about the two steps of the procedure, the visualization of infographic and the interview. The participants were also reminded that the questions didn't seek to evaluate intellectual and cognitive skills, but the informational characteristics of the infographic.

After the explanation, the free and informed consent form was presented for signature if the participant agreed with the conditions. The term is a document required by the UFPR Research Ethics Committee, which approved this experiment. Both steps were recorded and participants could revisit the infographic any time they wanted, even during the interview, in order to minimize possible interference of memory in the responses.

Results Analysis

The results obtained in the experiment were analyzed qualitatively, considering the context, terms, frequency and particularity of the answers. The numerical data were also taken into account only to identify trends or patterns in the responses.

Closed questions were tabulated by frequency of answers. Open questions and opinions expressed by the participants on other issues were grouped by affinity and relevance to the discussion.

Answers related to questions about understanding were classified as understood (U); partially understood (PU); not understood or inadequate response (NU/IR), and in cases where the participant did not answer a question, the response was labeled "no response" (NR). This classification model has been used in previous research involving pictorial comprehension tests (MAIA, 2008; SPINILLO et al., 2010). The response taken as correct (U) should mention sibutramine acting in the body, blocking the uptake of neurotransmitters, leaving these for a longer time in the body, which reduces the feeling of hunger and extends the sensation of satiety.

3 Results: Presentation and Discussion

Overall, the results showed a good level of understanding (Table 2). Combining all responses, those which presented with some level of understanding (U and PU) got 294 points out of the total of 350. Most participants viewed the infographic twice ($n = 26$).

When asked about possible difficulties of the public with the infographic, participants felt that the public would have an average difficulty to understand the infographic ($n = 25$), although most of the participants considered the infographic easy to understand ($n = 34$). In the first questions, the participants commented that the terms and health contents are complicated and could hinder the public's understanding.

For questions that evaluated understanding, 347 answers were obtained in total. The majority of responses were classified as understood ($n = 219$), followed by partially understood ($n = 75$) and not understood or gave inadequate response ($n = 53$).

Comparing the results between the groups, it is possible to identify a little variation in responses. However, when considering the responses classified as (U) and (PU), the group that viewed the Animated infographic (A) had the best performance, with the highest number of responses with some understanding ($n = 63$) and fewer with no understanding ($n = 7$). On the other hand, the

group that viewed the Interactive Animated (IA) infographic had the lowest number of responses with some understanding between U and PU ($n = 54$).

Table 2: Overall results

	Visualization average	U	PU	NU/IR	NR
Interactive Animated (IA)	2 times	40	14	16	0
Animated (A)	2 to 3 times	46	17	7	0
Animated with Narration (AN)	2 to 3 times	44	18	7	1
Animated, Narrated Without Text (ANWT)	2 times	43	13	12	2
Static Interactive (SI)	1 to 2 times	46	13	11	0
	TOTAL	219	75	53	3

When asked about difficulty, ease and suggestions, the perceptions of participants mostly had something related with steps 2 and 3 (Figure 3), which shows the functioning of the body with and without sibutramine. Step 2 shows the normal body function without sibutramine. In this step neurotransmitters are recaptured by neurons in two centers, satiety and hunger. Step 3 shows the action of sibutramine in each center.

Figure 3: Steps 2 and 3: explanation of normal body function and under effect of sibutramine



Thus, difficulties have been indicated relating to an excessive number of explanations in these steps ($n = 25$). The most common suggestions were to split the infographic into more steps ($n = 10$), which, according to participants, gives the chance to pay more attention to each explanation.

However, despite difficulties the points cited as facilitators of understanding were explanations in steps 2 and 3 ($n = 15$), especially for the comparison that can be made between the operation of the body with and without the drug.

3.1 Animation and Interaction

The results of varying presence/absence of animation and interaction in versions A, IA and SI indicated a higher level of understanding in the group that viewed the animated version (A) and a lower level of understanding in the group that viewed the interactive animated version (IA), where the animation and interaction were used together.

The animated version (A) showed 63 answers classified with some level of understanding, in other words, between U and PU, and 7 were classified as not understood. In the version where the animation was omitted, static interactive (SI), 59 responses were classified with some level of understanding and 11 were considered as not understood. Finally, the version that shows simultaneously Interaction and Animation (IA), got 54 answers with some level of understanding and 16 answers for not understood.

As regards the number of visualizations, versions which had interaction (IA and SI) had a lower number of views. These were between one and two times for static interactive (SI), and twice for interactive animated (IA).

Table 3 shows versions of the infographic in every line of the first column; in the second column appear the average views of participants for each version. In the third column there are results which had some level of understanding (U and PU), in the fourth, results for not understanding and in the fifth results with no response.

Table 3: Overall results of the groups which were tested for varying animation and interaction

	Visualization Average	U	PU	NU/IR	NR
Interactive Animated (IA)	2 times	54		16	0
Animated (A)	2 to 3 times	63		7	0
Static Interactive (SI)	1 to 2 times	59		11	0
TOTAL		176		34	0

Animations

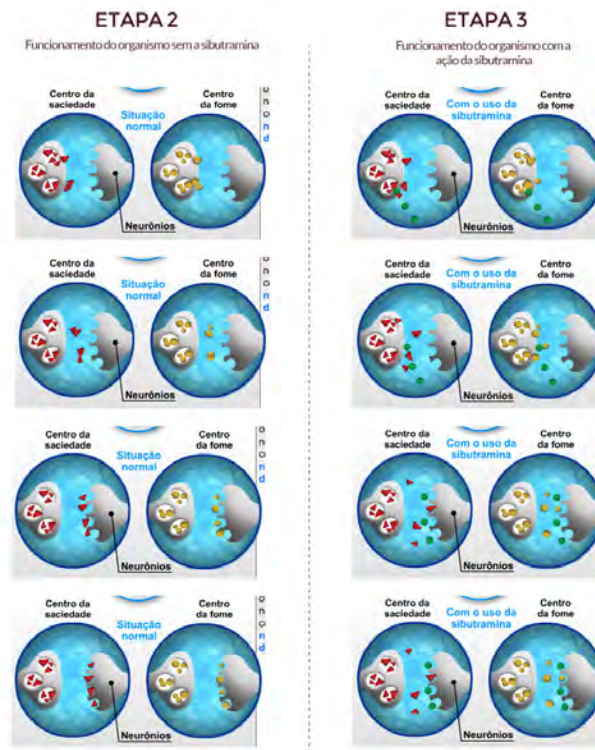
The higher level of understanding for the animated version (A) approaches the results of the meta-analysis carried out by Hoffler and Leutner (2007). From 26 studies reviewed by the authors, most indicated a better understanding when animation was used.

However, studies in the literature on learning involving animation have involved research on when and how animation can be beneficial to understanding. In this sense, the results corroborate studies that indicate the potential use of animation as an aid to explaining abstract phenomena (BETRANCOUT, 2005; AINSWORTH, 2008).

The animations also positively impacted participants' perception, which agrees with the studies by Souza and Dyson (2008). Participants considered the explanatory animations, found in steps 2 and 3, as an important aid to understanding the infographic.

Figure 4 shows some frames of elucidative animations of steps 2 and 3 to show the changes that happen during the animation.

Figure 4: Steps 2 and 3 in detail

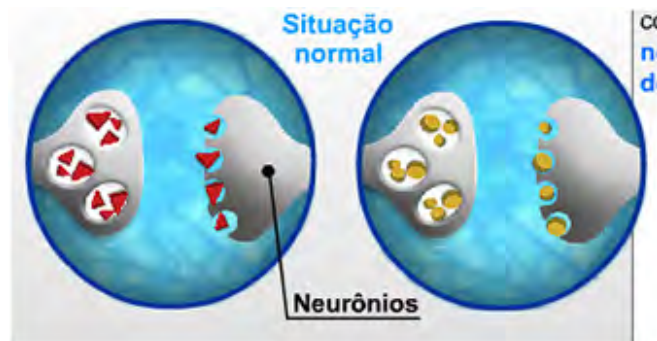


On the other hand, these same steps were perceived as difficulties. The amount of information provided in steps, such as the explanations of the satiety center and hunger center displayed at the same time hindered understanding.

According to the Coherence Principle of CTML from Mayer (2005), more simplified and objective versions of multimedia presentations usually have a better understanding, thus eliminating potential processing overloads. In line with this principle, most participants suggested splitting the infographic into more steps to reduce the amount of content presented at each stage.

Still with regard to difficulties in steps 2 and 3, participants reported problems in identifying the graphic representation of neurons in the infographic; even with the caption (Figure 5) this can indicate an influence of representation visual style on the perception of participants. Indeed, this is directly linked with previous studies (ASHWIN, 1979; FRASCARA 1984; GOLDSMITH, 1984; SPINILLO, 2002).

Figure 5: Neuron graphic representation



As general difficulties in the infographic, some participants commented on problems in reading the text with the looped animation displayed at the same time. This aspect is covered by the Modality Principle of CTML. In this principle Mayer (2002; 2005) explains that situations where there is simultaneous text and animations should be avoided in order to prevent cognitive overload. That is generated by word and image processing in the same channel, the visual channel. The author recommends a strategy to minimize this, using the auditory channel, so the text should appear as narration.

Interaction

The presence of interaction in Interactive Animated and Static Interactive versions obtained the highest numbers for not understood ($n = 16$ and $n = 11$), and the group that viewed the infographic Interactive Animated (IA) got the lowest level of understanding.

These results seem to oppose studies that indicated that the use of animations and interaction together can enhance the understanding of the animation (TVERSKY et al, 2002; WEISS, 2002; SCHWAN & RIEMPP, 2004). This is also the case with the Principle of Interactivity CTML (MAYER, 2002; 2005), which states that there is a deeper learning when the material has simple controls.

The kind of interaction used in the infographic, narrative control (Figure 6), is considered a type of simple interaction that provides limited resources for the user. Miranda (2013), in his study of infographics, also identified the use of simplified forms of interaction. The author points out that it cannot be affirmed that the use of more sophisticated forms of interaction promotes understanding.

In this sense, Lowe (2004) emphasizes that only adding interaction cannot solve problems associated with animations. In a study of inexperienced users' strategies to find relevant information in an animated weather map, the author found that the interaction led users to make use of simplified strategies that did not result in a satisfactory understanding of the map.

Figure 6: Highlight of the narrative controls on the infographic



3.2 Screen Text x Narration

The variation in text display mode also has a similarity between the results. The higher level of understanding was for Animation (A), which had text on screen, where 63 responses showed levels of understanding between U and PU, and only 7 were classified as understood by the participants.

The version of the infographic with animation, screen text and narration (AN) had 62 answers that showed levels of understanding between U and PU, 7 were classified as not understanding and one question was unanswered. And the animated, narrated version without text (ANWT), had the lowest levels of understanding. In this version, 56 responses showed levels of understanding between U and PU, and 12 responses were classified as not understanding and 2 questions were not answered.

In Figure 7 it is possible to observe the differences between the presentation of animated versions, animated narrated and animated narrated without text.

Figure 7: Steps of animated versions, narrated animated, and animated narrated without text



Table 4 shows in every line of the first column the versions of the infographic, and in the second column the average visualizations of participants for each version. In the third column there are results in which there has been some level of understanding (U and PU), in the fourth results for not understood, and in the last results for no response.

Table 4: General results of groups which were tested varying text display mode

	Visualization Average	U	PU	NU/IR	NR
Animated (A)	2 to 3 times	63		7	0
Animated with Narration (AN)	2 to 3 times	62		7	1
Animated, Narrated Without Text (ANWT)	2 times	56		12	2
	TOTAL	181		26	3

Although the differences in results were not significant, these suggest an opposition between the Principles of Modality and Redundancy proposed by Mayer (2005).

In the Modality Principle the author argues that people have a deeper learning with pictures and narration (text in audio) than with images and text on screen. However, in our experiment the version that had these characteristics, Animated Narrated Without Text (ANWT) had the highest number of responses classified as not understood and was visualized on average 2 times by the participants.

In the Redundancy Principle Mayer (2002; 2005) indicates that the presence of text on screen and narration can simultaneously generate an undesired effect called divided attention effect. That is, there is an overload on the visual channel, because this is used to process animation and text on screen.

Thus, the author recommends splitting the cognitive demand using the auditory channel, presenting the text as narration. However, in our experiment the version that had narration and text on screen (AN) showed a higher level of understanding than the one that had only narration (ANWT).

4 Conclusion

Overall, the experimental results indicate that only adding and combining interactive and animated features in infographics does not promote understanding. Instead, it can cause harm. However, when these features are individually observed, may be seen to aid comprehension in specific points of the infographic.

Animation was seen to be beneficial to understanding, especially in steps 2 and 3, when there was the explanation of the action of sibutramine on neurotransmitters. These steps were considered difficult to understand by the participants, but there was a higher level of understanding when the animation presented (Table 5).

Narration has proved to be a positive feature to aid understanding, especially when used in conjunction with the text, which opposes CTML. In the infographic, some aspects may have influenced this result, like the extensive use of medical terms such as “neurotransmitters”, “Norepinephrine”, which at first may have been difficult to understand only with narration and were explained by graphic textual reinforcement. However, it seems necessary to pursue further investigation into the use of narration in computer graphics, to experiment with some aspects of narration that can affect performance and were not controlled, such as the voice of the narrator.

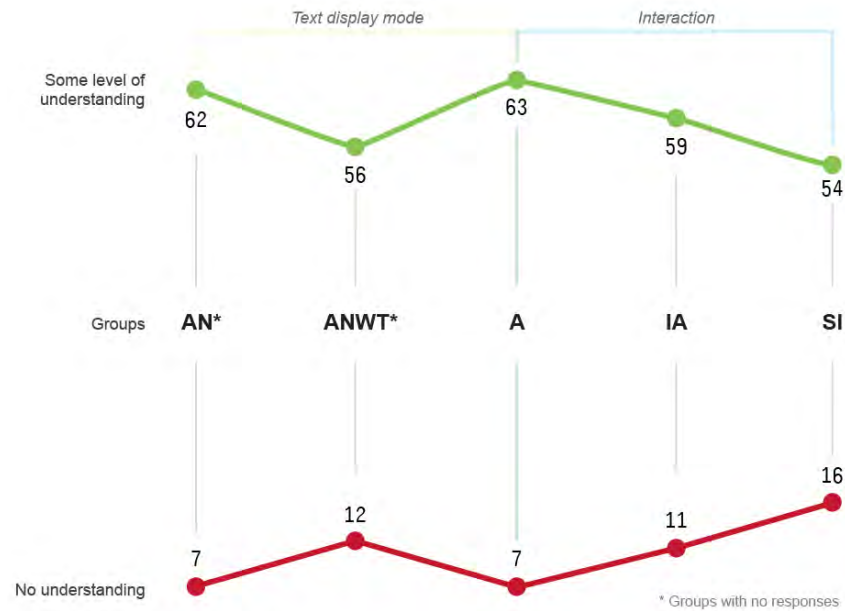
Table 5: General results

	Visualization average	U	PU	NU/IR	NR
		Answers with some level of understanding			
Animated (A)	2 to 3 times	63		7	0
Animated with Narration (AN)	2 to 3 times	62		7	1
Static Interactive (SI)	1 to 2 times	59		11	0
Animated, Narrated Without Text (ANWT)	2 times	56		12	2
Interactive Animated (IA)	2 times	54		16	0

The use of interaction combined with animation could contribute to promote understanding. But in the experiment, interaction resulted in a higher number of no understanding. Apparently, the way of using narrative controls was not adequate, which may have affected the understanding. This type of interaction complies with CTML, which says the benefit to understanding occurs by allowing participants to stop, analyze and inspect details. In the infographic, the planning and organization of content in steps seems not to have allowed the participants to perform these activities in order to contribute to understanding. It is also possible that the difficulties in some steps have discouraged participants, who may have used the interaction to go fast forward, passing by fundamental steps for understanding the content thus, leaving gaps.

Comparing the results of manipulations (text mode display and interaction), it may be concluded that the interaction variation generated a greater difficulty in understanding than the text mode display variation. This can be visualized better in chart 1, where the results of the animated group were placed at the center because these were evaluated for the two cases. On the left the results of changes in text display mode, and on the right are the results from interaction variation are presented. The line above corresponds to the results where there was some level of understanding, and the line below is the number of responses to understanding. Unanswered questions were not considered.

Chart 1: General comparison between results



Overall, this experiment identified the following effects of interaction and animation in understanding:

- The animation helps understanding, but seems to demand a higher level of attention from the infographic reader;
- The concomitant use of animation and narrative controls made it difficult to understand the contents.

Also with regard to interaction, it is not possible to conclude if other forms of interaction are more appropriate to the way in which content of infographic is tested. Therefore, there is a need for future studies to investigate the influence of the type of interaction in understanding infographics and skimming strategies of readers in infographics. As limitations of this study, the reduced sample size should be considered, which was due to the exploratory characteristics of the study.

This present study also indicates the need for a theoretical tool that offers support to the developers of interactive and animated infographics, allowing further analysis of the information content. In this way, it will be possible to define more effective strategies of how and when to use animated and interactive resources to promote a higher level of understanding in infographics.

References

- AINSWORTH, Shaaron. *How do animations influence learning?* School of Psychology and Learning Sciences Reserch institute, Unversity of Nottingham, University Park, Nottingham, UK, 2008.
- ASHWIN, C. The ingredients of style in contemporary illustration: a case study. In: *Information Design Journal*, v. 1. Londres, 1979. p. 51-67.
- BETRANCOURT, Mireille. The animation and interactivity principles in multimedia learning. *The Cambridge handbook of multimedia learning*, p. 287-296, 2005.
- CASTIEL, L. D. Insegurança, ética e comunicação em saúde pública. *Revista Saúde Pública* . v. 37, n.2, p.161-167, 2003.
- FRASCARA, J. Design principles for instructional materials. In: R. EASTERBY; H. ZWAGA (eds.). *Information Design: the design and evaluation of signs and printed material*. Chichester: Wiley, 1984. p. 469-478

- GOLDSMITH, E. *Research into illustration: an approach and a review*. Cambridge: Cambridge University Press, 1984.
- HÖFFLER, T. N.; LEUTNER, D. Instructional animation versus static pictures: A meta-analysis. In: *Learning and Instruction*, n. 17(6). 2007. p. 722-738.
- LOWE, R. Interrogation of a dynamic visualization during learning. In: *Learning and Instruction*, v.3, n.14. 2004. p. 257-274.
- LUIZ, O. C. Jornalismo científico e risco epidemiológico. *Ciência e saúde coletiva*, v.12 n.3. Rio de Janeiro, Maio/Junho, 2007.
- MAIA, Tiago Costa. *A representação de dimensões de tempo em instruções visuais e sua relação com imagens mentais de usuários*. 2008. Dissertação de Mestrado. Departamento de Design. Universidade Federal do Paraná.
- RANGEL, M. L. Epidemia e Mídia: sentidos construídos em narrativas jornalísticas. *Saúde e Sociedade*, v.12, n.2, p.5-17, jul-dez 2003.
- SCHWAN, S.; RIEMPP, R. The cognitive benefits of interactive videos: Learning to tie nautical knots. In: *Learning and Instruction*. v. 14(3). 2004. p. 293-305.
- SPINILLO, C. G. Instruções visuais: algumas considerações e diretrizes para o design de seqüências pictóricas de procedimentos. In: *Estudos em Design*. Rio de Janeiro, 2002.
- SOUZA, J. M. B.; DYSON, M. Are animated demonstrations the clearest and most comfortable way to communicate on- screen instructions? *Information Design Journal*, v. 16. p. 107- 124, 2008.
- TVERSKY, B. BAUER-MORRISON, J.,; BÉTRANCOURT, M. Animation: Can it facilitate? In: *International Journal of Human-Computer Studies*, n. 57. 2002. p. 247-262.
- TULIS, T.; ALBERT, B. *Measuring the user experience*. Burlington: Morgan Kauffman, 2008.
- WEISS, R. E.; KNOWLTON, D. S.; MORRISON, G. R. Principles for using animation in computer-based instruction: theoretical heuristics for effective design. In: *Computer in Human Behavior*. USA: Elsevier Science Ltd., 2002, p. 465 - 477.

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Chapter 2

Social interaction guidelines for Brazilian digital television: the example of “Tererês” TV program

Taygoara A. do Carmo Sousa, Paulo Fernando de A. Souza

keywords: interface design, Brazilian digital TV, interactivity, usability

The main goal of this research is to present some social interaction guidelines within the Brazilian model of TV. This study starts from a set of research methods in design specifically applied to applications in digital television, analyzing the migration of an analogical TV program to an interactive version for the digital format. An important conclusion of this research is the validation of a set of parameters and guidelines of social interaction applied to digital TV. Besides, a relevant contribution of this study is to present a model of organizing and projecting design interfaces to digital TV as well as to help designers and developers to work better in the field of interaction design and interfaces to digital TV.

1 Introduction

Conventional TV, or analog TV as it is also known, requires little or no response level from the user; it has broad territorial coverage and a language that is accessible to all social classes. This TV signals transmission model, most of the time, promotes communication that is one-way, without exchanging individual experiences and without considering the cultural diversity among different geographic areas. The internet, for its part, has user dynamics that requires greater capacity for understanding, requires constant inputs, allows interaction and enables content sharing. However, in Brazil, it is still not accessible to much of the population, with only 31.5% of homes having access to this means of communication, according to the IBGE institute (2010), and thus it does not have such a representative coverage as TV.

After the television and internet networks became unified, which was enabled by the implementation of the Integrated Services Digital Broadcasting Brazilian Terrestrial System (ISDB-TB, original acronym in English), the TV set has become a potential means of multilateral information-sharing in Brazil. In this new scenario, television gradually ceases to be just a passive receiver and becomes a processing, data storage and sharing device, and this is a significant change that requires reflections on the strategies of creation, production, distribution and consumption of the content posted in the Brazilian Digital TV System.

In a complex world, i.e. in a world ruled by connections between increasingly interdependent parts, the TV system is part of a web of networks where each of them relates to the others. As such, the TV receiver is also expected to enable these interrelationships. The Integrated Services Digital Broadcasting Brazilian Terrestrial System (ISDB-TB) allows these interdependent connections and supports the TV set as the contact point between the viewer and a number of other systems

or interacting agents. For Cardoso (2012), the connection of the contact points between different systems takes place by means of interfaces, i.e. “cultural artifacts, tangible or intangible, designed to facilitate interaction between man and his environment, or even physical or logical devices that make the adjustments between systems” (CARDOSO, 2012, p. 192). If we apply this concept to the digital television transmission system, we will get the following interface points, starting from the viewer: the remote-control, the graphic features of the interactive application loaded on the TV set, the very TV set screen surface and the receiving and transmitting data mechanisms (antenna and cable), considering that each of these points (interfaces) is responsible for inter-relationships between the viewer and the other system points.

These interfaces are responsible for the correct operation of networks that surround us and to fulfill their purpose, they need to be carefully planned by multidisciplinary teams that pay attention to the usage context, market realities, political interests, technical feasibility and aesthetics-formal aspects. To Moraes (2010a, p. 64), in scenarios like this, which are defined as dynamic and complex, the main challenge for the designers is not within the technical and linear aspects, but in the not very well known and decoded field of the intangible attributes of industrially produced goods. For Flusser (2010, p. 97), our society is gradually ceasing to be governed by materiality and, increasingly, the intangible and immaterial are standing out as the complex world priorities.

The advent of interactive digital television has brought a new virtual interface, which is still relatively little studied: the graphical user interface of targeted applications, specifically for interaction through television, so that designing these surfaces has become a major challenge for designers in the era of iDTV. In this hybrid field, between the borders of “conformation” and “information”, the designer should equip himself technically and theoretically, according to the specific needs of the projects he/she intends to carry out. This search is the first step towards a design practice guided by a proper design methodology, for grasping the tangible and intangible aspects of artifacts and interfaces to be designed.

From this perspective, this study provides an interactivity concept overview, more specifically, on mutual interactivity, i.e. the interactivity marked by inter-relational actions, mediated by the Brazilian digital TV system. It also attempts to understand the technology involved in this interaction by means of the TV and in the use of the image receiver as a socialization device. Aiming to systematize the acquired knowledge, this research also mixes interactivity and usability concepts and organizes some guidelines aimed at developing applications for social interaction experiences in digital TV, now called Social TV.

The Social TV is a model of interactivity mediated by television, defended by authors such as Pablo César et al. (2008), Konstantinos and George Lekakos Chorianopoulos (2011), among others. Within this interaction model, the priority is socialization among people. To this end, the viewer is offered a series of interpersonal communication, entertainment, creation and content distribution capabilities between networks, via the interactive digital TV system.

In order to observe the social interaction implications in a TV show, there was an exercise in applying some guidelines for social interactivity design in digital TV in a pilot episode of a 3-minute short video series entitled “Tererês”. This series promotes cultural diversity by means of airing short theatrical videos in the broadcast television commercial breaks, in which children and young people are taught a number of hairstyles of African origin, called “Tererês”, their origins and meanings. By making use of the methodology that was organized for this study, an interactive interface prototype that enables communication among viewers themselves and with the television station was developed for the “Tererês” TV program. This study was developed by designer and professor Taygoara Sousa as part of the Visual Arts Graduate Program in the Federal University of Bahia, at the Master’s level, under Professor-Doctor Paulo Souza’s guidance.

2 Methodological Approaches

This study is based on the qualitative research approach; it has a descriptive character and uses the deductive method to critically analyze the impact of social interactivity on a digital interactive television model, using already established principles. In order to create the interface prototype, which was developed as an implementation example of social interaction in a program originally made to run on conventional TV, a set of diagnostic design methods and applications development for interactive digital television were used, comprising the association of the following methods:

- Interface Prototype Design Methodology (IPDM), proposed by Lekakos et al (2001);
- Meta-project, proposed by Moraes (2010b);
- Rapid Application Development method (GAWLINSK, 2003).

In IPDM methodology, the interface design is approached in a comprehensive and well structured first data collection phase, where the project user's requirements are established. This collection of information is carried out in order to provide data related to the interface design principles, focused on usability, aiming at the development of an interface mock-up, i.e. a low-fidelity model with paper printed simulations of application screens. After a heuristic evaluation, conducted by experts in interactive television interfaces, a high-fidelity model is developed using an easily accessible declarative language, that enables the embedding of video, to create links between media and to make the closest possible imitation of the real television watching experience.

As an analysis tool for developed application requirements, the Meta-project (MORAES, 2010b) is a critical reflection on the design activity carried out as a form of prior assessment or after project completion. In short, it is an analysis from the perspective of technological, production, marketing, materials, environmental, socio-cultural and aesthetic-formal factors, aiming to diagnose the positioning of the system or device designed in a relational universe, in which the project influences and is influenced by the context in which it appears. This method assumes that the project is a set of variables constantly on the move and it needs to be evaluated as such in a complex world, with the design helping in the understanding and interpretation of complex productive and projective conditions.

Finally, the Rapid Application Development is used in the stages of the TV program development, specification, production/test and launch/operation, allowing review steps to be conducted after the product release, according to the viewers' opinions, just as currently takes place with the main programming products from broadcasters, such as soap operas or reality shows. According to Gawlinski (2003), after the program launch, the application will be evaluated by viewers and the development cycle will be restarted, aimed at correcting perceived flaws during use.

Furthermore, for a better understanding of the graphic interface needs, this research also used "LucidChart" (LUCID SOFTWARE, 2013), an online tool for flowchart preparation, which aided the development of the low-fidelity mock-up and facilitated the broader information flow view in the development stage of the alternatives.

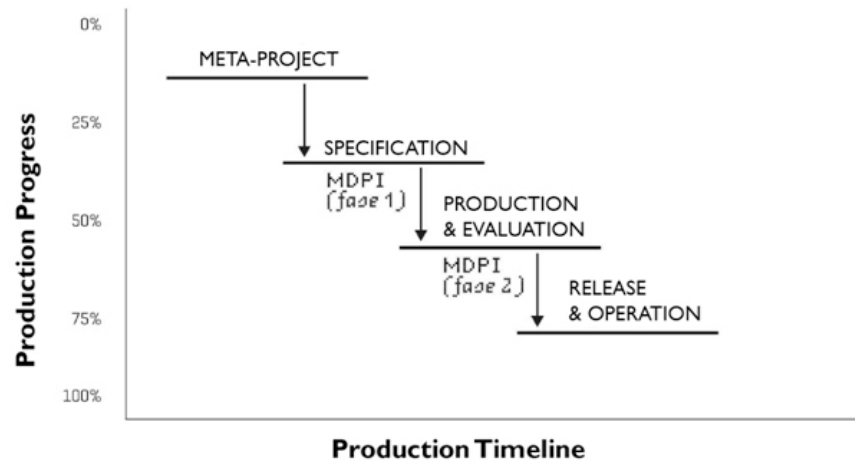
This study advances the proposal for a specific methodology in developing applications for interactive Digital TV, within the Social TV perspective, with an integration of the previously described methods, for what is called "Design methodology of social interactivity in iDTV", which is organized in four stages, namely:

1. Development: stage in which the program is thought of as a whole and the project briefing is prepared;
2. Specifications: stage which analyzes the application context and determines its functionality and requirements;

3. Production and Evaluation: the stage which hosts the graphic design, technical architecture, programming and heuristics evaluation;
4. Release and operation: the stage in which the application is released for the viewer's use.

Figure 1 graphically depicts the social interactivity design methodology in iDTV, used in this study:

Figure 1: Social interaction design methodology in iDTV (SOUSA, 2013).



The time function depicted in Picture 1 refers to a generic design, which may vary for each stage and, thus, no specific time magnitude for the production stages is expressed. This method follows the assumptions cycle for the iDTV applications development proposed by Gawlinsk (2003). Therefore, the final interface adjustment to use context would be made from the viewers' comments about the interactions carried out after the application's "release and operation" step. However, this methodology step was not carried out in this study.

3 Social Interactivity Guidelines in iDTV

In the age of interactive digital television, "the development of ideal languages and formats for each media type must be done in line with the cultural habits of the public" (CANNITO, 2010, p. 16). According to Cannito (2010), the audience does not care about the technology itself, but rather about the type of content they are consuming. However, as interactivity via the television set is becoming a habit, these new user-viewers will need to build a mental model suited to this new interaction experience. Therefore, one must bear in mind that the audience that consumes television is extremely diverse, and the age, gender, education and social classes are distinct. This fact makes it impossible to standardize the context use and hinders the development of an accurate user profile for the developed applications.

Having this complex user in mind - the viewer - the "Guide to digital television services" (FINLAND, 2004, p. 10), recommends avoiding the use of content scrollbars by reminding that the viewer cannot freely browse the content as he/she would by using a mouse in most TV sets, for example. This guide additionally recommends the use of content paging, of virtual keyboards and also of the standard colored buttons that are part of the remote control for appliances aimed at iDTV. The authors Cybis et al. (2010, p. 300) present a set of ergonomic criteria focused on the development of iDTV applications that prioritize the following: a) Compatibility with the viewers' expectations; b) Simplicity and guidance; c) Consistency/Coherence; d) Limited workload; e) Clarity in presentations; f) Readability.

The criteria described above are suitable for the interaction design in iDTV. However, when it comes to the design for a Social TV, they become insufficient. The Social TV is the model of interactivity through television in which the priority is socialization among people. Therefore, it uses audiovisual content to encourage sociability and interpersonal communication, verbal and non-verbal. The Social TV allows the viewers to create and distribute their own content. The authors Gingerson and Lee (2002) suggest that social interactivity in digital media should encourage the participation of users, supporting social interaction components, and promote the visibility of connected people and their activities. For Chrorianopoulos and Lekakos (2011), the design of an application for Social TV should be thought of in order to: a) encourage the act of watching TV together; b) minimize interruptions in programming flow; c) enable content exchange among users; d) not to impose interaction; e) allow multiple levels of attention.

Table 1 lists and organizes the referenced authors' criteria and suggestions, and it also presents some guidelines for the design of interactivity in Social TV.

Table 1: interactivity Guidelines for iDTV (SOUSA, 2013).

CRITERION	INTERACTIVITY GUIDELINES FOR iDTV
Compatibility with viewers' expectations	Interactive content must comply with the viewer's expectations; Information should follow the TV program schedule. It should be regionalized so that it becomes an intrinsic part of the viewer's everyday life; Access to this interactivity should be the viewer's choice and not an imposition. Therefore, the interactive graphical interface should never entirely overlap the TV programs themselves.
Simplicity and guidance	The functions and information minimization is a critical aspect to achieve this quality. The use of everyday metaphors makes the interface intuitive; Whenever possible, a small guidance text should be offered to the user to explain what he/she should do in the interaction; Feedback on system status should be provided; The icon names for command definitions and fields should be defined carefully and preferably with user participation; Complexity must be presented in levels, in order to greatly simplify the basic interactions; Whenever possible, recurrent actions in the application should be associated with the interactivity colored keys of the remote control; Commands that are seldom used can be listed in a menu, but basic commands should be readily available, visible and clearly named without abbreviations.
Consistency and Coherence	The visual identity, layout and typography should be consistent, and they should build a sense of unity in all applications and have television aesthetics and grammar; The designer must choose among the existing standards in interactive modules, such as the "L" standard or use overlaps; Actions within applications should be consistent with each other and with the major systems used by users.
Limited workload	Navigation through very long texts or lists should be made by means of paging instead of line scrolling; The viewer will not be interested in performing too many actions, given his passive attitude; It is necessary to ensure that the paths are short and the actions are simple; the number of actions or paths must be reduced as much as possible.
Clarity in presentations	The designers must develop their programs in compliance with the usable area and the safety margins of conventional screens (4: 3), instead of high definition wide screen (16: 9); They must comply with the technical image characteristics in the HDTV format.
Readability	Whatever the font used, there should be a greater spacing between letters and it should not be less than 24 points; The text lines should not have more than 50 characters. It is advisable to arrange the texts in small blocks; Avoiding fonts with serifs and saturated colors is also advisable.
Sociability	Applications for Social TV should: a) encourage the act of watching TV together; b) minimize interruptions in programming flow; c) enable content exchange among users; d) allow multiple levels of attention; e) encourage the participation of users; g) support social interaction components; h) promote the visibility of connected people and their activities; i) Support the connection between different devices; j) Treat interaction as a playful activity.

We believe that the guidelines described above adjust the use of interactive digital TV to the behavior and culture of television, and they also leverage this device's social potential, making it more than just a signal receiver. In fact, Social TV applications, when developed based on usability criteria, turn every TV set into a personal intercommunication vehicle, allowing the spread of information and of personalized content. However, besides the guidelines presented above, we believe that the interactivity design for Social TV needs to be planned with two fundamental aspects taken into account: a) the content, which could be the responsibility of journalism and advertising professionals from television stations or produced and distributed by users, in Social TV; and above all, b) the characteristics of the platforms that will mediate the interaction.

4 The Interface Development

The “Tererês” Program – Original Version

The “Tererês” project was drafted in 2010, in the city of Salvador, BA, Brazil, as an activity within the Production and Image Analysis subject, taught by Professor Taygoara Sousa, as part of the design undergraduate course in the Federal University of Bahia. This is a series of short story videos for viewing in conventional television commercial breaks. The Tererês Project was originally planned to have twelve (12) independent episodes, of one minute and half each. However, at that time, only the series pilot was produced, which is the only episode to have been produced so far, because the project is still in fundraising stage and was never actually aired. This way, the pilot episode was used in this study because it is original content and it was developed to analog TV standards, which is a required prerequisite for the content conversion exercise between different technologies.

The episodes of the “Tererês” series are intended to teach children and young people the detailed steps to make some hairstyles of African origin. The structure of each episode follows a standard format. The plot unfolds in a linear flow and begins with an opening vignette and a brief introduction of the main character in an everyday situation. Then, animated picture cards are presented, depicting the necessary materials and the making of the hairstyle itself. Instructions on how to make the hairstyle are displayed step by step, with texts added, also telling viewers about its significance in the cultural context of origin. At the end of the process, images that value the main character's hair and photos with a range of possibilities for the same hairstyle are shown. Before the sponsors' signature, a vignette with the website address is shown. This website offers more in-depth content on the topics covered in the episodes of the “Tererês” series. In the pilot episode of “Tererês”, special care with the colors and displayed textures can be noticed, expressed both by the graphic parts used, and also by the photographic plans that integrate the video, in order to enhance the visual identity (Figure 2):

Figure 2: Samples from the visual identity adopted for the “Tererês” series (SOUSA, 2013).



The typography used in all informative texts presented in the episodes of the “Tererês” series was “Yanone Kaffesatz”. This digital font has a rationalist approach and presents an unmodulated appearance. It does not have serifs, it has uniform serifs and has a configuration that is similar to the “Tiresias” typeface used as a standard by the British television network BBC, which was carried out by the Royal National Institute of Blind People (RNIB), for easy screen viewing by people who have low visual acuity. In order to prevent reading difficulties on the part of the “Tererês” series viewers, the minimum size limit for textual elements of the episodes was established at eighteen (18) points, according to the BBCi (2005, p.16).

In its design, the type “Yanone Kaffesatz” clearly distinguishes characters that can be easily mistaken for others (such as the lowercase “l” and the number “1”). These features, also according to the BBCi (2005), make it a great typography option for use on the TV screen. Moreover, this type has an average opening, rounded design and elongated serifs, which are features that give a typographical style consistent with the graphic concept of the series, based on vertical bars. Figure 3 shows a comparison of the typeface used in Tererês with the one used by the BBC:

Figure 3: Comparison between Yanone Kaffesatz and Tiresias (SOUSA, 2013).



In its original version, the Tererês project is a service that consists of the television show and a website with additional information. This site acts as an advertising vehicle for the interactive program on digital TV, providing information and answering questions about the project, but its main goal is to enable the viewer's participation. In addition to the episode videos and the website, there are also advertisements in television commercial breaks and in printed media, such as billboards, bus ads, newspapers and magazines, as part of the Tererês Project product-design system (Manzini and VEZZOLI, 2004).

The Tererês series was produced to be transmitted in analog mode via broadcast, i.e. by means of antennas located on the ground. In this model, the signal is not digitalized and the information flow takes place in one direction only, which makes the use of interactivity mediated by the TV set impossible.

The “Tererês” Program – The Social TV Version

Interactivity enables new possibilities and raises other issues that affect both the production process and the final product format. Bearing this in mind, in the development of this first interactive version of the Tererês series, it was observed that the original format, designed to be aired in commercial breaks, limited the interaction possibilities and their meanings. Furthermore, there were technical limitations, such as the short duration time of each episode, which made full loading of the interactive application unfeasible and its synchronization difficult; or such as marketing issues, imposing inflexible limitation on each TV commercial time slot; these technical limitations eventually forced a conceptual change in the series format.

In the version for Social TV, proposed by this exercise on applying social interactivity guidelines for iDTV, the Tererês series episodes no longer run in TV commercial breaks; they are currently run at the end of an eponymous thematic video segment, integrated into the program called “Aprovado”, made by Bahia Television network, affiliated to Brazilian Globo TV network. This program choice was due to its affinity with the Tererês proposal in its digital version. Indeed, according to Mira Silva

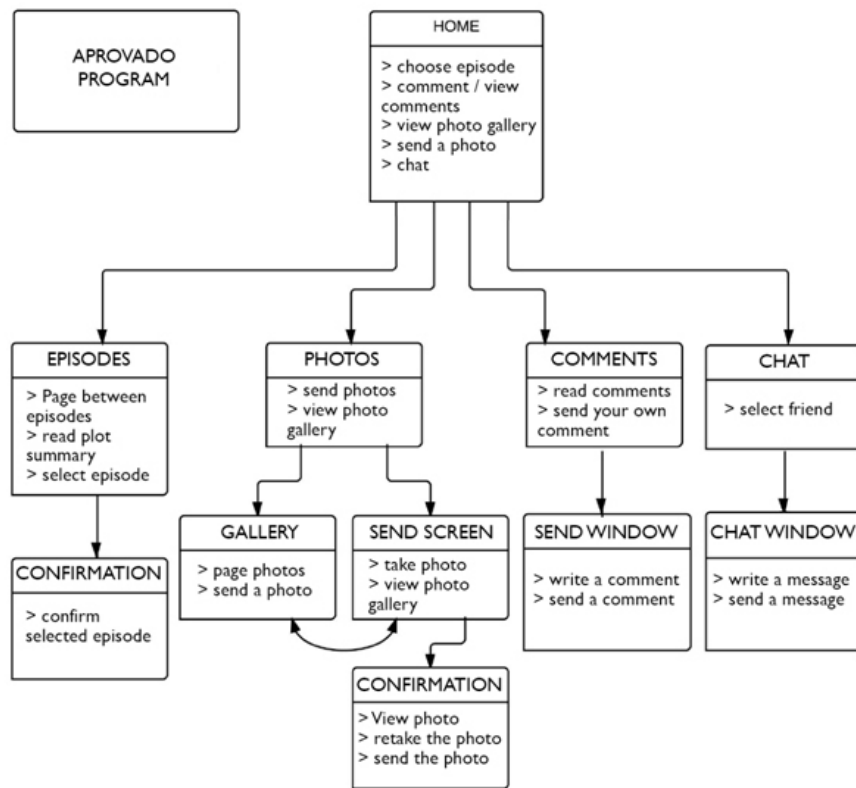
(2013), the program director, the “Aprovado” TV show is an education and culture magazine that deals with several issues, prioritizing diversity and knowledge. Therefore, according to this program director, the “Aprovado” and “Tererês” programs dialogically relate with each other, considering that the series episodes provide information, discuss the self-esteem issue, show historical data on African origin hairstyles and show how they are used nowadays in Brazil.

However, Mira Silva (2013) points out that due to the current concept of the program, its target audience has a higher age range than before and “Aprovado” is currently aimed at adults aged between 25 and 30. As a result, the original concept of the Tererês series had to be modified, and the episodes were replanned without the playfulness required by children and teenagers. In each display of the Tererês segment, an interview with students or professionals who have knowledge of African-Brazilian aesthetics and beauty will be held. In these interviews, topics related to the African-Brazilian racial issues, self-esteem and representation in the media will also be discussed. Interactivity will be encouraged live by the show host, and it should be an important concept in this program segment, which will be reinforced in the texts, the scene elements and viewers’ interventions, mediated by the show host.

The Tererês interactive application can be accessed throughout its segment of “Aprovado”, and its main goal will be to allow the viewer to send their own content related to the program, or to access content posted by others. It is noteworthy that the application should also be developed in versions that are compatible with mobile devices. These devices may interact with the TV show synchronously, i.e. in real time, by accessing the program-related content while the program is on the air; or asynchronously, that is, any time, unrelated to the content displayed on TV.

As laid out in this study’s proposed methodology, after the project analysis and its socio-cultural, technical and marketing aspects relations, a low-fidelity mock-up of the application interface for the “Tererês” Social TV program was developed, aimed at planning the interface’s formal aspects (Figure 4).

Figure 4: Low-fidelity mockup for Tererês in Social TV version (SOUSA, 2013).



Based on the low-fidelity mockup, the interface's formal aspects were planned and the interactivity art layers were developed: a) “wireframe”; b) “hierarchical and organization elements of information”; c) “interaction objects”; d) “colors”; e) “Background”. The screen areas that would be occupied by each content section were established, composing an “L” shaped profile around the space reserved for the program, as indicated in the study guidelines, especially with regard to “compatibility with viewers’ expectations” and “consistency and coherence” aspects.

The basic structure of the interface, also called “wireframe”, and the placeholders’ definition for each content group also determines the browsing dynamics. In addition to the space reserved for the TV station programming, the interface has three fixed and two variable spaces. The photos, chat and reviews sections have their fixed home screens and, when selected, they display their contents in the variable area on the screen right side. Advertising is only displayed on the main screen, considering that when a content is selected and displayed in the variable area, the contents of the “episodes” section take the place of advertising, remaining there until the user decides to return to the main screen, until the episodes section is highlighted again in the variable area. In its browsing dynamic, this structure enables the complexity to be presented at different levels, preventing the user from being forced to make decisions unless this is absolutely necessary. This way, the guidelines related to “Simplicity and guidance” and “limited workload” are followed.

To meet the application requirements, arrow-shaped buttons, rectangular buttons in the active and inactive states, and also indicating selection, were designed. Moreover, in order to facilitate typing messages, a recurring action in an application for Social TV, the layout of a virtual keypad similar to that used in mobile devices was designed. In line with the “Usability Guidelines for Social TV”, each section of the application was associated with a color of the remote-control standard interactivity keys. Figure 5 shows the initial screen of Tererês in its Social TV version.

Figure 5: Tererês graphical interface main screen in the Social TV version (SOUSA, 2013).



On the main screen of the Social TV version of Tererês, one can observe how the elements composition of the information hierarchy and organization creates groups according to the content type and the relevance degree. In this sense, the colors are presented as a determining factor to make the distinction between sections clear. This distinction is also reinforced by titles and icons that head each content group. We believe that the application interface's basic structure complies with the majority of the “Sociability” group guidelines. But we know that a TV application, with social interactivity, will only be fully interactive when viewers can directly talk to each other and send their own content without the need for TV stations’ mediation. Therefore, we anticipate that the first step in this regard is to stimulate stations to use interactivity increasingly in order to “teach” their viewers. However, the broadcasting of interactive applications on the part of broadcasters will only occur when new advertising marketing models in interaction spaces are established. To this end, this proposed interface reserves a space for publicity material related to the program theme.

Moving on to the next steps of a “Social interactivity design methodology in iDTV”, a high-fidelity mock-up which simulates the Tererês application operation for Social TV using web and videographic composition tools was developed. It is important to point out that when this interface is released, its browsing should be enabled for several transaction types, in addition to the remote control, such as voice commands, gestures or even actions taken by other devices. However, for this exercise, we prioritized the evaluation of actions by remote control which is the most common type of navigation and which carries the largest number of limitations, given the understanding that the system should allow accessibility, regardless of the features offered by the TV set connected to the Internet.

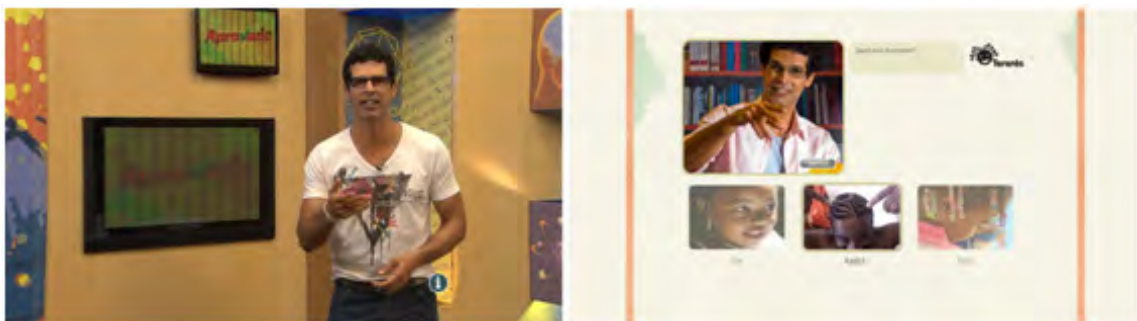
The area reserved for the chat, represented in green in Figure 6, enables the social interaction expansion within the application, according to the guidelines established for this search. It follows the same selection criteria, system status visibility and color standardization of other screens. These factors, combined with the respect for the visual identity system rules developed for Tererês, make this application compliant with the criteria from the “Consistency and coherence” guidelines group, given that after the repetition of certain patterns, the viewer will be able to use the interface intuitively, without the need to relearn the operating logic for each new task.

Figure 6: “Online friends” Screen of Tererês in Social TV version (SOUSA, 2013).



The evaluation of the Tererês graphical program interface for Social TV followed the guidelines presented in Table 1 as its requirements, based on the performing of two tasks: 1) access the system and perform the posting of a picture taken with the interactive application aid; and 2) return to the normal broadcast program. To perform the first task, the viewer must trigger the interactive application. To do so, press the interactive button on the remote control. In this step, there is a criterion suggesting that the interaction must not be imposed on the user. In fact, on this interface, the invitation to interact takes place discreetly by a small icon on the lower right side of the screen. Then the viewer should choose a registered user, with the help of the remote control arrows, and confirm it by pressing the “OK” button. These initial steps are shown in Figure 7.

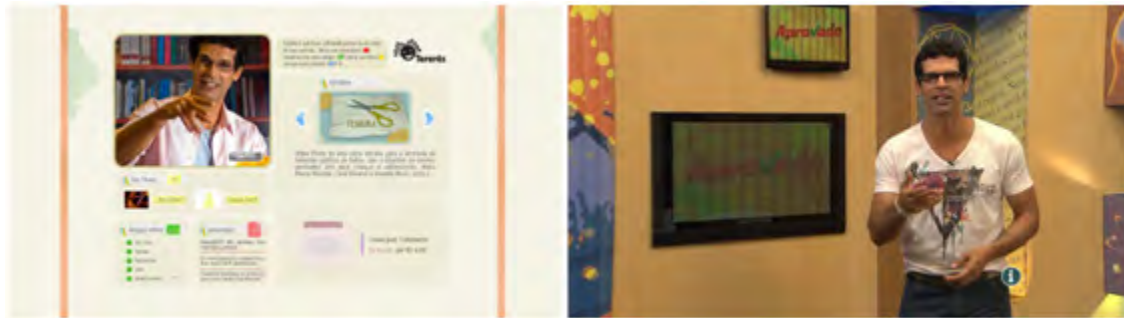
Figure 7: Invitation to interactive navigation in Tererês Social TV version (SOUSA, 2013).



On the main application screen, with the help of information located on the tips area, the user must use the arrow keys or the color keys on the remote control to select between sections. In this particular case, to perform the requested task, the user must press the yellow button or the arrow keys on the remote control. Then, using the arrow keys on the remote control, the user must select the “Upload Photo” option and press the “OK” button to trigger the camera on the television. At this stage of the process, the user must follow the instructions on the tips area and navigate through the interface buttons, choosing between taking a new picture or sending a picture that has already been taken. If the user wants to take another photo, he/she must use the arrow keys to move the cursor to “Take another.” In case the user chooses to send the captured image, he/she should place the cursor on the “Upload Photo” button.

After the first steps in implementing the required task, the viewer is expected to carry out the second stage of the evaluation, which is to abandon the interactive application and return to the normal broadcast program. To do so, he/she must follow the instructions on the tips area and press “EXIT” twice in a row. When this action takes place, the interaction is interrupted and the linear flow of the regular broadcast programming is once again the focus of the viewer’s relationship with the TV set.

Figure 8: Return to normal broadcast programming in Tererê Social TV version (SOUSA, 2013).



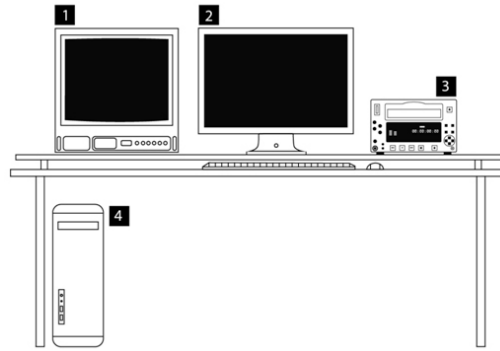
Regardless of the numerous issues that can be raised concerning the adoption of the proposed interactivity pattern, with respect to the designer’s role in the interactivity construction, we believe that this research plays an important role toward organizing and demonstrating the use of a set of methods and guidelines, exclusively designed for social interaction design in the Brazilian digital TV.

5 Setting Up the Design Workstation for Digital TV

The audio-visual contents in Tererê’s pilot episode were captured on DVCAM tapes, with DV-NTSC (720x480) format, and digitized in a non-linear video edition system. In sequence, the mounting and post-production phases were carried out with the help of editing software for creation, composition and animation of videographism. As shown in Figure 9, the workstation for the conventional TV program is set up as follows:

- Standard definition monitor for referencing (SD);
- Computer monitor;
- Videotape (VT) for DVCAM;
- Mac/PC with capture board for audio-visual, and image editing software as well as video codecs.

Figure 9: Design workstation for conventional TV editing (SOUSA, 2013).

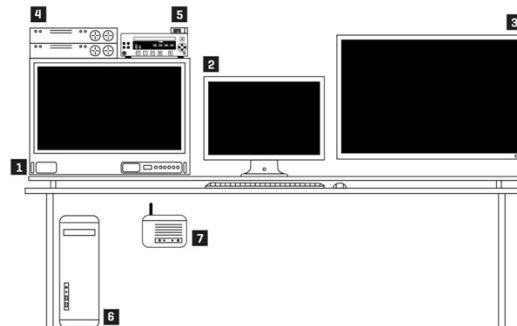


When editing for conventional TV formats, the capture contents are firstly copied and identified from VT-DVCAM, and further edited in post-production in order to generate episodes that will be sent for TV broadcasting. It is important to note that the final edited audio-visual content will be unaltered, both during transmission and reception of signals. This means that the transmitted material is exactly the same as the one that was finished on the editing line, linearly presented to the audience, with sequence determined by program editors and directors.

When planning the episodes for Social TV broadcasting we need to take into account some changes during production that will significantly reshape the workstation. The content will be captured in HDTV (1080i) format, and further copied in a non-linear editing system. Similarly to conventional TV, the mounting and post-production phases will use editing software for the creation and composition of videographism, but, now, the Digital TV service must be designed and determined before transmission, involving the development of applications that will be part of the program. In this sense, the workstation will have some extra equipment added, as follows (Figure 10):

1. High-definition monitor for referencing (HD);
2. Computer monitor;
3. TV set for broadcast and connected signals (Smart TV);
4. Set-top boxes (several models);
5. Card readers of different sizes and types (SD card, pen drives, DVD etc.);
6. Mac/PC with image editing software, video codecs, programming tools for online and mobile applications, particularly TVDi applications;
7. Broadband internet connection.

Figure 10: Design workstation for Social TV editing (SOUSA, 2013).



As shown in Picture 10, some differences can be seen in comparison to conventional TV editing workstations. In fact, in Social TV editing there is no videotape, since the images are captured directly from memory cards or discs. Besides, the referencing monitor must have high-definition quality, performing 16:9 instead of 4:3 format. However, we must take into account the need for adequacy in both formats, considering portability as a relevant feature in TVDi broadcasting. In order to test applications in different platforms it is necessary to have a broadband network connection as well as several models of set-top boxes, attending demands for different brands available on the market. Minimally, the workstation needs one Smart TV set for testing and visualizing of application results. In this sense, such a change in workstation infrastructure implies not only new methodological approaches, but also significant budgetary resources, for both equipment investment and development of personal skills and training for designers.

6 Final Considerations

When analyzing the results of the Social TV interface prototype evaluation made by several users, it can be seen that the interface which is proposed in this exercise meets most guidelines established as criteria for this activity. However, it is necessary to highlight some issues that may be raised regarding the adoption of this type of interactivity in an open TV channel.

Mira Silva (2013), director of the “Aprovado” TV show, mentions the lack of specialized professionals and the viewers not having access to digital inclusion as some of the main obstacles to the adoption of this social interaction level in an open television station. According to her, this way of interacting requires a certain degree of “digital literacy”, besides demanding a relatively high financial investment for the equipment purchase, which makes it impractical for a great deal of the public of open TV channels.

On the other hand, Brito (2012) adds that when a television station opens the interactive channel, it should be noted that this channel becomes a two-way path, and thus, it is very difficult to control what is sent by viewers. Therefore, we can say that it is a major challenge to develop content control mechanisms that meet the TV station’s principles, so that television companies can adopt the interactivity model proposed here without conflicting with the “sociability” guidelines shown in Table 1.

Interaction on Social TV is governed by the concept of mutual interaction, and it is characterized by the possibility of communication and information-sharing between the interacting peers. Given that television is traditionally a vehicle whose schedule grid simulates social interaction spaces, such as sport events and concerts, we understand that social interactivity by means of digital TV can contribute to an increased sense of belonging and consequently, it stimulates the relationship between people who are the interactive television system’s users. However, designing this interactivity is still largely an unfamiliar task for most designers who work in the production of television content.

References

- BBC - IPTV GEL. *Style guide: Building an IPTV Global Experience Language for the BBC*. março 2012. Retrieved from: < <http://goo.gl/IntA1> >.
- BRITO, Hugo. *A interatividade na TV aberta comercial brasileira*. Salvador, May 14th, 2012. Interview.
- CANNITO, Newton. *A Televisão na Era Digital: Interatividade, Convergência e Novos Modelos de Negócio*. 1 ed. São Paulo: Ed. Summus, 2010.
- CARDOSO, Rafael. *Design para um Mundo Complexo*. São Paulo: Cosacnaify, 2012.
- CESAR, Pablo; CHORIANOPOLOUS; Konstantinos; Jensen, J. Jens. *Social television and user interaction*. ACM Comput. Entertain. 6(3), artigo 4, maio 2008, p. 1-10.

- CHORIANOPOULOS, Konstantinos; LEKAKOS, Georgios. *Introduction to social TV: enhancing the shared experience with interactive TV*. Journal of Human-computer Interaction, 24(2), 2008, p.113-120.
- CYBIS, Walter; BETIOL, Adriana; FAUST, Richard. *Ergonomia e Usabilidade: Conhecimentos, Métodos e Aplicações*. 2 ed.: Novatec: São Paulo 2010.
- FINLANDIA. Ministry of Transport and Communications. *A guide for digital TV serve producers*. 2004. Retrieved from: <<http://goo.gl/pnS1p>>.
- FLUSSER, V. *Uma filosofia do design: a forma das coisas*. Trad. Sandra Escobar. 1 ed. Lisboa: Ed. Relógio D'água, 2010.
- GAWLINSKI, Mark. *Interactive television production*. 1. ed. Oxford: Focal Press-Elsevier, 2003.
- IBGE. Pesquisa Nacional por Amostras de Domicílios (PENAD). 2010. Retrieved from: <<http://goo.gl/KOvIF>>.
- LEKAKOS, Georgios , CHORIANOPOULOS, Konstantinos; SPINELLIS, Diomidis. Information Systems in the Living Room: A Case Study of Personalized Interactive TV Design. *9th European Conference on Information Systems*, Bled, 2001.
- LUCID SOFTWARE. *Lucid Chart*. Retrieved from: <<https://www.lucidchart.com>>.
- MANZINI, E.; VEZZOLI, C. *Product-service systems and sustainability: opportunities for sustainable solutions*. Milão: INDACO, 2004.
- MORAES, D. Metaprojeto como modelo projetual. *Strategic Design Research*, 2(3), São Leopoldo, 2010a, p. 62-68.
- MORAES, D. *Metaprojeto: o design do design*. 1. ed. São Paulo: Blucher, 2010b.
- SILVA, Mira. *A interatividade no programa Aprovado*. Salvador, June 24th, 2013. Interview.
- SOUSA, Taygoara A. do C. *Diretrizes para o design da interatividade social na TV digital brasileira: o exemplo do programa "Têrerês"*. 2013. 131 f. Dissertação (Mestrado) – Escola de Belas Artes, Universidade Federal da Bahia, 2013.

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Chapter 3

Doulas, mothers, and cell phones: Storytelling and a supportive doula approach for mothers at risk for postpartum depression

Judith A. Moldenhauer, Judith Fry McComish, Carla J. Groh

keywords: doula; smartphone app; storytelling and information design; maternal and child health; mobile health care

Postpartum depression (PPD) affects approximately 10-15% of women worldwide. Postpartum doulas provide mothers and their families with non-medical emotional and practical support through the post-birth (postpartum) period. This paper discusses the importance of storytelling in the design and use of a cell phone application developed in the USA for postpartum doulas to help mothers identify PPD symptoms, break their sense of isolation, and get help. This paper then explores how the use of this cell phone app, with its focus on storytelling, could be adapted for use with women in developing countries.

1 Introduction

Approximately 10-15% of mothers worldwide suffer from postpartum depression (PPD) with some evidence that its incidence could be even higher (Almond, 2009; Chandran, et al 2002). One of the risk factors for PPD is lack of social support, which is not having sufficient or adequate help in integrating a new baby into the family (Beeber & Canuso 2005). The lack of social support can be aggravated by other risk factors including low-income or poverty and a lack of education. In modern industrialized societies, where the birth experience has become more medicalized, and where people are often separated from family and close friends, doulas – non-medical individuals who provide emotional, physical, and tangible support for women during labor, birth, and the period following birth (called postpartum) – can provide this kind of supportive care that may otherwise be missing. Postpartum doulas specifically can help a new mother sort out her postpartum needs, gather additional support to address those needs, and create networks for support. In a study that documented the ‘domains of postpartum doula care’ (McComish & Visger 2009), ‘emotional support emerged as the most frequently used domain of care and focused on the mother. The predominant feature of this domain was client-directed discussion with the doula actively listening to the mother and her needs... the doula would encourage her to express feelings, process her birth story, and take care of herself by building support networks’ (McComish & Visger 2009: 151). Thus conversational storytelling – the give and take of talking, listening and responding to feelings, thoughts, and experiences – is at the heart of the doula/mother relationship and of the nature of social support in general. It is also at the heart of the design of our mobile-based materials for

postpartum doulas to use with their clients to help reduce the effects of PPD by recognizing the symptoms and getting treatment early.

The development of a cell phone app for use by mothers and their doulas was based on our experiences with a first round of focus groups in late 2010 of doula trainers, doulas, and mothers regarding educational materials for postpartum care. Most individuals ‘told us they would like to see the materials developed to have digital applications for smartphones or digital tablets... the younger mothers clearly preferred accessing information on smartphones rather than in hard copy’ (McComish, et al 2013: 6). The initial cell phone app design was presented to a second round of focus groups in 2011; the current design is result of this second round of feedback.

The value of this app to mothers and doulas is underscored as more people use smartphones in the U.S. and worldwide. The 2015 Pew Research Center report that ‘nearly two-thirds of American adults (64%) now own a smartphone of some kind, up from... the spring of 2011, when 35% of Americans were smartphones owners’ (Pew: 13) and that ‘young adults, non-white, low income Americans are especially dependent on smartphones for online access’ (Pew: 18). A 2015 UNESCO report, ‘Reading in the mobile era: A study of reading in developing countries,’ notes that ‘of the estimated 7 billion people on Earth, over 6 billion now have access to a working mobile phone’ and that ‘mobile devices are the most ubiquitous information and communication technology (ICT) in history’ (West, et al: 16). While problems of distribution and access exist in various developing countries, cell phones can play a vital role in the personal and cultural dynamics of postpartum care.

This paper will discuss the design of our cell phone app and how the app could be adapted for use in maternal and child health programs of developing countries to help postpartum mothers tell their stories and minimize the effects of PPD in their lives.

2 Stories and Themes

The nurturing, trusting relationship between doula and mother prompted the research team to think that doulas may be one of the best resources for helping address PPD in new mothers, especially among low-income women in Detroit. PPD often goes undetected or untreated because mothers do not know the symptoms for PPD, associate ‘depression’ with mental illness and do not want to be labeled as ‘crazy,’ or do not have the resources or access to resources to get help. We conducted focus groups with doula trainers, doulas, and mothers regarding postpartum care. Their stories – especially their emotional, intellectual, and physical experiences regarding anxiety and depression, and their insights into those experiences – were the foundation for the verbal content and visual design of our materials. Two major, and inter-related themes arose from our discussions. The first theme was, ‘How do I [the mother] feel?’ As one doula trainer put it, ‘it all goes back to where the mother is at that moment.’ That is, how a mother feels at any given time. She may feel differently from day to day or even hour-to-hour, but the point is to address how she feels – and her needs – at the moment. The second theme was ‘Who can I talk to?’ Having the opportunity to express her feelings, get advice, and be taken seriously validates the way a mother feels, breaks her sense of isolation, and puts her on track to cope with her feelings and ‘go on.’ In a worldwide study of PPD, the overwhelming answer of women to the question of how to treat PPD was to ‘be able to talk with someone’ (Oates, et al: s14).

Two additional themes from the focus groups influenced the design of the app: flexibility and interactivity. The design needed to be flexible in responding to the emotional changes and needs that a mother could feel. And the design needed to be interactive so that it provides a format that allows for exchanges between doula and mother, and that a mother could easily work with it on her own. The doula would initially take the mother through the app and help her decide whom to contact for what purpose (developing her network of support). In this way, the doula could explain the symptoms, annotate the range of social agency resources available, and help the mother decide which tasks she needs help with during the postpartum period. The app is then ready for the mother when

she needs it, and she knows how to edit her list of contacts and tasks as needed.

Thus, storytelling is central to the design of the app and to its use. Storytelling as a research and design methodology (Moldenhauer, 2008) informs the question-and-answer structure of the navigational sequence, and is the platform for the interaction between doula and mother. The app personalizes the mother's experiences and personalizes the information, advice, and support provided by the doula. In this dialogue, storytelling enables the give- and- take of information sharing at a personal level that builds a trusting relationship between doula and mother. The doula is then able to provide support for the mother's needs based on how the mother is feeling (Beeber & Canuso 2005).

It is important to note that the doula cell phone app does not use the term PPD but rather use terms that the mothers used to describe their feelings. We found that mothers did not like the term 'postpartum depression' because of its association with – and stigma of – mental illness and because they often did not know what it really was. Often their first thought about PPD was that of postpartum psychosis, the extreme end of PPD – stories of women killing their babies or harming themselves. They often did not associate their feelings of crying a lot, sadness, not wanting to leave the house, being overly protective of their babies, anxiety, or being uninterested in doing day-to-day things as possible signs of PPD. They just knew that 'something wasn't right.'

The Doula Cell Phone App

Figure 1: Doula cell phone app: screens 1 and 2 (From McComish, J.; Groh, C. & Moldenhauer, J.; Development of a Doula Intervention for Postpartum Depressive Symptoms: Participants' Recommendations. *Journal of Child and Adolescent Psychiatric Nursing* Copyright © 2013. Wiley Periodicals, Inc. Reproduced by permission of John Wiley and Sons)



The cell phone app begins with the screen that says, 'How do I feel?' It is the starting point for the app; everything else in the app responds to that question. The list of 'feelings' runs from common feelings that mothers may experience during the first couple of weeks of postpartum – feelings often associated with the 'baby blues' – to serious symptoms of PPD. The naming of the feelings came from the words used by the mothers during the focus groups to describe their feelings. Each feeling was designed as a typographic icon – a visual interpretation of the description – that works as a mnemonic device and, through its animated quality, picks up on the emotional content of the words. The typographic icon modifies the abstraction of the printed word to make the description of the feeling more tangible and, thus, more personal.

The second screen shows only the implications for the 'feeling' selected initially by the mother followed by 'What does it mean?' 'Who can I talk to?' and 'What can help me get through?' The phrase 'What does it mean?' serves as a way to help mothers learn the symptoms of PPD, know the difference between signs of 'baby blues' and PPD. It serves as an initial gauge to the severity of their experiences, as well as to help them figure out whom to call. Navigation buttons to the mother's

address book with a list of her contacts and their phone numbers or to an extensive resource list of agencies and social services and their phone numbers are under ‘Who can I talk to?’ (screens 3 and 4). The mother can choose to import any of these agency numbers into her address book. ‘What can help me get through?’ is a list of activities and tasks that the mother can annotate with the names of people she can call to help her with those specific items (screens 5 and 6). She can also add items to fit her particular needs. From here she can navigate to some self-care tips (screen 7). ‘What can help me get through?’ also shows up at the bottom of the screens for her address book and the list of resources.

Figure 2: Doula cell phone app: screens 3 and 4



Figure 3: Doula cell phone app: screens 5 and 6



Figure 4: Doula cell phone app: screen 7



The key to using this app is setting up the names and numbers in the mother's contact list – who to talk to and who to call for help with such things as grocery shopping and looking after her children while she runs errands. The doula would help the mother set up the app, discuss various symptoms (feelings) with the mother, help her decide whom she can talk to – especially advise her on the service agencies – and what kinds of tasks would relieve her of some responsibilities, and increase her time for rest and restoration while adjusting to life with a newborn. The mother's story is central to how she will shape the specifics of the app to her needs and contacts. And, setting up the app will facilitate storytelling between doula and mother, allowing the doula to tell the mother about PPD and its symptoms, set up the contacts for the mother to use if she feels those symptoms. Support received from the doula during this process may have the potential to shorten an episode of PPD or at least lessen its effects. If a mother uses this app when she feels any of these symptoms, she is may be more likely to get the help she needs, and, thus, feel 'better' sooner. The app is designed to quickly connect a mother to her support network, to help her figure out her needs and who to contact. The first screen is the point of entry to the app and does not waste time getting to the heart the matter – how a mother is feeling at that moment. The second screen is the point from which the mother can get access to the people who can help her at that moment. With three clicks, she can be talking with someone.

While the app is intended for use on a 'smart phone' such as the iPhone, the information can be adjusted to a non-smart phone simply by setting up a 'my support' contact list with names and numbers, and a 'help with tasks' list, annotating the listings as much as is possible through the cell phone brand and provider.

3 Adapting the Doula Cell Phone App to Developing Countries

Adapting our cell phone doula PPD app to the needs of new mothers in developing countries could address an important gap in their maternal and child health programs. PPD is not just a phenomenon of industrialized Western societies. The experience of PPD is worldwide but is often thought of as something that is a part of motherhood and that women just have to be tough and get through it (Ramachanran, et al 2010; Chandran, et al 2002). PPD (and maternal mental health in general) is often overlooked by many public health programs in developing countries, which usually concentrate on preventing maternal death during childbirth, child nutrition, and disease prevention. Even in developed countries that provide good and readily available medical coverage for all its citizens, such as Chile, maternal and child care includes little care for mental health and even less information or follow-up about PPD (Rojas et al, 2007). PPD is not 'on the radar' of health initiatives of many developing countries because of social customs or because the sheer physical act of survival of mother and child in the face of rampant disease and scarce medical resources is a hard enough task. Yet there are studies that demonstrate that addressing the mental health of a mother, specifically regarding PPD, helps increase the likelihood that the child will survive and thrive (Beeber, et al 2004).

Two studies looked at PPD in India, one among the poor in the city of Goa (Patel, et al 2002) and one in a rural area of Tamil Nadu province near the town of Vellore (Chandran, et al 2002). The Goa study concluded that 'economic deprivation and poor marital relationships were important risk factors' for PPD, (Patel et al, 2002: 46) as was gender-bias (wanting a boy baby but giving birth to a girl), which is a common risk factor in societies that value male children over female children. 'The implications of the findings of this study for policy and practice is that mental health must be integrated into maternal health care in low-income countries,' and that 'improving marital communication and reducing gender preference should be important components of any such interventions' (Patel, et al, 2002: 46).

In the Tamil Nadu study of women recruited from village antenatal clinics, ‘low income, birth of a daughter when a son was desired, relationship difficulties with mother-in-law and parents, adverse life events during pregnancy and lack of physical help were risk factors for the onset of post-partum depression’ (Chandran, et al 2002: 503). The study found that ‘both antepartum and post-partum depression are significant public health problems in terms of frequency’ (Chandran, et al 2002: 502). Most significantly, ‘none of these mothers sought help for their symptoms, although many were functionally impaired and were barely coping with their responsibilities. One possible reason for this low utilization of health services could be the belief held by mothers, family members and even the area health workers that this state was a normal part of pregnancy and the post-partum period, or a temporary maladjustment that would remit. A screening programme to detect post-partum depression and identify mothers in need of help certainly seems warranted’ (Chandran, et al 2002: 502). The study concludes that,

antepartum and post-partum depression are common, heterogeneous and largely undetected public health problems. Screening for depression in the last trimester and in the post-partum period... is a service that needs to be incorporated into maternal and child health programmes. There is a paucity of research from developing countries addressing the consequences of post-partum depression on the cognitive, emotional and physical health of infants born to women with this disorder. Research aimed at measures to prevent post-partum depression and to elucidate what treatments work best – and are practical in low-income countries – is also urgently required (Chandran, et al 2002: 503-504).

As with the US doulas and the cell phone app, the interaction and storytelling between healthcare worker and mother should be at the heart of adapting the app to developing countries. That would mean adjusting the use of the cell phone app to the cultural and communication contexts of each country. The paper, ‘Mobile-izing Health Workers in Rural India,’ (Ramachandran, et al 2010) describes the use of mobile phones by village ASHAs in Orissa. (An ASHA is an Accredited Social Health Activist; the Indian National Rural Health Mission mandates that one woman from each village serve as an ASHA to promote health services among pregnant women.) ASHAs used the phones to show their clients seven short videos (each less than one minute long) on ‘danger signs that could occur during pregnancy and immediate actions to take’ and on the importance of taking iron pills during pregnancy. The researchers ‘coached them [ASHAs] on pausing, asking questions and ensuring that their clients understood’ (Ramachandran, et al 2010: 1894). One example of an ASHA visit describes the ASHA ‘pausing and repeating the points shown in the video’ (Ramachandran, et al 2010: 1894) when the mother-in-law and the husband joined the conversation with the ASHA and the pregnant woman. The ASHAs also made videos of their interaction with clients, and in many of them ‘pregnant women related their experiences’ (Ramachandran, et al 2010: 1895) of pregnancy and spoke of their appreciation for what the ASHA has done for them.

The doula app could, for example, be adapted for use in India with an ASHA or other health care workers. The Orissa study (Ramachandran, et al 2010), though not about PPD per se, recognizes the vital importance of how the design of the media and the structuring (i.e., pacing, sequencing) of the health information can encourage conversational storytelling between healthcare worker and client in order to personalize the information and make it meaningful to that individual. This is exactly the function of our doula app. The Orissa study also recommends an interface that ‘eliminates the need to navigate through heavily text-based menus;’ our doula app uses typographic icons and short, jargon-free phrases. If the mother had a ‘smart’ cell phone, the healthcare worker could show the mother the information on the phone, and help her set up her contact list and list of tasks. The healthcare worker could also show her websites where she could listen to other women tell their experiences, and record her own account of PPD. If the mother’s cell phone is not a smart

phone, then a contact list of people with whom she could talk about her feelings or ask for help with chores could be created. If the mother did not have a cell phone, the healthcare worker could bring her own smart phone to show videos and visit websites as a means to begin conversations and help the mother feel less isolated. In countries where a cell phone is shared among the people of the village, and each person has a SIM card containing his/her contacts, a mother could simply insert her SIM card – complete with her contact list – into the cell phone body when it was her time to use the phone. The main point of the app and use of a cell phone is to connect a mother to others, to be able to talk with someone, and share the story of how she is feeling, and break her sense of isolation and helplessness. A study (Oates, et al 2004) that found PPD is experienced worldwide regardless of culture. The authors concluded that for women suffering from PPD, ‘social support from family (and in Europe friends), practical and emotional support from partners and having somebody to talk to were universally expressed as the remedy for postnatal depression’ (Oates, et al 2004: s13).

Figure 5: An ASHA using a cell phone with a family in Orissa, India (Photo courtesy of Divya Ramachandran ©2010 ACM, Inc. Included here by permission.)



Figure 6: An ASHA using a cell phone with a woman in Orissa, India (Photo courtesy of Divya Ramachandran ©2010 ACM, Inc. Included here by permission.)



4 Issues in Adapting the Doula Cell Phone App for Developing Countries

While the use of cell phones to help reduce or prevent PPD could be very helpful, some important infrastructure and cultural issues need to be addressed. The biggest problem for the Orissa study (Ramachandran, et al 2010) was the amount of training needed for the AHSAs to use the device and the software effectively. This will continue to be a major issue when depending on local health care workers with low-literacy skills. The study also recognized the constraints of providing care to women within more traditional societies with strong social and familial structures that define women’s roles and limit their personal interactions. The authors stressed the need to address those structures when employing new technologies and communicating new information.

The study of cell phone use by the ASHAs of India (Ramachandran, et al 2010), clearly recognized that just the availability of a cell phone was not enough to make an impact on the lives of pregnant women in a village. The researchers realized that while ‘interventions often focus on immediate affordances of ICTs [information and communication technologies], like information or knowledge transfer... ICTs for development can instead directly address barriers to change... to persuade targets of an intervention in favor of change, and motivate key community members who act as agents of change’ (Ramachandran, et al 2010: 1889). Researchers therefore addressed the power dynamics of the village – such as the low status of women in general, the dominance of the mother-in-law and the husband in the daily life and decision-making of young married women, and the influence of the ‘headman’ of the village whose support (or lack of) could make or break the efforts of any health worker – and the inadequate level of consultation/education provided by

the ASHAs. To motivate the headman and the ASHAs, both made brief testimonial videos: one by the headman stating his support of the ASHAs and others recorded by the ASHAs as their clients stated the value of their ASHA sessions. The approval of the headman for the work of the ASHAs helped persuade a woman and her husband's family of the value of the information presented by the ASHAs. With this endorsement and coaching by the researchers on how to present the videos and elicit interaction with the woman and her family, the ASHAs – through the storytelling exchange – could more effectively persuade women (and their families) of the importance of the information.

The United Nations Foundation and Vodafone Foundation Technology Partnership in collaboration with the mHealth Alliance published a discussion paper (Ranck, 2011) that clearly lays out the technological, logistical, and bureaucratic problems that interfere with providing health care in developing countries via wireless networks and mobile devices. The incompatibility of software used by different agencies, the fragmentation of data flow (that is, the lack of coordination of data collection and management between local and national levels), complexity of supply chains, need for adequately trained and qualified health care workers, and lack of governmental infrastructure are some of the difficulties described in the paper. The UNESCO report on reading (West & Chew 2015) and the use of mobile phones in developing countries also discusses cultural (gender inequality) and technological (connectivity, cost of airtime) barriers to mobile access.

5 Conclusion

While the United Nations Foundation's discussion paper presents the obstacles to efficient wireless health services, it also contains recommendations for maximizing the promise of mobile devices to improve health care in developing countries. Two of the paper's recommendations for maximizing the promise of mobile devices to improve health care in developing countries were at work in the development of our doula cell phone app: 'design thinking for data collection' and 'building systems from the ground up' (Ranck, 2011: 45). 'Insights taken from the design field could be useful in the context of eHealth systems...Designers might be able to develop creative 'work arounds' or forms more friendly to health workers or platforms that are more clearly integrated into workflows and clinical contexts... A sound design approach begins with the end users and then structures incentives and rewards for collecting and transmitting accurate data – for making good decisions at all levels' (Ranck, 2011: 45). The UNSECO report notes that 'people are more likely to engage in literacy activities on their mobile phones when they see tangible benefits to doing so' (West & Chew 2015: 38) that suggests a link between improved literacy and improved healthcare. It is this kind of collaborative engagement that will be needed to adapt our app and address the cultural and technological realities of women suffering from PPD in developing countries. Decreasing the incidence and impact of PPD can make a difference in the well-being of women and children around the world – and mobile cell phone technology can help make that happen.

Referências

- ALMOND, P. 2009. Postnatal depression: A global public health perspective. *Perspectives in Public Health*. v.129, n.5: 221-227. DOI: 10.1177/1757913909343882.
- BEEBER, L & CANUSO, R. 2005. Strengthening Social Support for the Low-income Mother: Five Critical Questions and a Guide for Intervention. *Journal of Obstetric, Gynecologic, & Neonatal Nursing*, v.34, n.6: 769-776. DOI:10.117/0884217505281885.
- BEEBER, L.; Holditch-Davis, D., Belyea, M., Funk, S & Canuso, R. 2004. In-home Intervention for Depressive Symptoms with Low-income Mothers of Infants and Toddlers in the United States. *Health Care for Women International*, v.25, n.6: 561-580. DOI:10.1080/0739933049044830.

- CAMPBELL-VOYTAL, K.; McComish, J., Visger, J., Rowland, C. & Kelleher, J. 2010. Postpartum doulas: Motivations and perceptions of practice. *Midwifery*, v.27, n.6: e214-221. DOI:10.1016/j.midw.2010.09.006.
- CHANDRAN, M.; Tharyan, P., Muliyl, J. & Abraham, S. 2002. Post-partum depression in a cohort of women from a rural area of Tamil Nadu, India: Incidence and risk factors. *The British Journal of Psychiatry*, v.181, n.6: 499-504. DOI: 10.1192/bjp.181.6.499.
- McCOMISH, J. & VISGER, J. 2009. Domains of Postpartum Doula Care and Maternal Responsiveness and Competence. *Journal of Obstetric, Gynecologic, & Neonatal Nursing*, v.38, n.2: 148-156. DOI: 10.1111/j.1552-6909.2009.01002.x.
- McCOMISH, J.; Groh, C. & Moldenhauer, J. 2013. Development of a Doula Intervention for Postpartum Depressive Symptoms: Participants' Recommendations. *Journal of Child and Adolescent Psychiatric Nursing*, v.36, n.1: 3-15. DOI: 10.1111/jcap.12019
- MOLDENHAUER, J. 2008. Prescription Medicine Labeling Design: Connecting Stories and Personalizing Information. In M. Averinou, & R. Griffin (Eds.), *Selected Readings of the International Visual Literacy Association*, IVLA 2007: Visual Literacy Frontiers – Information, Culture and Diversity, 147-154.
- OATES, M.; Neema, S., Austen, P., Giangeaud-Freudenthal, N., Figueiredo, B., Gorman, L., Hacking, S., Hirst, E., Kammerer, M., Klier, C., Seneviratne, G., Smith, M., Sutter-Dallay, A-L., Valoriani, V., Wickberg, B & Yoshida, K. 2004. Postnatal depression across countries and cultures: a qualitative study. *The British Journal of Psychiatry*, v.184, n.46: s10-s16. DOI: 10.1192/bjp.184.46.s10.
- PATEL, V.; Rodrigues, M. & DeSouza, N. 2002. Gender, Poverty, and Postnatal Depression: A Study of Mothers in Goa, India. *American Journal of Psychiatry*. v.159, n.1: 43-47. DOI: 10.1176/appi.ajp.159.1.43
- PEW RESEARCH CENTER. 2015. *The Smartphone Difference*. < www.pewinternet.org/2015/04/01/us-smartphone-use-in-2015/ > retrieved 19/06/2015
- RAMACHANDRAN, D.; Das, P., Canny, J. & Cutrell, E. 2010. *Mobile-izing Health Workers in Rural India*. CHI 2010: 1889-1898. <research.microsoft.com/pubs/122814/p1889-ramachandran.pdf > retrieved 29/06/2011
- RANCK, J. 2011. *Health Information and Health Care: The Role of Technology in Unlocking Data and Wellness – A Discussion Paper*. Washington, D.C.: United Nations Foundation & VodafoneFoundation Technology Partnership. < unfoundation.org/assests/pdf/info-as-care/pdf > retrieved 15/07/2011
- ROJAS, G.; Fritsch, R., Solis, J., Jadresic, E., Castillo, C., González, M., Guajardo, V., Lewis, G., Peters, T. & Araya, R. 2007. Treatment of postnatal depression in low-income mothers in primary-care clinics in Santiago, Chile: a randomized controlled trial. *The Lancet*, v.370, n.9599: 1629-1637. DOI: [http://dx.doi.org/10.1016/S0140-6736\(07\)61685-7](http://dx.doi.org/10.1016/S0140-6736(07)61685-7)
- WEST, M. & CHEW, H.E. 2014. *Reading in the mobile era: A study of mobile reading in developing countries*. Paris, France: UNESCO. <<http://www.unesco.org/new/en/unescoc/themes/icts/m4ed/mobile-reading/reading-in-the-mobile-era/> > retrieved 19/06/2015

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Chapter 4

Design and interactive bilingual literature

Rita Couto, Cristina Portugal, Eliane Jordy, Ana Correia, Felipe Alram, Lucas Ribeiro, Natalia Brunnet

keywords: design, education, technology, narrative, inclusion

The paper describes the design process of an interactive book in bilingual digital format (Brazilian Sign Language - LIBRAS and Portuguese) through an investigation that encompasses relationships between Design, Education and Technology. The book has deaf children as the target audience, but it can equally interest hearing children, according to the interactivity features and the story in two languages. The paper presents a summary of the methodology that guides the research, contemplating studies of similar objects, the synthesis of the theoretical foundation and the first sketches of illustrations of characters and scenarios, as well as the initial soundtrack options. The project aims to develop, from the perspective of design, strategies that enable knowledge about the needs and potentials of deaf children, encouraging their development and, therefore, proposing a reflection on the conditions of educational inclusion and social participation of deaf children on society.

1 Introduction

This paper presents an interdisciplinary investigation that is being undertaken, involving the fields of Design, Education and Technology, which was covered by the grants “Universal Edital 14/2013 – CNPq” and “Edital Faperj” for supporting the development of educational materials for activities of teaching and research in 2014. It is being developed by the team of researchers from LIDE/DAD/PUC-Rio, Laboratório Interdisciplinar de Design/Educação (LIDE) from Departamento de Artes & Design (DAD) at the Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio).

Investigations being undertaken at LIDE/DAD/PUC-Rio encompass the development of products, resources, methodologies, strategies, practices and services aiming to promote functionality, related with the activity and participation of people with disabilities, reduced mobility or handicapped, aiming for their autonomy, independence, quality of life and social inclusion (ATA VII/CAT, In: PORTUGAL, 2013).

Digital technology brings new possibilities for the inclusion of people with special needs into society. Deficiency is not an attribute of the human being, but a complex set of situations, many of them created by the social environment.

Consequently, it is the responsibility of society to make the necessary changes for the full participation of people with disabilities in all areas of social life. However, it is a question of attitude or ideology regarding the social changes; while at the political level, it is a question of human rights. (ATA VII/CAT, In: PORTUGAL, 2013).

An action of fundamental importance is the development of means that allow relationships between knowledge about the needs and potentials of children with special needs and the tools, equipments and toys that may stimulate their development. This approach may be considered as necessarily double. In other words, on the one hand it is essential to know the needs and restrictions, on the other it is also essential to investigate and discover elements that allow one to meet them.

Based on the ideas drafted previously, the focus of this study is to produce a bilingual digital interactive book (Brazilian Signals Language – LIBRAS and Portuguese), having the hypermedia environment as a tool in developing the reading process of deaf children, but not exclusively them.

The narrative of the interactive book has as its theme the city of Rio de Janeiro, due to the commemorations of its 450 years, aiming to raise the awareness of children of the cultural heritage and the development of their citizenship. Aiming to reach this desideratum, it is intended that a narrative will be made available, in digital format, under an important point that constitutes the history of the city of Rio de Janeiro in order to help the teaching-learning process of deaf and hearing children, having as its basis the competences determined by the relevant Brazilian Laws (“Lei nº 9.394/96 – Lei de Diretrizes e Base da Educação Nacional”, BRAZIL, 1996).

The paper reports the methodological process on which the research is based, starting from the first stage of investigation that comprised the study of similar issues, to analyze examples that would stimulate comprehension about the problem being studied. Research is being developed about the interaction possibilities and theoretical foundation that is propitiating the development of the narrative and of studies about the storyboard and illustration. The methodology also includes the development of options of visual, verbal and sound language, in order to collaborate with the process of interpretation and constructing the meaning of the information that will be made available. The first hypotheses about possibilities of inserting sounds by means of graphical representation are also being studied.

2 Research Methodology

The team of researchers from LIDE linked with the project, Rita Couto, Cristina Portugal, Eliane Jordy, Ana Correia, Felipe Alam, Lucas Ribeiro and Natalia Brunnet, have weekly meetings at LIDE/DAD/PUC-Rio in order to discuss questions about the theoretical foundation and to plan actions for the development of the book. Also, during those meetings, the planning, organization, analysis and distribution of tasks is done.

The qualitative research being performed has an exploratory character, aiming to provide more familiarity with the problem, in order to make it more explicit. According to guidelines from Gil (1997), flexible planning was adopted, in order to allow the consideration of the various aspects regarding the study object.

It involves the literature and a document survey, as well as interviews with specialists in bilingual education. It foresees sessions for validating the book throughout the project process, to be carried out at the National Institute for Deaf Education in Rio de Janeiro. The development of the narrative is pointing to a universe of interactive possibilities, by means of illustration, scenarios, acoustics, written text and text in LIBRAS, aiming to allow children to make their choices using their own repertory.

Besides, the research includes interdisciplinary theoretical knowledge about Design and education, pertaining to the research line Design in Teaching-Learning Situations, having as its focus studies that propitiate the creation of strategies, under the light of Design Methodologies. This in turn contributes to building virtual educational materials aiming to help in the propagation, technological knowledge, innovation and strengthening of this knowledge area (COUTO et al., 2014).

3 Narrative

The option adopted of a fictional narrative for the digital book aims to induce in the reader, under the perspective of Barthesian thinking, ‘flavored knowledge’, illuminating both the object book, as well as the reader hunched over it, by means of an experience that aims to include both the hearing, as well as the deaf, in the use that they make of the language. (PORTUGAL; et al., 2015)

Words are no longer deceptively designed as simple tools, they are launched as projections, explosions, vibrations, flavors: writing turns knowledge into a party. (...) writing is everywhere where words have flavor (flavor and knowledge have, in Latin, the same etymology). (...) it is this flavor of words that makes knowledge deep, fruitful. (BARTHES, 1987, p.21)

The narrative of the digital book highlights, mainly, objects and environments. Its setting is a neighborhood in the city of Rio de Janeiro, “Cosme Velho”. It is presented in sequence, with a beginning, a course of events, a climax and an ending that suggests a new beginning. Despite a realistic figuration, the narrative brings elements of fantasy that enables the protagonists – two children of different races and characteristics, one deaf and the other hearing – to know each other and become friends. Two characters allowing deaf and hearing children to identify with them.

LIBRAS is the first language of the deaf, written Portuguese being the second one, according to the bilingual teaching orientation. LIBRAS grammar is different from Portuguese grammar because it does not make use of connectives or articles and there is no verbal conjugation. Besides, inside a text there must be elements establishing a link between the parts. In the digital book being developed, narrative has the role of having significant links that make the cohesion of the written text, combining it with sound and images.

Under this perspective, the ideas of Vilches (2003) were used as the foundation, to whom “each medium has its own criteria of pertinence and to semanticizing its languages; on the other hand, each language depends upon a specific support to express itself” (VILCHES, 2003, p.244). In other words, the exploration of the resources and languages of each platform and the complementarity of contents between them may open, for the reader, countless narrative possibilities.

The shapes and narrative universes progress with the evolution of the media and means of expression, as well as the use that we make of the new technologies.

The format of digital history that is coming will encompass several different formats and styles, but it will be, essentially, a unique and unmistakable entity. It will not be an interactive “this” or “that”, although much of this format can be extracted from tradition, but a reinvention of the act of telling histories itself for the new digital medium; (MURRAY, 2003, p. 236).

In a literate society such as ours, children relate with the written language much before their ingress in school. Learning to read means learning to read the world, giving it a meaning, sharing reading experiences, talking about the relationship that, sometimes, happens between the reader and some texts.

Within this context, the proposed work had the objective of guiding the narrative process in a playful way, organizing a language and a proper esthetics for the medium, using current platforms such as tablets and smartphones, propitiating a way for the deaf and hearing children to manage the narrative, by “moving through the narrative world on their own initiative, building a personal interpretation of the story” (MURRAY, 2003, p. 237). Thus, the link between one scene and another will be built by the reading child – based on its repertory and subjectivity – and by means of the links that offer distinct paths, turning the reading not only into an activity with an end in itself.

Approaching the child with the universe of books in an open way is a commitment that Education must have. Fanny Abramovich, a Brazilian author of children’s literature, says that if ‘the child is the only culprit in adult tribunals by not reading, one must ask for the not-guilty verdict, because more guilty are the adults that do not provide this contact to it, that to not open to it that and many other tracks for walking through the world of letters’. (ABRAMOVICH, 1999, p.163).

4 Analysis of Similar

The foundation process of the research had an analysis of similar in order to allow a greater proximity with the research object to be developed and with the target public, children from six years old. (PORTUGAL, C. et al., 2015)

The first part of this study consisted of an analysis of printed books. In order to exemplify the path taken, the books “Pelo Rio” (By the River) and “Aconteceu na escola” (It happened in school) stand out.

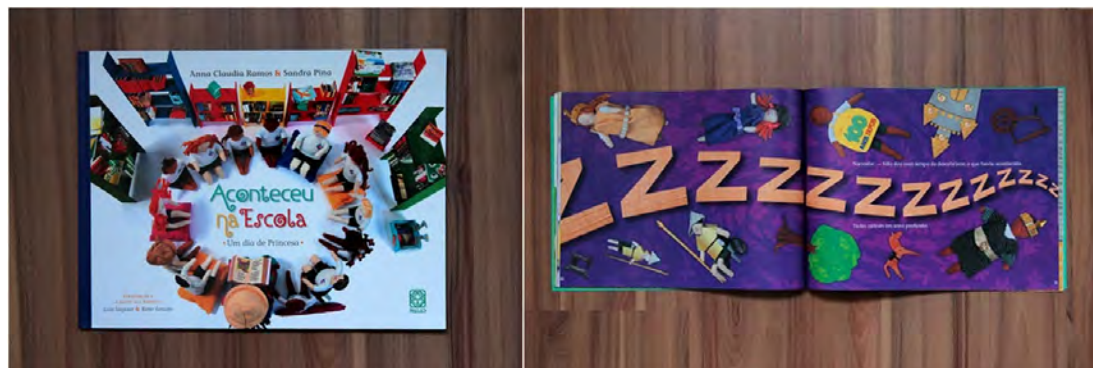
The book “Pelo Rio”, published in 2014 by the Argentinean Vanina Starkoff, has illustrations and written texts. It talks about the quest for happiness and alludes to the path that we pass along in life, having the river as the metaphor of this journey. The narrative happens basically by means of images supported by short texts, which complement the meaning of the image. This set composes one story where, on each page, there is a predominance of image over written text. The book has 36 pages and the target public indicated in the publication is in the age group between 4 and 10 years.

Figure 1: Pages of the book “Pelo Rio”, from Vanina Starkoff.



In the educational area, the book “Aconteceu na escola” by Anna Claudia Ramos and Sandra Pinas was one of those chosen as a similar item due to the type of illustration, basically composed of drawings and photographs of objects, in a mixed technique. The narrative examines in a playful way the question of citizenship and inclusion. It provokes the reader to reflect about physical characteristics and aesthetic concepts.

Figure 2: Pages from the book “Aconteceu na escola” by Anna Claudia Ramos and Sandra Pina.



The second part of the study about similar consisted of an analysis of application books. In order to illustrate this research the book “Fantastic flying books of Mr. Morris Lessmore” was selected, an application book inspired by Hurricane Katrina, by Buster Keaton and by the tale “The Wizard of Oz”.

It has a narrative appeal with relevant content and allows readers to have an exciting reading experience by accessing the resources of augmented reality. The reader must perform tasks and interact with the story in order to unlock the content. The application is compatible with iPad and iPhone.

Figure 3: Pages from the book “Fantastic flying books of Mr. Morris Lessmore”.



The printed book as well as the applications analyzed were selected as being similar due to the fact that the narrative is not primarily structured on the verbal text but on imagistic strategies, with resources that demand imagination, and the verbal treatment is complementary. The option for an imagistic narrative proved to be essential to work more efficiently and easily with LIBRAS.

Burdek (2006) states that ‘Design is an activity associated with creativity and creative fantasy, with the spirits of invention and technical innovation’. (BURDEK, 2006, p.225). This reflection was fundamental for the understanding that the development of the format is influenced by several contexts and conditions which determine the choices and the visual elements.

5 Analysis of Interactions

The same methodology of analysis of similar items was used for studying interactions compatible with the content of the narrative and the adequacy of questions regarding the possibilities of potentiating competences and abilities which may enrich the development of deaf and hearing children.

First the content made available by Apple about interactions available for the iPad was searched, then other sources available on the internet that showed interactions of interactive digital books for children were equally researched.

Fifteen videos were selected and, from the analysis of each one of them, the most appropriate interactions for the narrative of the digital book were selected. Thus, for each scene in the narrative a possibility of interaction was indicated, in order to enable the testing and evaluations with deaf and hearing children.

Next, the interactions selected for dialogue with the narrative are exemplified, using some screens captured from the analyzed videos.

Narrative section of the 1st scene: In the foothills of Corcovado live Ana and José. The scene is a village in “Cosme velho”, foothill of Corcovado. The planned interaction is the customization of the personages Ana and José. Similar interaction was found in the book “It’s the Great Pumpkin, Charlie Brown”. There is the possibility of customizing the personage that will be present in the history. However, this customization is limited, since the user can only change its clothes.

Figure 4: Screen from the book “It’s the Great Pumpkin, Charlie Brown”.



Narrative section of the 2nd scene: Ana and José are friends and have a lot in common, but also have their differences. The scenery shows Ana and José in the village where they live.

The things that they have in common are: they love to suck an orange, in the tree that is in the village. The interaction previewed is children shaking the iPad and the fruits falling on the soil. There is also the possibility of moving and pressing the fruits.

Similar interaction found: in the book “The Tale of Peter Rabbit” by Beatrix Potter, the user may, in a given page, click on the scenery so that the fruits will appear. The reader can move them with the finger and squeeze them with a pressure.

Narrative section of the 4th scene: As they have been friends since being very young, Ana and José already spent some summers, autumns, winters and springs together.

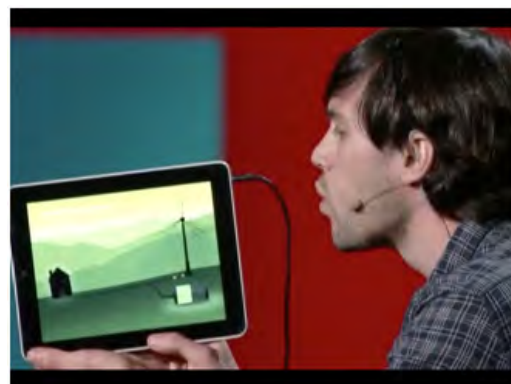
In order to illustrate autumn, for instance, the scenery has dry leaves falling from the trees and children playing with them in the soil. The interaction previewed is to enable the children to blow over the iPad mic so that the leaves will move and fly.

A similar interaction found was a speech given at the TED conference by Mike Matas, presenting the interactive book “Our Choice”, by Al Gore. This book gives the opportunity for the user to blow the iPad mic that is at the bottom, at the side of the charger input, thus generating a reaction on the page of the book.

Figure 5: Screen from the book “The Tale of Peter Rabbit” by Beatrix Potter.



Figure 6: Screen from the book “Our Choice”.



6 Visual Language of the Narrative

Portugal et al. (2015) says that the written and visual languages are systems of symbols created by the social activity organized by individuals. Currently, with the advent of digital technologies, the visual language became highly valued. Symbolic representations, due to the media, become increasingly sophisticated, aiming at the dialog between the individual and his/her social context.

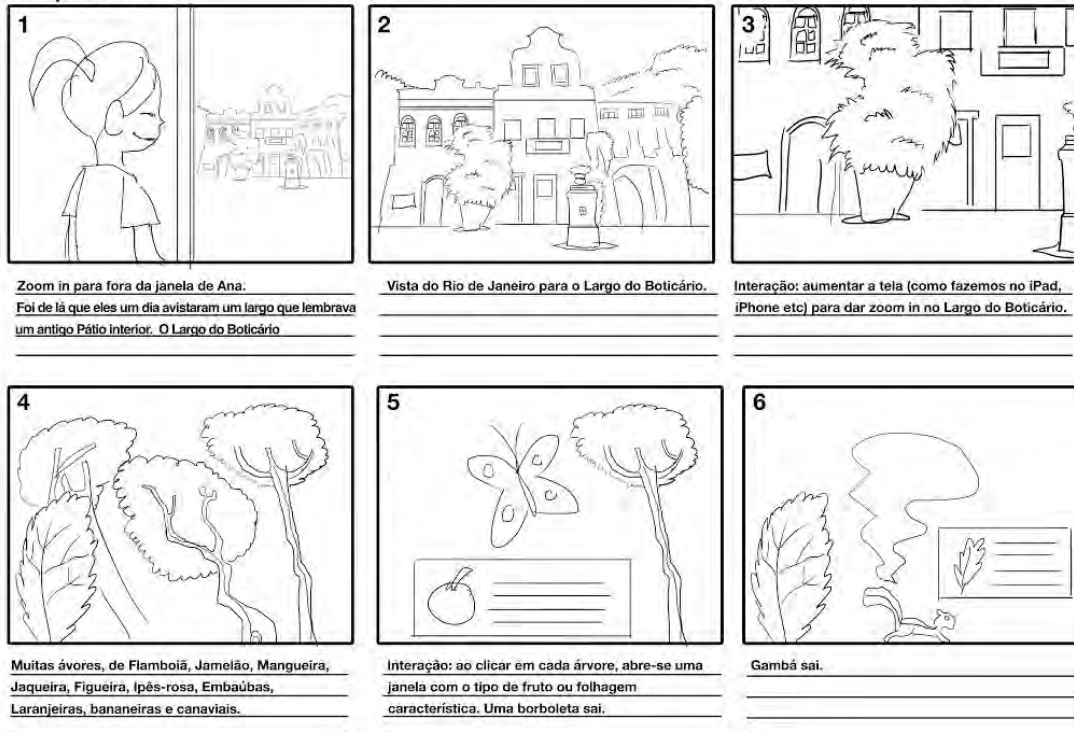
By combining storytelling with resources of digital technologies, the narratives are elaborated under the perspective of multiple languages, allowing text, photography, video, audio and graphics to be digitally translated and simultaneously visualized.

After extensive research about the most appropriate visual language for the proposed narrative, the process of creating the storyboard started. In order to illustrate the guiding principles of this works, Teixeira et al. (2014) is cited, stating in its studies that: the composition of the visual space contributes to the readability and interaction in a digital visual interface. This may be effectively achieved by means of parameters for using the graphic-visual elements with the principles of design, which contribute to the reading, orienting the narrative flow and highlighting the resources of interactivity.

Thus, the concepts and techniques of Information Design, applied to the project of the visual language, collaborate with the process of interpretation and construction of the meaning of the available information, as is possible to see in the studies already developed about storyboard and illustrations.

Figure 7: First studies of the narrative storyboard.

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The first studies for the illustrations of the digital book are being made in parallel with the storyboard development. They include the definition of personages, navigation icons, transition pages, scenarios for LIBRAS and others.

Figure 8: Study of illustrations of scenarios and personages.



7 Prototyping

After analyzing the interactions used in other books for the iPad, a report was produced in order to enumerate and classify them. From this consolidation, it became imperative to move to a new stage in the development and application of the studies performed during the research: prototyping.

The first generation of ideas was based on the concepts of Information Design, which is an area pertaining to the field of Graphic Design. It aims to equate the syntactic, semantic and pragmatic aspects surrounding information systems by means of contextualization, planning and production of the graphic interface of information for its public, in this study for deaf children, but not exclusively. The basic principle of Information Design is to perfect the process of information acquisition effected in analogical and digital communication systems (PORTUGAL, 2013). Thus, the possibilities offered by the iPad screen were analyzed, and elements such as icons, background, color, typography and others were observed during the weekly meetings of the project team. In those meetings lay-outs were elaborated for some screens, to define font, body, alignment and positioning of the LIBRAS interpreter on the screen, aiming to create a first prototype. This process makes it possible to make adjustments and corrections as well creating new proposals.

The prototype has some proposals for buttons for the commands “next page”, “initial page” and “configurations”.

This method allowed the identification of some problems in the first proposals, so that the team could evaluate and redefine some of them.

The next prototype was produced with the aim of testing how the visual and conceptual insertion of the LIBRAS interpreter into the history would be. The option adopted was to insert the video with the image of the interpreter at the left of the screen, simulating a sheet of paper, with an overlay over the illustration, so that, on the same screen, the reader may read the text, watch the video in LIBRAS and visualize the illustration, in order to make the user experience more fluid and uninterrupted.

Figure 9: Images of buttons and their applications in the book.

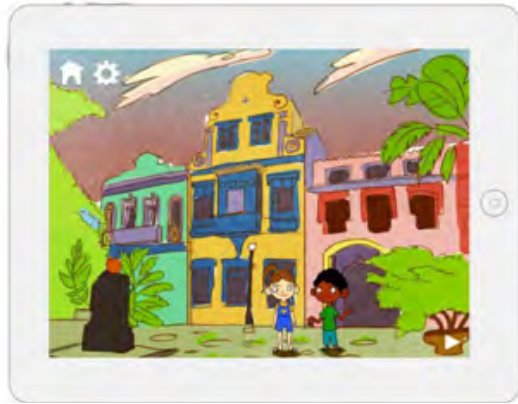


Figure 10: Image of the second prototype of the book.



Analyzing the second prototype, the need was confirmed for the presence of a real LIBRAS interpreter, in order to produce a more suitable product. For that, a contact was made with a teacher from the INES – National Institute of Education for the Deaf -, Ronaldo Gonçalves de Oliveira, so that they could intermediate our relationship with the student body of the institute in order to select some students that could be interested and, agreeing with the scope, tell the history in LIBRAS.

After selecting students from the INES, the one chosen to perform the filmed interpretation tests of one part of the narrative in LIBRAS was the student Emanuel Carvalho, as Figure 11 shows.

Figure 11: Screen capture of student Emanuel Carvalho filming.



With images from tests, the first prototype with the real interpreter on screen was produced, as shown in Figure 12.

The next stages consist of filming the whole narrative in LIBRAS, developing all storyboards and illustrations, in order to, finally, create the programming of the digital book interactions.

Figure 12: Image of the third prototype.



In parallel with this study research is being performed for inserting sound, considering the relevance of sound in interactive digital projects, as will be discussed next.

8 Study About the Possibility of Including Audio in the Narrative

Symbolic representations, due to the media, become increasingly sophisticated, aiming to have dialog between the individual and his/her social context.

The relevance of sound in hypermedia projects is pointed out by Belloni and Subtil (2002), when they affirm that the production, treatment and editing of audio, both as an independent element or as a part integrating the interactions during the development of hypermedia environments, aims to intensify the process of immersion and cognitive engagement of the user, by making the experience of interactivity and navigation more complex and attractive.

In consequence, this experience surrounded by image, hypertext and sound becomes more complex and complete, because it reaches the user in different senses by means of a unique object of communication: hypermedia. All those ways of expression – languages – are mixed in the same message, building meanings, carrying representations and spreading symbols.

From this perspective, this study considers the need of including sound even for a deaf audience, because, besides potentiating the interaction with hearing children, it is also a source of stimulus for the former, by means of the vibration that the iPad provides.

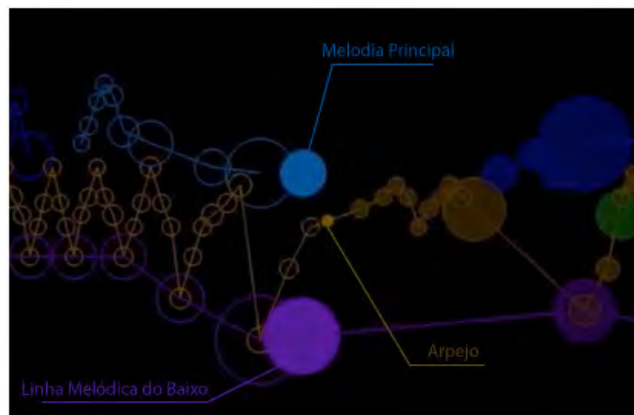
A musical composition is being developed for the project. In principle, besides being available by a sound medium, stimulating the sense of audition, it will also be offered by means of a software called “*Music animation machine*” that allows the graphic representation of music in several ways.

In order to exemplify the use of the software in this study, an analysis developed by a member of the team who is a musician is presented, about a video available in Youtube called “*Debussy, Arabesque #1, Piano Solo*”, which illustrates the effect enabled by the aforementioned software.

On it, music is represented by means of a scatter plot where the “x” axis represents time and the “y” axis is the height of the notes. Each note is visualized by a circle whose size changes according to the length of the note. The greater the length is, the greater the size of the circle and vice-versa. Besides, colors are used to separate and identify different musical ideas, such as: during the beginning of the piece, arpeggios are presented in yellow, and the melodic line of the bass is presented in purple; blues may be considered in that representation as being the main melody. Besides the colors, these ideas are also unified by means of lines linking the circles to one another.

Empty circles represent notes already played, lightened and moving ones, the notes being played and the full ones, notes that will still be played.

Figure 13: An example of the screen for visual representation enabled by software “Music animation machine”.



The objective of this tool is to allow the deaf child to interact with the hearing child and with the music being played. By means of the graphic representation of sound, the deaf child will receive the information visually. At a preliminary stage, this work is still being improved, in order to identify the best way of offering this resource in the interactive digital book.

9 Closing Remarks

In a report titled “LIBRAS Literature stimulates the inclusion and development of deaf children”, published in “Globo newspaper” in 2011, Fernanda Brescia states that stories in printed or digital format stimulate the vocabulary and the acquisition of abilities by deaf children. Narratives translated or adapted for the Brazilian Sign Language (LIBRAS) are the most recommended ones. The report mentions the teacher and coordinator of the Nucleus of LIBRAS from the Faculty of Letters, Federal University of Minas Gerais (UFMG), Elideia Bernardino, for whom the contact with LIBRAS must be encouraged early. “The sooner [the child] has contact with LIBRAS, the better, because it will help the cognitive development and he/she will acquire a language early. Learning LIBRAS won’t interfere in the learning of Portuguese”, she states.

According to the researcher, the body and face expression of the interpreter telling a story transmit feelings that help in the integration and development of children from the deaf community. The written text is cold for a person that does not dominate the language. On the other hand, with LIBRAS the child feels the narrated emotion.

Coming to meet the ideas previously presented, it is believed that the project of a digital book that could be easily accessed in mobile devices and that promotes a ludic and interactive experience is of great relevance not only for deaf but also for hearing children.

Joining this is the opportunity of developing a project born from a partnership between three areas – Design, Education, Technology – reaffirming the interdisciplinarity that must permeate the development of projects in the field of Design.

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References

- ABRAMOVICH, F. *Literatura Infantil: Gostosuras e bobices*. 5 ed. São Paulo: Scipione, 1999.
- ATA VII - Comitê de Ajudas Técnicas - CAT. Available in: <<http://www.assistiva.com.br/>>. Access Jan 02, 2013. In: PORTUGAL, C. *Design, Educação e Tecnologia* (online – www.design-educacao-tecnologia.com). Rio de Janeiro: Rio Books, 2013.
- BARTHES, R. *Aula*. São Paulo: Cultrix, 1987.
- BELLONI, M. L.; SUBTIL, M. J. Dos audiovisuais à multimídia: análise histórica das diferentes dimensões de uso dos audiovisuais na escola. In: Maria Luiza Belloni. (Org.). *A formação na sociedade do espetáculo*. São Paulo: Loyola, 2002, p. 27-46
- BRESCIA, F. *Literatura em Libras estimula inclusão e desenvolvimento de crianças surdas*. Available in: <<http://g1.globo.com/minas-gerais/noticia/2011/10/literatura-em-libras-estimula-inclusao-e-desenvolvimento-de-criancas-surdas.html>>. Access on Dec 10th, 2011
- BURDEK, B. E. História, teoria e prática do design de produtos. São Paulo: Edgard Blucher, 2006.
- COUTO, R. M. S.; et al. Interactive digital book for deaf and listener children. In: *EDULEARN14, the 6th annual International Conference on Education and New Learning Technologies*. Barcelona: IATED Digital Library, 2014.
- GIL, A. C. *Como elaborar projetos de pesquisa*. São Paulo: Editora Atlas, 1987.
- MURRAY, J. *Hamlet no Holodeck: o futuro da narrativa no Ciberespaço*. SP: Itaú Cultural-UNESP, 2003.
- PORTUGAL, C. *Design, Educação e Tecnologia* (online – www.design-educacao-tecnologia.com). Rio de Janeiro: Rio Books, 2013.
- PORTUGAL, C. et al. Design and Narrative for Deaf and Listener Children. In: Kia Ng; Jonathan P. Blown; Nick Lambert. (Org.). *EVA LONDON 2015 Electronic Visualization and the Arts*. 1ed. London: BCS Learnin & Development Ltd, 2015, p. 100-105.
- PORTUGAL, C. *Design, Educação e Tecnologia*. Rio de Janeiro: Rio Books, 2013.
- TEIXEIRA, D. e; et al.; A sintaxe visual no design de interface do book app infantil treasure kai and the lost gold shark island, p. 79-91. In: *Anais do 11º Congresso Brasileiro de Pesquisa e Desenvolvimento em Design*. v. 1, n. 4]. São Paulo: Blucher, 2014.
- REILY, L. H. (2003). As imagens: o lúdico e o absurdo no ensino de arte para Pré-escolares surdos. In: I. R. Silva; S. Kauchakje & Z. M. Gesueli (Orgs.), *Cidadania, Surdez e Linguagem: desafios e realidades*. Cap. IX (pp.161-192). SP: Plexus Editora.
- VILCHES, L. A migração digital. São Paulo: Loyola, 2003.
- Mike Matias: *A próxima geração de livros digitais*. Available in: http://www.ted.com/talks/mike_matias?language=pt-br. Access on April 2nd, 2014
- "It's the Great Pumpkin, Charlie Brown". Available in: <https://www.youtube.com/watch?v=6-pDulUumXQ>. Access on April 10th, 2014
- "The Tale of Peter Rabbit" by Beatrix Potter. Available in: <https://www.youtube.com/watch?v=Xo6ry2s53HU>. Access on April 10th, 2014
- "Our Choice" by Al Gore. Available in: <https://www.youtube.com/watch?v=LV-RvzXGH2Y&t=162>; Access on April 10th, 2014
- Debussy, Arabesque #1, Piano Solo* (animation ver. 2). Available in: <https://www.youtube.com/watch?v=A6s49OKp6aE>. Access on April 10th, 2014

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Section 2

Design education

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Chapter 5

Pictograms in teaching drawing to the visually impaired: a case study of a teenager's drawing of a bird

Mari Ines Piekas

keywords: pictogram, visual disabilities, children's drawings, teaching drawing

This paper presents part of ongoing research using the method for teaching drawing from Pictographic vocabulary for inclusive education – Part 1 – Animals (Duarte and Piekas, 2014), which aims to be a facilitating resource that will broaden the cognitive processes of children with special educational needs. The thoughts of M. L. B. Duarte, S. Coutinho, B. Darras, M. Massironi, J. M. Kennedy, M. Heller and F. J. de Lima on children's drawings, pictograms and tactile drawings were taken into account. The book's pictograms were developed from graphic schemes done by sighted children, which underwent formal adaptation using lines and basic geometric shapes. Its proposal comprises teaching congenitally blind children and teenagers how to draw these pictograms. Finally, some graphic solutions, found by one of the research participants regarding the drawing of the bird, are presented. The results so far are favorable and may contribute to perfecting the method.

1 Introduction

In his Letter on the blind, Diderot (1916) already showed the relationship between signs, tactile perception and communication in the mid-eighteenth century. He described the great tactile capacities of blind people and made way for the philosophical foundations of the notion of sensory compensation, promoting a discussion on vision and touch and the conflicts involving these two senses (Heller, 1991). For Diderot, tactile language was seen as a possibility for connecting ideas among individuals with this disability and society. In his words,

We have arranged that these signs should be common property and serve, as it were, for the staple in the exchange of our ideas. We have made them for our eyes in the alphabet, and for our ears in articulate sounds; but we have none for the sense of touch, although there is a way of speaking to this sense and of obtaining its responses. For lack of this language, there is no communication between us and those born deaf, blind and mute. (Diderot, 1916: 89).

According to Monteiro et al. (2007), the notion of the importance of tactile signs has come a long way, starting with the creation of the Braille system in 1829, constituting a side path for the development of blind people that enables further access to the processes and products of our culture, and this is precisely why reading and writing in this system is so important. Castellanos (2008: 39), on the importance of image in the context of visual disabilities, adds that “nearly two

hundred years after the invention of the tactile alphabet, a groundbreaking initiative of Louis Braille, the work must continue and be constantly updated to face a culture that presents itself and spreads in a fundamentally visual format.” Castellanos questions whether reading maps, signage, artwork and other media adapted for tactile reading is efficient, that is, whether the visually impaired are able to read these two-dimensional images without first going through a literacy process. We must, therefore, extend the research on the function and importance of drawing in this field and in regard to its learning. In this sense, it is important to remember the contribution of Lima & Da Silva (2010), based on the studies of Lima et al. The authors point out the need for studies that provide visually impaired children with access to image and on the importance of a shared graphic language in an inclusive setting. For them, it is of great importance

1) to develop (...) a language for tangible pictorial representation; 2) that this language is taught to visually impaired children; 3) that drawing is part of the daily life of the blind child, as it is for the sighted child; 4) that research is done aimed at standardizing the production of these drawings (...) (Lima and Da Silva, 2000).

Lima (2001), considering the research of Lima et al. and Lima and Da Silva, points out that “with the knowledge of how the sighted give meaning to their world through drawing, the blind will be able to represent their own world in a language shared by all (...)” (Lima, 2001: 14). However, thinking in this sense implies the question: what kinds of drawings can be shared by sighted and blind children placed in the same context? Knowing that sighted children produce communicational drawings (Darras, 1998), studies of this kind of graphic production were prioritized, and this has become a reference source for creating the animal pictograms contained in the book *Pictographic vocabulary for inclusive education – Part 1 – Animals* (Duarte & Piekas, 2014)¹. The development of this proposal was supported by several authors on children’s drawing; however, those aimed at their communicational aspect were prioritized.

Oliveira (2008), based on Vygotsky’s studies, shows that the path of drawing in childhood is not individual, but a process inserted within the context, as a mediator sign that represents certain contents. Along the lines of that same author, Ferreira (2003) comments on the specific role of drawing:

The concepts and meanings are produced, reproduced and modified by language. The meanings of the figurations in children’s drawings are cultural and a product of their experiences with real objects mediated by words and interactions with the “other”. The child’s perception is shaped by culturally produced meanings, and his drawings indicate this. (...) The child is continually interacting, communicating and sharing the meanings of his socio-cultural world with a language that is common to the society to which he belongs. This common language targets the child’s experiences and funds the conceptualized reality. This same reality is played by the child who draws, imagines and fantasizes creating means of communication through image.” (Ferreira, 2003: 35).

These authors’ observations refer to the socio-cultural and educational aspects and the importance of graphic language in this context. Likewise, for Darras (2003a), the study of a drawing must be related to the environment in which it was produced. For this author, socio-cultural aspects influence its production, the graphic result being closely linked to communication between people and their surroundings. This focus of study is inserted in the field of dialogical cognitive semiotics² that addresses the meaning of images and how they are internalized by the individual, through cognitive processes, in

1 The book *Pictographic vocabulary for inclusive education –Part 1– Animals* can be downloaded in pdf format at: <http://editorainsight.com.br>

2 Cognitive semiotics, according to Fastrez (2003), refers to a body of research that deals with the relationships between cognitive processes and semiotic systems. For the author, “the human being uses his brain to think both his cerebral capabilities and the properties of the environment in which he lives. Certain cognitive activities cannot be understood unless approaching the group level rather than the individual.” (Fastrez, 2003: 9)

a relationship of that individual with the socio-cultural and educational environments. In this sense, for Darras (2003a), a drawing has a communicational function, and for the child, it will be produced with this same function. From the standpoint of Darras and Duarte (2007),

If we observe the activity of a sighted child in a stimulating environment consisting of other people, games and especially drawing materials, we see the inclusion of a complex set of practices, some of which are related to the production of graphic signs. We insist on the global approach of this activity because, for us, drawing is not separated from its action and communication environment. (Darras and Duarte, 2007: 54)

Communicational drawings, i.e., those which identify the world's objects, are simple drawings, containing essential characteristics of the object's shape, and this can be observed in children's schematic drawings. This position is consistent with the thought of Darras (1998), for whom the graphic activity in childhood is very intense and the schemes produced by children have simplified, generalizing and neutral features. According to the author, this intellectual process of reduction and generalization of the wide variety of objects and situations that surround the human being is fundamental for greater memorization and recognition of this diversity (Darras, 1996).

From the standpoint of Coutinho et al. (2007), authors such as J. Goodnow and N. H. Freeman point towards the theory of R. Arnheim on 'structure' as the child's first perception of the object. Thus, the drawing made by the child, in the authors' interpretation, "is not a replica but an equivalent of the original. This means that the drawing encompasses certain properties of the original, and that these properties or the units chosen to represent this form of equivalence are based on the original structure" (Coutinho et al., 2007: 32).

Still for Coutinho et al., the basic lines and geometric shapes used by the child, when organized visually, result in a drawing, an image. This organization is closely related to a sequence of construction of the drawing, i.e., the action of tracing a particular line tends to influence the tracing of the following line and so on, consequently interfering with the final result (Coutinho et al., 2007).

For these researchers, from the point of view of J. Goodnow, children's drawings can be regarded as a 'construction', for which it is necessary to choose and combine the pieces to be drawn. According to Coutinho et al. (2007), Goodnow says that, just as with drawing, other daily activities also have order, sequence and direction as important aspects, because the beginning of a particular activity can change the following action, and so on, influencing its outcome. In her investigation of the human figure, Goodnow reports that, at school age, children start drawing from top to bottom, but use two strategies. In the first strategy "(...) the child completes the graphic units while drawing: head + eyes + nose + mouth + body + pair of arms + pair of legs." In the second strategy, after drawing the head, body and legs "(...) the child returns to add details to any unit already represented, such as arms, hair, eyes or mouth". (Coutinho et al., 2007: 35). For authors "This means that the drawing comprises certain properties of the original subject, and that these properties, or the units chosen to represent this form of equivalence, are based on the original structure." (Coutinho et al., 2007: 32). According to Coutinho et al. (2007), children start drawing by the outline and not the surface, and this may also be related to the general idea of structure, as proposed by R. Arnheim. In that respect, Duarte and Piekas (2014: 37-38) point out some theoretical propositions about drawing in childhood:

- a. much more than providing a visual perception, the act of drawing in childhood is a way of classifying objects in the world. The drawing is, thus, a "representative" concept (Arnheim, 1980);
- b. what is at stake in the child's drawing is not accuracy nor visual similarity, but a simple, sufficient and "logical" presentation of a given object, its "understanding" (Luquet, 1913);
- c. the use of regular, simple and symmetrical shapes to indicate the essential components that define the objects corresponds (in addition to issues of visibility and cognition) to a tracing solution that involves motor skills (Duarte, 2011).

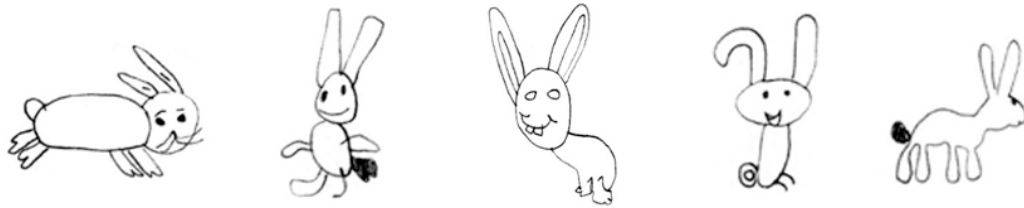
As mentioned, the use of lines and basic geometric shapes to build graphic schemes is a solution that also involves the motor capacity to trace lines (Duarte, 2011). To that end, thinking of a kind of educational proposal that would encourage and facilitate the learning of drawing, the need arose to develop a method based on schematic drawings made by sighted children. In the book's proposal, the idea is, at first, to offer children pictograms of animals, among other categories of nature such as plants, flowers, fruits and vegetables.

2 From Children's Drawings to Pictograms

Observing the graphic production of sighted children, especially between the ages of 5 and 10 (Duarte, 2007, 2008; Piekas, 2010; Duarte and Piekas, 2014), it was noted that they use planning and graphic representation resources that maintain the key attributes of objects, using lines and basic geometric shapes.

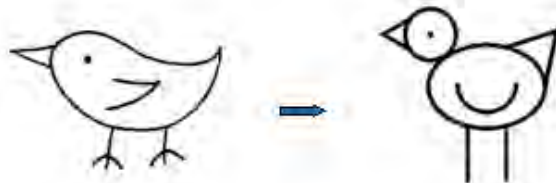
Given this framework, and according to studies and field research on graphic schemes, it is worth mentioning that children also note the formal and componential perceptual properties of animals. For example, what elements are required in a drawing of a rabbit, in order for it to look like a rabbit? It must have a head, eyes, nose, mouth, body, legs and tail, though it is essential to have long ears, as this is the formal property that defines this animal from other four-legged animals (Duarte and Piekas, 2014). The figure below (Figure1) shows the presence of these formal attributes in drawings of rabbits made by sighted children.

Figure1: Graphic schemes of rabbits drawn by sighted children. Source: GIADE and LabDIA archives.



After selecting the animals³, they were adapted into pictograms, which are simplified drawings, with a specific type of formal structure that applies to the entire set, as shown in the example of both a scheme and a pictogram of a bird in the figure below (Figure 2), and in other pictograms throughout the text.

Figure 2: Drawing of a bird by Xênia, 11y.o. Source: LabDIA. Pictogram of a bird. Source: Duarte & Piekas, 2014.



According to Darras, pictograms should remain neutral and not contain any particular aspect of what they represent, so that they can be useful in many different situations (2008 apud Duarte

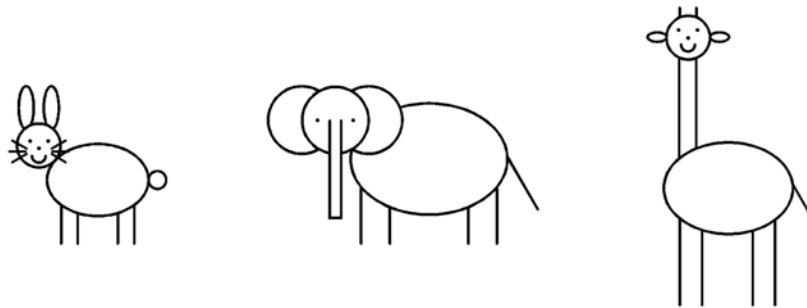
³ The animals studied and adapted into pictograms are those that often manifest in children's drawings, observed from data collection: cat, dog, rabbit, pig, cow, monkey, lion, giraffe, elephant, bear, bird, duck, swan, fish, shark, whale, turtle.

and Piekas, 2014). Also within this context, regarding the qualities of a pictogram, Massironi (1982: 121) adds:

In order to understand how to come up with a successful configuration, one must first understand the choice of attributes used to achieve the end that these settings must meet: to be read and understood by the observer employing the least possible cognitive effort and, consequently, allow the quickest possible reading.

To facilitate not only tactile reading, but also the drawing of pictograms by visually impaired children, such pictograms were prepared within the same pattern of construction, for example, oval body, circular head, parallel vertical straight legs, a curved line for a mouth, dots for eyes and a nose. Some distinguishing formal features are highlighted, such as the rabbit's ears, the elephant's trunk and the giraffe's neck (Figure 3).

Figure 3: Examples of pictograms from Pictographic vocabulary for inclusive education – Part 1 –Animals (Duarte and Piekas, 2014).



The drawings of animal pictograms went through a formal division. They could be very small, small, medium or large in size, classified into land, air or water animals, as well as domestic or wild (Figure 4).

Figure 4: Examples of pictograms from Pictographic vocabulary for inclusive education – Part 1 –Animals. Bird: air, very small size; Cat: land, small size, domestic; Lion: land, large size, wild; Shark: water, large size. Source: Duarte and Piekas, 2014.



Contour lines were also prioritized as a feature of the drawing, as they are among the most important elements studied and applied in methodologies for teaching drawing to the visually impaired, especially in the research by Kennedy (1983) which, through numerous studies, says that the blind person understands that the contour line of the object can be represented by the contour line of the drawing. From studies on this researcher's theory, Duarte complements:

Kennedy found that blind people share with other individuals the understanding that a contour line denotes the edges or boundaries of the surface of an object. He concluded, then, that the ability to accept a line (in the drawing) as a replacement for the surface edges of an object is located out of sight, beyond the purely visual patterns, which occurs, too, through the experience of touch (Duarte, 2011: 77).

The proposal for the method of the book Pictographic vocabulary for inclusive education – Part 1 – Animals (Duarte & Piekas, 2014) emerged from studies with blind children and procedures

associated with adapted teaching materials and resources using relief contour lines. In function of the results previously achieved with systematically built drawings, using graphics and respecting the drawing sequence, it was possible to confirm certain criteria that were being studied (Duarte, 2004, 2011; Piekas, 2010). It should be noted that these pictograms are being evaluated among children and adolescents and may be modified in the future in relation to their formal characteristics.

Notes on the sequence of creation of a drawing are part of this research and have the theoretical support of Coutinho & Ferreira (2009). The study of the sequence encompasses the concept of order, which refers to the organization of components in the drawing process, that is, which component is drawn first and which is represented next. Many of the graphic results obtained with this research denote new possibilities to improve the method studied, in order to reduce the mental burden on the blind child or teenager in the process of learning drawing. Lima (2001) reinforces the need for research aimed at re-encoding the object, from the three-dimensional to the two-dimensional shape, and the importance of simplifying the image with emphasis on the shape's key features. For the author, not only these features are relevant, but also the dimensions of the drawing. According to Lima (2001),

(...) eliminating a load in the semantic memory provides a greater range of vocabulary when naming the figures, indicating that the problem of recognition of the figures is not in the act, but in the access to memory, perhaps because the blind do not have a pictorial or imagetive memory bank large enough to be able to discriminate and generalize as required for the appointment of other figures that are not yet familiar to them (Lima, 2001: 83).

In this regard, Duarte (2008) complements Lima's opinion and points out that the simplified drawing, representing a class of objects with similar formal characteristics, provides great savings in mental effort. Duarte (2007) speaks of the importance of having a representative of a category of objects and how this can be two-dimensionally represented by a drawing on tactile relief. For this, the author quotes, referring to the theories of Eleanor Rosch⁴, an example (Duarte, 2007: 471): "a sparrow is a better representative of the category of birds than a pelican or an owl". In this sense, the drawing of a bird with the formal characteristics of a sparrow would be, according to Duarte, the ideal type of drawing for visually impaired children.

It is with this standard, simple and generalized drawing, capable to be automated, like all standard cognitive components (included by Darras at the base level of cognitive categories), that a set of drawings was defined to be taught to blind children. It is about promoting a reverse process of seizure of objects, in which the first information is not the visual perceptual sense, but a haptic, tactile sensation, offered as the possible summary of a visual image. (Duarte, 2007: 477).

In this sense, the theoretical framework within children's drawing, visual impairment and cognitive semiotics contributed to a proposal for teaching drawing that is being applied to two children and two teenagers, all with congenital blindness⁵. The results obtained and the data analyzed to date already denote possibilities for applying the proposed method. The case study below shows one of the many results achieved by one of the participants in the research.

4 For Duarte, from Rosch's studies, "(...) a category is a collection of objects considered equivalent, similar, based on the principles of: a) gathering the most information with minimal cognitive effort (principle of cognitive savings); and b) the information conveyed is effective because the perceptual world comes to us as structured and systematic, much more than arbitrary or random."

5 Research approved by Ethics Committee in Research on Human Beings (CEPSH – Comitê de Ética em Pesquisa Envolvendo Seres Humanos) under n. 701.072, in the Doctorate of Visual Arts, within the Graduate Program in Visual Arts of the State University of Santa Catarina, directed by professor Dr. Maria Lúcia Batezat Duarte.

3 Case Study: Drawing of a Bird from a Pictogram

The participant A. S. V., 14 years old, female, has congenital blindness and has attended a regular school since the age of 5. She participates in extracurricular OM (orientation and mobility) activities and tasks using Assistive Technology at the specialized care center for visual disabilities. Since she was a child, A.S.V. has interacted with different kinds of domestic animals, and regarding graphic activities, she did drawings in school contouring relief drawings of animals. She says that she likes to draw, and she believes it can help her better understand and know objects, as well as help in her social and educational interaction. In addition to the bird pictogram, the participant is also studying the giraffe, monkey, cat, rabbit and lion pictograms.

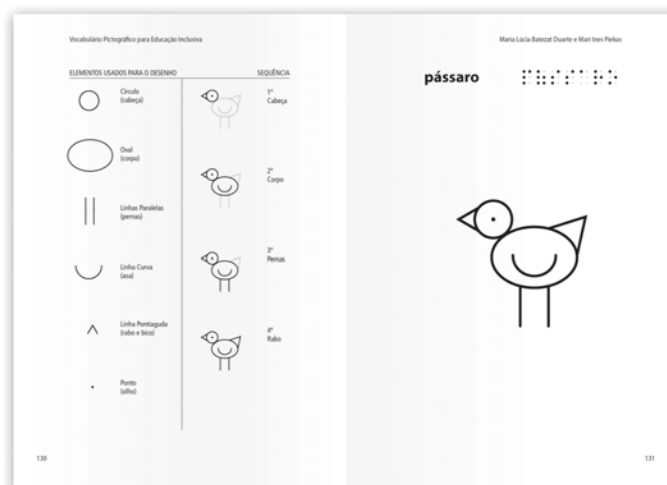
The graphic results of A. S. V.'s bird design will be presented in the order they were made. The study time was of two hours, divided into two meetings. Before starting the study with the method, the participant was requested to make a drawing from her memories of contact with live birds (Figure 5).

Figure 5: Drawing of a bird by A.S.V., from childhood memories. Source: personal archives.



The proposal for drawing a pictogram of a bird can be seen in the figure below (Figure 6), which shows a drawing sequence and the elements necessary for the construction of the figure.

Figure 6: On the left are the elements and sequences used for the drawing. On the right is the finished animal. Source: Duarte & Piekas, 2014.



Studying the graphic elements that make up the animal drawing is suggested for the first steps of the learning process, and this can be done by means of exercises ranging from scribbles, drawing static and moving lines, drawing geometric shapes, among other exercises. It should be noted that

what was expected from the repetition of lines and geometric shapes (Figure 7) and (Figure 8) when preparing the animal pictograms was to promote a motor exercise culminating in a graphic automatism and, therefore, cognitive savings, necessary to visually impaired children when drawing, so that the brain can arrange the information received (Duarte, 2011).

Figure 7: Proposed exercise with moving lines. Conception: Duarte & Piekas, 2014.

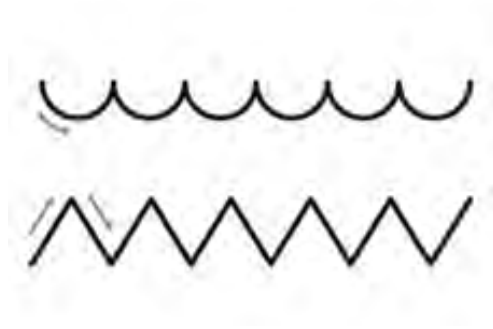


Figure 8: Proposed motor exercises using hard board with stenciled circles. Source: personal archives.



It should be noted that it is essential to use appropriate materials⁶ to prepare drawings that result in tactile line, as shown in the figure below (Figure 9).

Figure 9: Proposed materials to be used in pictogram drawing exercises: 1. board with a rough (e.g. canvas) or soft (e.g. E.V.A.) surface; 2. object or tri-dimensional model; 3. plan of the pictogram in thick material, divided into components; 4. sheet of paper; 5. pencil; 6. card with drawing of the pictogram (with contour lines and tactile relief). Source: Duarte & Piekas (2014).



One of the key steps to understanding the two-dimensional design is the study of the three-dimensional object through tactile reading. At that point in the process, the main parts of the animal are identified, which will be part of the two-dimensional drawing (Figure10). For Duarte (2011), the tactile reading of the object, understanding its structure and learning drawing can, over time, build a conception of how to represent the object studied two-dimensionally.

⁶ This type of material is proposed because it is easily available for users to acquire; however, the possibility of using other materials is also being researched.

Figure10: Tactile reading of the tri-dimensional object and resulting drawing. Source: personal archives.



In the next step, the participant tactually reads the drawing based on the relief contour, and then reproduces what was tactually perceived (Figure 11). It can be seen that the shape of the drawing of the bird below is more readable relative to its formal characteristics compared to the drawing above.

Figure 11: Tactile reading of the pictogram in relief contour and resulting drawing. Source: personal archives.



This, as well as the previous stage, is the time to see how the drawing of a bird can be conventionally represented and which graphic elements can be used to build it. The following drawing (Figure 12) shows a second attempt from the sequence suggested in the method. The participant declares that it was easier to build the parts in sequence, and that the result was closer to the drawing of the pictogram.

Figure 12: Drawing of a bird by A.S.V., from the sequence suggested in the method. Source: personal archives.



It is worth mentioning that, as the child or teenager advances in the drawing process, more details can be added for each animal – like paws, claws, fur, feathers and spots, as well as variations in the shape—according to the eagerness and cognitive and motor skills of the person who is drawing. One of A. S. V.'s skills that is worth mentioning is her ease in following the tactile line of the drawing being created on paper, which stimulates the continuity of the exercise (Figure 13).

Figure 13: Drawing of a pictogram of a bird by A. S. V. Source: personal archives.



It is noteworthy that this skill should be learned and practiced by the blind child as soon as possible, as it is fundamental in the drawing process, in understanding the image drawn and in reading tactile drawings, mostly found in study materials and literature books. In the case of the study of the bird, the participant was offered some variations in the shape of the pictogram added from the baseline, as shown in the figure below (Figure 14):

Figure 14: a. bird eating; b. bird walking; c. bird flying. Source: personal archives.



Below is the graphic result of a free composition with birds shortly after the study of the pictogram (Figure 15). The figure shows that the pictogram's components (body, head, legs, wings, beak) are repeated and respect a certain proportion, and the drawings denote movement and direction. The composition shows how the drawing is inserted within the context in which it is produced, as suggested by Oliveira (2008) and Darras and Duarte (2007) and also how the image materialized A. S. V.'s idea, demonstrating the communicational character of the design.

Figure 15: "Birds eating corn on the school's sidewalk". Free drawing by A. S. V. from the study of the pictogram. Source: personal archives.



4. Final Remarks

The preliminary results achieved with the case study of participant A. S. V. based on the method described in Pictographic vocabulary for inclusive education – Part 1 – Animals (Duarte and Piekas, 2014) show positive and encouraging results to date, and denote the need for further development in order to complement the book's proposal, especially with regard to auxiliary teaching materials and with new formal divisions of the pictograms;

The process of drawing the bird pictogram made by A. S. V. and presented in this paper, as well as drawing other animal pictograms that have been studied at other points in the research, contribute to reinforce the importance of providing congenitally blind children and teenagers with simplified figures without excessive graphic detail, so that the tactile reading of the object's shape can be easily done, as suggested by Lima (2001). Although not discussed in this paper, aspects such as size, spacing between elements of the drawing (lines and geometric shapes) and quality of the line in tactile relief, among others, are being evaluated in parallel to the study of the shape;

The theoretical approach contributed to trace correlations with the practice, particularly in regard to the data collected from sighted children's drawings and the formal adaptations that composed the pictograms;

The drawings of sighted children, source of data for creating the pictograms, have contributed beyond the study of the shape, indicating graphic possibilities that lead to new reflections on elements of visual language;

The steps proposed in the method, such as tactile reading of the three-dimensional object, tactile reading of the pictogram, motor exercises to study the elements of the drawing, and building the drawing of the pictogram, have proven to be fundamental to the success of learning the drawings, according to A. S. V.'s graphic results;

Drawing, seen as a language with communicational function (Darras, 2003b), may be shared among all students, provided the teaching material is adapted according to the needs of visually impaired children;

On the other hand, it is worth stressing the importance of teaching drawing one-on-one to blind children and teenagers, as occurs in this study, whether in regular schooling or a specialized care center, because, in many situations, the need for sensorimotor imitation arises, where the teacher and the student draw together (Duarte, 2011; Piekas, 2010). It is crucial to highlight the importance of respecting the possibilities and limitations of each child;

It is believed that this research can collaborate with other researches, especially those focusing on Universal Drawing, as well as with the preparation of relief images for children's literature books, didactic and pedagogical books, toys, signs, packaging and other media;

Another expectation, based on the results achieved, is to continue the research in order to improve the drawings of animal pictograms, study the drawing of pictograms of other categories of objects and refine the method proposed in the book Pictographic vocabulary for inclusive education – Part 1 – Animals;

For Duarte and Piekas (2014), even though the method is based on drawings aimed at blind children, because of its communicational and cognitive function, it can be used by all children.

References

- COUTINHO, S. G. et al. 2007. O desenho de observação: um estudo comparativo entre Inglaterra e Brasil. In: SPINILLO, C.; FARIAS, P.; PADOVANI, S. (Eds.) *Selected Readings of 3th the Information Design International Conference*. Curitiba: SBDI
- COUTINHO, S. G.; FERREIRA, E. S. 2009. Estudo trans-cultural do processo de desenho infantil e de memória de crianças entre 5 e 12 anos da França e do Brasil. In: SPINILLO,

- C.; BENDITO, P.; PADOVANI, S. (Eds.) *Selected Readings of 3th the Information Design International Conference*. Curitiba: SBDI.
- DARRAS, B. 1996. *Au commencement était l' image: du dessin de l' enfant à la communication de l'adulte*. Paris: ESF Éditeur.
- _____. 1998. A imagem, uma visão da mente: estudo comparado do pensamento figurativo e do pensamento visual. Tradução: Maria Lúcia B. Duarte. *Recherches en communication*. Paris, France, n. 9.
- _____. 2003a. A modelização semio-cognitiva confrontada com os resultados da neurociência – O caso da produção de esquemas gráficos. Tradução: Maria Lúcia B. Duarte. *Recherches en Communication*. Paris, France, n. 19.
- _____. 2003b. Children's drawing and information design education: a semiotic and cognitive approach of visual literacy. In: SPINILLO, C.; BENDITO, P.; PADOVANI, S. (Eds.) *Selected Readings of the Information Design International Conference*. Recife: SBDI.
- DARRAS, B.; DUARTE, M. L. B. 2007. Regards aveugles, mains voyantes. *Reliance – Revue des situations de handicap, de l'éducation et des sociétés*. Lyon, France: Éditions Éres, n. 25: 54-63.
- DIDEROT, D. 1916. *Diderot's early philosophical works*. Translated by Margaret Jourdan. London: The Open Court Published London. In: < <http://tems.umn.edu/pdf/Diderot-Letters-on-the-Blind-and-the-Deaf.pdf> > , 30/10/2015.
- DUARTE, M. L. B. 2001. Esquemas gráficos: o pensamento, a comunicação, o ensino da arte. In: 1^o Seminário Desenho: educação, cultura e cognição. ECA/USP/FAPESP, São Paulo.
- _____. 2004. Imagens mentais e esquemas gráficos: ensinando desenho a uma criança cega. In: MEDEIROS, Maria Beatriz de. (Org.) Arte em pesquisa: especificidades. *Anais do 13^o Encontro Nacional da ANPAP*. Brasília: UnB: 134-141.
- _____. 2008. Sobre o desenho infantil e o nível cognitivo de base. In: OLIVEIRA, S. R. R.; MAKOWIECKY, S. (Orgs.) Panorama da pesquisa em artes visuais. *Anais do 17^o Encontro Nacional da ANPAP*. Florianópolis: 1283-1294.
- DUARTE, M. L. B. 2011. *Desenho infantil e seu ensino a crianças cegas. Razões e método*. Curitiba: Insight.
- DUARTE, M. L. B.; PIEKAS, M. I. 2014. *Pictographic vocabulary for inclusive education: 1 - animals*. Translated by Marc Breyer. Curitiba: Insight.
- GONZÁLEZ, E. 2007. *Necessidades educacionais específicas: intervenção psicoeducacional*. Tradução: Daisy Vaz de Moraes. Porto Alegre: Artmed.
- HELLER, M. A.; SCHIFF, W. 1991. *The psychology of touch*. New Jersey: Lawrence Erlbaum Associates Publishers.
- KENNEDY, J. M. 1993. *Drawing and the Blind: pictures to touch*. London: Yale University Press.
- LAPLANE, A. L. F de; BATISTA, C. G. 2008. Ver, não ver e aprender: a participação de crianças com baixa visão e cegueira na escola. *Caderno Cedes*, Campinas, vol. 28, n. 75: 209-227, maio/ago. 2008. In: <www.scielo.br/pdf/ccedes/v28n75/v28n75a05.pdf>, 05/02/ 2013.
- LIMA, F. J. de. 2001. *O efeito do treino com desenhos em relevo no reconhecimento háptico de figuras bidimensionais tangíveis*. Tese (Doutorado), Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto / USP – Depto de Psicologia e Educação, Ribeirão Preto.
- LIMA, F. J. de; SILVA, J. A. da. 2000. Algumas considerações a respeito da necessidade de se pesquisar o sistema tátil e de se ensinar desenhos e mapas táteis às crianças cegas ou com limitação parcial da visão. *Revista Benjamin Constant*. Número 17. Ano 6, Dezembro. In: < www.abc.gov.br/.../nossos_meios_rbc_revdez2000_txt17.doc >, 10/03/2015.
- MASSIRONI, M. 1982. *Ver pelo desenho: aspectos técnicos, cognitivos, comunicativos*. São Paulo: Martins Fontes.
- MONTEIRO, P. R.; MANHÃES, L. P.; KASTRUP, V. 2007. *Questões acerca da teoria da compensação no campo da deficiência visual*. In: <<http://www.abc.gov.br/?catid=4&itemid=10061>>, 15/04/ 2015.

- OLIVEIRA, M. K. 2008. *Vygotsky: aprendizado e desenvolvimento: um processo sócio-histórico*. 4ª ed. São Paulo: Scipione.
- PIEKAS, M. I. 2010. *A desconstrução do esquema gráfico aplicado ao ensino de desenho para crianças cegas*. Dissertação (Mestrado), Pós-Graduação e Artes Visuais, Centro de Artes, Universidade do Estado de Santa Catarina.

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Chapter 6

Collaborative learning process through co-creation of graphic representations for synthesis (GRS)

Juliana Bueno, Stephania Padovani

keywords: graphic representation, design, visual thinking, collaborative learning.

In the Design field, collaborative work is a constant exercise during professional practice throughout college undergraduate years. However, during postgraduate work in Design, students start doing research work and usually learn theoretical subjects only through personal scope. With the goal of suggesting changes to such practice methodologies, this study aims to draw attention to a significant learning of theoretical classes in postgraduate Design, through collaboration principles. For this, the use of Graphic Representations for Synthesis (GRS) produced in groups within the classroom is proposed as a didactic strategy. This paper presents the results of a qualitative study, in which the production process, analysis and discussion of GRS developed collaboratively by 18 students during the classes of User-Centered Design in a Brazilian postgraduate course were investigated. Overall, results have shown that the use of GRS supported students' teaching/ learning process.

1 Introduction

Collaboration is seen as an essential means to knowledge building within both organizational (Owen, 2001; Simonin, 1997) and educational (Stahl, 2006; Vygotsky, 1978) contexts, as it brings different perspectives and points of view to the realm of the problem.

Heeman et al. (2010) emphasize that collaboration is an activity where different people help each other; in other words, there is a combined effort, as opposed to individual, with a goal of reaching a specific end. In this sense, it is understood that its meaning is directly connected to concepts like sharing, interaction, cooperation and teamwork (Ferreira, 2004).

In the field of Design, professional practice constantly encourages the designer to be involved in a collaborative way during a project-related activity. At times, he or she will be involved with other designers during the conception of a product or system, at times involved with professionals from different fields that will assist during the implementation phase. Sometimes, designers also become engaged with their target audience when the project at hand has the premise of Participatory Design. Thus, designers rarely work on their own.

In Design undergraduate education, we often find a collaborative context very similar to the one seen in professional practice. Students are encouraged to interact with classmates and to constantly work as teams. However, when the postgraduate scene is analyzed, a shift in paradigm is found. Theses and dissertations are developed and defended individually and, despite interacting verbally with classmates during classroom time, many theoretical subjects foresee and evaluate the learning

accomplishments of postgraduate students always by their predominantly individual aspect.

The current study has as a premise the recovery and exploration of collaborative work during teaching/learning of theoretical subjects at a postgraduate level in Design. Our aim is to effectively provide a significant and collaborative learning of subjects addressed during theoretical and expositive classes. Therefore, the use of Graphic Representations for Synthesis (GRS) is proposed. GRS are produced in groups as cognitive artifacts for the discussion and revision of class contents.

Padovani (2012) defines GRS as visible bi-dimensional artifacts created with the objective of fostering the understanding of written information. Tversky & Suwa (2009) argue and stand for GRS production in a collaborative way. Taking the same path, Heiser et al. (2004) discourse about the subject and note as benefits of GRS built in groups:

- the foundation of a common focus amongst the participants;
- promotion of interactivity and involvement;
- stimulation of an effective and pleasant collaboration;
- creation of shared meanings;
- better listening and recollection of the points of discussion.

Within this context, this study stands for production of GRS in a collective way towards fomenting analysis and discussion about theoretical subjects from the Design area of interest, such as research (in a qualitative way) as it happens with the collaborative learning that these GRS could end up promoting.

Therefore, theories that underlie and corroborate the precepts of the described study will be addressed first. After that, we will address the study method as well as the results of the process obtained through classroom observation of produced material, discussions and collaborative analysis of GRS done by a team of 18 students (master's and doctoral students) during the subject of User-Centered Design (UCD), ministered at the Postgraduate Program in Design (PPGDesign) of the Federal University of Paraná (UFPR).

Later, the potential use of GRS will be discussed and how the collaborative learning process happened through the GRS produced, discussed and analyzed by the groups will be presented, as well as results obtained. Last, study conclusions and their respective outcomes will be presented.

2 Theoretical Background

In this study, GRS are understood as cognitive artifacts. Norman (1991) defined a cognitive artifact as an artificial device designed to maintain, present or operate information, and that fulfills a communicational function. By assuming communication function, it can be stated that the cognitive artifact aims to describe, explain, inform or educate its target audience with minimal ambiguity.

There are authors that specifically address the functions of cognitive artifacts in educational environments. For example, Derry (1990) coined the term cognitive tool to refer to instruments that students engage in significant processing information. On the other hand Jonassen & Reeves (1996) associate the term with tangible or intangible technologies that enhance human cognitive ability for thinking/reasoning, problems solution and learning. These authors point out that cognitive tools stimulate further thinking and information processing as these are developed by learners, besides fomenting critical reflection on the subject at hand.

In the context of this study, GRS are assumed to be collaborative cognitive artifacts of teaching /learning. This idea is shared by Visser (2006), who considers that the external representations undertaken by designers throughout the ideation process are cognitive artifacts, as they allow a direct externalization of mental imagery.

The external representations facilitate manipulation of entities, reasoning, hypothesis testing, reflection, conversation, and consequently favor decision-making throughout the design process. They also help designers to compare different solution alternatives and envision the consequences of their adoption (Visser, 2006).

So, in this article, we study the production, discussion and analysis of GRS to foster **significant learning**. During this process, students engage in what is called **visual thinking** in order to be immersed in a process of **collaborative knowledge construction**.

Significant Learning by Way of Representations

First, before addressing the significant learning associated with the use of representations, it is worth stressing the learning vision in which the study is anchored. It adopts the cognitivist point of view, based on the significant learning theory of Ausubel and Novak (described in Moreira, 1999).

To Ausubel, significant learning is the process through which new information (new knowledge) relates in a non-arbitrary and substantive way (non-literal) to the learner's cognitive structure. According to Moreira (1999), this cognitive structure (also called knowledge structure) can be understood as the total content of ideas and their organization in the mind of an individual, resulting from mental processes by means of which it acquires and utilizes knowledge.

According to the same author, significant learning would occur, then, when new information relates to a specifically relevant content of the individual's knowledge structure (prior knowledge). Such content would need to be clear and available on the structure of the individual to act as an anchor point to new ideas and concepts.

Moreira (2008) extends this significant learning vision, pointing out that learning in a meaningful way would be to acquire declarative and procedural knowledge with understanding, enforcement capacity and transfer. Also according to the author, the learner sees sense in learning situations, assigns meaning to them and shares the knowledge gained in this context.

Among the ways to encourage/foment significant learning suggested in the literature, one can cite exercises involving graphic representations. Jonassen & Reeves (1996) coined the expression "learners as designers" to refer to the significant learning that takes place through the production of representations. The authors point out that the best results of mental development occur when students try to represent what they have learned.

This point of view is shared by Moreira (2008), stating that one of the ways to promote significant learning in a formal teaching situation is through the use of graphic representations that explore relationships between concepts. In this sense, also Suwa & Tversky (1997) argue that graphic representations allow ideas to be visually expressed, crystallize them, pause/resume the project (working as an aid to memory) and generate associated thoughts.

Visual Thinking

To Roam (2009), visual thinking means taking advantage of our innate ability to see as much with our eyes as to what the author calls "the mind's eye". This is in order to discover ideas that are otherwise invisible, develop them quickly and intuitively, and then share them with other people so that they simply understand.

Similarly, Cyrs (1997) argues that visual thinking can be defined as the ability to conceptualize and represent thoughts, ideas and data in the form of pictures and graphics. The author explains that visual thinking would be a way of thinking consisting of three cognitive structures that overlap: imagination, visualization and design.

Imagination refers to identifying different roles/functions/purposes for given objects and seeing different alternatives and possibilities of use.

Visualization correlates to visually perceiving objects and the relationships between these perceptions and the past experiences of the observer.

The Design expresses and represents ideas in some visual format.

Collaborative Knowledge Building through GRS

Collaborative Knowledge Building (CKB) can be defined as a communication and social process whose objective is the co-creation of knowledge artifacts (Stahl, 2006).

For CKB to be a real possibility in teaching/learning environments, Scardamalia & Bereiter (2006) argue that there is a need to change the treatment of students, which should no longer be seen as mere student inquirers and begin to be recognized as members of a community of knowledge building, whose emphasis is on creation and innovation.

Singh et al. (2009) include CKB as an active construction process of meanings from the development of shared objects in activities. This process, as the authors explain, has three key features:

- Constant transformation process: group activity changes as new creations emerge (eg, ideas, artifacts), seeking new practice ways;
- Social knowledge: knowledge emerges from the interaction that takes place between the participants and not within the individual mind of each participant;
- Mediation by artifacts: the participants interpret the messages conveyed by artifacts and modify them collectively, producing new information that is reanalyzed by the group.

The use and benefits of GRS as mediator artifacts for collaborative knowledge building have been discussed and demonstrated in several research projects, not only in the scope of Design, but also in areas such as Psychology, Engineering, Education and Computer Science (Buxton 2007; Eppler & Pfister, 2011; Mayer, 2007; McGown et al., 1998).

For instance, Eppler & Pfister (2014) not only defend GRS as an effective communication tool for group work, but also highlight the importance of its being hand-drawn and done collaboratively. In addition, and to corroborate this idea, they emphasize that hand-drawn GRS does not only involve, but also maintains the group involved, focused and concentrated. Mayer (2007) proposes that “hand-drawn conceptual sketches” (which can be adapted for the context of GRS) can be classified as logical, metaphorical (or conceptual) and configurational.

In logical GRS, typical forms of diagrams are used. In metaphorical GRS, individuals use familiar images such as bridges, funnels, mountains, trees or meteorology to express ideas or insights. The configurational GRS represent people (like dolls) and their mutual relations (or barriers to relationships).

Pfister (2013: 27-28) investigated the issue of graphic representation and its main benefits for knowledge management. The author carried out wide research about authors who have the graphic representation as a key point for the organization and management of work and also for collaborative learning. Thus, from the author’s perspective, the benefits found in the research can be divided into three distinct categories: creation, sharing and knowledge documentation.

Creation:

- Represents ideas of a group and not just of individuals and thus increases commitment of all group members to process;
- Enhances coherence, completeness and creativity;
- Allows expression of the vague and the specific and extraction of the crucial and the relevant;
- Makes implicit knowledge explicit;

- Helps to abstract or generalize from a concrete phenomenon or situation;
- Signals work in progress and invites modifications;
- Helps to explore changes in perspective and overcome mental blocks;
- Supports clarification of existing ideas and developing/testing of new ones;
- Aids memory during problem solving;
- Helps to organize thoughts.

Sharing:

- Externalization of ideas and shared meanings;
- Relieves limited working memory;
- Facilitates information processing and communication;
- Promotes efficient and enjoyable collaboration and establishes a joint focus;
- Leads to better listening and engagement of team members;
- Enhances accessibility of ideas and building on earlier ideas.

Documentation:

- Becomes instant documentation for subsequent reference or later analysis;
- Builds a collective graphic memory which facilitates archiving and retrieval of information.

3 Research Method

The study lasted eight weeks (one class per week) and consisted of the observation and recording in the classroom of the productions, discussions and collaborative analysis within Graphic Representations for Synthesis made by a group of students at DCU discipline, taught at the postgraduate course in Design at UFPR (southern Brazil).

The class consisted of 18 students, of which: 4 were masters and 10 doctoral students (all are postgraduate students in Design). There were also four students attending the course as external students, coming from different areas such as: Computer Science, Mechanical Engineering and Management.

The first seven accompanied classes included three didactic stages in class, as shown in Figure1.

- Step 1: the teacher worked on the theoretical content in class in about an hour and a half, using slides and pausing for further explanation where students had more specific questions on the topic addressed;
- Step 2: students were required to organize themselves into small groups of 4 or 5 people and produce, in A3 format, a GRS about the theoretical content presented in class. In addition to the A3 sheet, various materials were made available for groups to share, such as marker pens, adherent tapes, cords, colored paper, glue, scissors and post-it. The time set for this activity was 30 to 40 minutes;
- Step 3: the groups exchanged the GRS produced, and analyzed and discussed the production of another group. Then, the group that analyzed and the group that produced the GRS discussed the issues raised about their production. This step took approximately 10 minutes.

Figure 1: Diagram of synthesis of the didactic steps of the classes.



During steps 2 and 3, one of the researchers traveled between the groups making a text record, images (photos and videos) and audio recordings of the discussion of the GRS group making process. It is worth clarifying that the records made in images and audio were previously allowed by the participating students.

Meanwhile, the lecturer attempted to clarify those issues that arose within the groups about the class theme. At the end of the activity, each group was also asked to produce and deliver in the next class a summary in writing as to how the process of production of a GRS happened. In order to vary the dynamics of activities for a few classes we asked students to switch their working groups, and some surprise elements for the production of GRS were inserted. Table 1 shows the subject covered in each class, which was the surprise element proposed for each activity and total GRS collectively produced per class.

Classes 1 and 2 did not have the surprise element, allowing free GRS work. From class number 3, to each class a new element was brought to excite students in graphic productions. Each proposed element of surprise was first tested in order to establish a relationship with the contents of the class to which it referred. At the end of the first seven classes, 34 GRS were produced in A3 format by the group in question.

By class 8, the steps were not followed, because it was a synthesis of the content covered so far. During this, students gathered in groups again and each group chose an A3 folder (numbered 1-7), which contained all the GRS prepared in that particular class. With the material at hand, the group should then draw up a panel summarizing the theme of the class to which the selected folder referred, making use of GRS contained within it. The only requirement was that the groups seek to make use of elements contained in all GRS received for the preparation of the panel, and could therefore, cut them and regroup them, as needed.

Table 1: Information about the theme, surprise element and the total GRS produced in each class analyzed.

	Class theme	Surprise element	N° of GRS produced
Class 1	Conceptualization User-centered design	Free GRS	5
Class 2	UCD Process	Free GRS	5
Class 3	Interface Design principles	Metaphor and redesign	4
Class 4	Dimensions and metrics evaluation	Metamorphosis	5
Class 5	Methods and analysis techniques	Deconstruction	5
Class 6	Methods and techniques of synthesis	Mandala	5
Class 7	Methods and evaluation techniques	Braindrawing	5
Class 8	Synthesis of class theme addressed	Free GRS/panel	5

In the context of discussion and production of GRS (classes 1 to 7), after meeting in groups, each group of students had only their own records made in a notebook during the lecture as supporting material for the content to be represented, as seen in the example in Figure 2. The slides for each class were provided to students just a few days after the activity.

During the moments of group discussions, there was always a great sharing of ideas and individual understandings of the topic discussed in each class (which were complementing the rest of the course). It was also observed that such times were often propitious for students to remedy doubts and troublesome points on the subject under discussion with the other members of the group.

Figure 2: Students consulting the personal records and discussing the theme of the class to be represented.



Overall, it was found that the oral participation of students within their respective groups was large. There was enough room for everyone to express their ideas, propose forms of graphic representation of the content (through brainstorming) and discuss which would be the most propitious. After collectively deciding which proposal would be produced, some groups resorted to online search of visual references (via laptop and mobile devices), as shown in Figure 3.

Figure 3: Students doing research online to assist them visually in the preparation of the GRS.



Then, they produced an outline of the GRS. Sometimes they did it on scrap paper, others on the A3 sheet, but always with a pencil. It was interesting to note that in many groups, all participated, including in the collaborative artistic finalization of the GRS. For example, while a member of staff reinforced the drawing in marker pen, others were writing the title or producing subtitles for the GRS (Figure 4).

Figure 4: Students collaboratively finalizing the art for the GRS produced.



Figure 5 shows a total of seven images, each representing a sample GRS collaboratively produced during the first seven weeks.

Figure 5: Examples of GRS produced in each theme/class.



Figure 6 illustrates step 3 of the didactic process, where groups analyze the production of another member of staff and discuss the strengths and weaknesses of the evaluated GRS. At these moments, it was realized in class that during the evaluation of the work of colleagues, the assessment group would review theoretical aspects discussed in class, reviewing the production of its own GRS (when comparing the work) They also had the opportunity to argue with the other staff on how other staff production was understood, ask about flawed or ambiguous elements and propose improvements.

As assessed staff, the group argued/defended their point of view and choice by a particular graphic representation by the evaluation staff and agreed or not with the dubious points indicated.

Figure 6: Groups analyzing and discussing the GRS produced by other groups.



Figure 7 shows the dynamics of class 8 (which lasted 3 hours), which had the choice of theme/class by the respective groups, discussion of the theme and the transfer of the contents, making use again of personal notes from each member of staff.

Figure 7: Groups discussing the theme /class chosen.



Figure 8 brings images of some groups during the preparation of the summary panel, also done in a collaborative way.

Figure 8: Groups producing synthesis panel about the theme/class chosen.



This last class also had a different final closure characteristic. Each group, rather than assessing the work of just another group, had to present their own production orally to the class, explaining how the subject/class was reviewed and synthesized. After the presentation, the whole class could argue about the synthesis prepared by the group, suggest improvements and remedy specific questions with other classmates and the teacher.

Figure 9 shows some final results of the synthesis of panels produced by the various groups during class.

Figure 9: Results of synthetic panels about the theme/class theme produced by the groups.



Results and Discussion

In the general context, the use of GRS during the course was positive, especially in the collaborative context. The debate between groups on the subject provided mutual assistance in solving doubtful aspects about the class theme. When the questioning persisted, the group called on the teacher for help.

Throughout the classes, students demonstrated clearness in the arguments to colleagues and a gradual and significant learning, where the contents of previous lectures seemed interconnected and consistent when discussed again among the group.

In the analysis and discussions of productions from other teams, questions were always relevant, not sounding like mere criticism. In their written briefs of the creative process of GRS, some teams even reported what other teams had argued about the GRS presented; they agreed and described what would be the possible improvements for a later redesign of the GRS.

In the course of the activities, it was found that the groups had a strategy to synthesize only a key point in the class, even for the short time to produce a GRS in class. However, this did not mean that discussions on the subject were shallow. Instead, most of the time, students permeated all of the content covered in the lecture before defining the best alternative GRS to be drafted.

On further analysis of production, it was noted that about the type of graphic representation adopted by the groups of class 1 to class 7, 30 of the total 34 GRS produced, we used the metaphorical context. One used configurational context drawing, and the other three were a configurational and metaphorical context junction.

In class 8, of the five productions, all of them had the similar element in the production of the group's strategy of taking a GRS from a certain class as a base and bringing elements of others as content aggregators. An interesting fact was also that three of the five groups synthesized classroom content into three-dimensional representations, exceeding the two-dimensional character of the GRS used.

Generally, as concerns the graphic aspects of the representations, the groups opted to work with little explanatory textual information, and the text appears only in short phrases, labels or captions. Many GRS used the arrow feature to indicate sequencing.

During the classes, the researcher informally dialogued with students about what they thought of the didactic steps applied during the 8 weeks, the collaborative work and the use of GRS during classes. Here are some testimonials:

- "I think the GRS help us to better memorize the content";
- "I'm enjoying the classes a lot, I would like to have worked this way in my entire educational process";
- "All content is related and I do not forget from one class to another";
- "I would like to work like this in other disciplines";
- "The GRS are very interesting, I find myself applying them beyond the classroom, in meetings with people from different areas who sometimes do not understand what I'm trying to explain to them".

At the end of the course, the 18 students also answered a questionnaire anonymously, which aimed to investigate what they thought of the use of the GRS strategy in class for more significant and collaborative learning.

The answers were unanimous in considering the preparation of GRS an important element for the assimilation of a gradual and consolidated content. Of the total of 18 students, only one of them replied that he preferred to work individually, two suggested alternating, and the others stressed that collaborative work (production, analysis and discussion) contributed to learning in a pleasant way.

Examples of responses collected in questionnaires about advantages and disadvantages of working in a group:

- “The process of creating GRS was very helpful to the group because the cognitive abilities and also conceptual representation from individuals were valued when juxtaposed and placed under discussion”;
- “The teamwork has enabled a better understanding of the content and generated more creative alternatives”.

Examples of responses collected in questionnaires about advantages and disadvantages of producing GRS in the classroom and by hand:

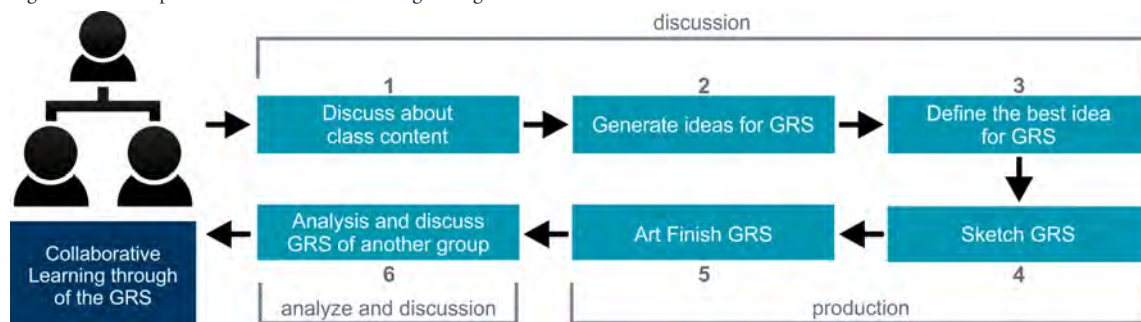
- “The GRS donee in the classroom allowed the group not to forget what was reviewed and discussed. Doing by hand makes the job faster”;
- “Advantageous for sure. Because, for a few reasons, the classes are made in recent days and with so much information/memories would be lost in time. Doing GRS in the classroom, the information is fresh and helps the construction of the task and in my case, the GRS solved doubts because while we were doing the GRS, I kept asking and wondering about what was taught”.

Examples of responses collected in questionnaires about the contribution of the dynamics of GRS for learning of the discipline:

- “The GRS break the Brazilian unilateral teaching paradigm to encourage student participation in shaping both the evaluation of the content, and in proposing new ways of presenting it or increasing it”;
- “The dynamics with GRS contributed to learning as it summarized contents approached in a ‘mild’ and relaxed way”;
- “Yes, they helped a lot. For every GRS, all content had to be reviewed and understood again”.
- Participants were also asked about the fact that the researcher made records (images and videos) during classes; none of the respondents considered the fact inhibiting for a collaborative construction process of the GRS, but one of the respondents stressed not feeling comfortable with the recording, because he didn’t know where this would be disclosed.

Based on what was seen during the discipline, Figure 10 illustrates a preliminary model of the collaborative learning process through the GRS, based on what was observed and recorded (verbally and visually) during the seven DCU classes accompanied.

Figure 10: Model process of collaborative learning through of the GRS.



The process involved collaboration as a common factor in all activities and was divided into six stages. The first three stages were discussing the class content (reviewing the class and troublesome points), generating ideas (brainstorming) and defining the best idea for the GRS.

The fourth and fifth stages are related to the production of GRS itself, i.e. the sketch and art finalization itself. The sixth stage comprises the analysis and discussion on the GRS produced by another group; here, the group that analyzes eventually revisits the content of the class, its own GRS and argues with the group that produced it, examining the strong and weak points.

4 Conclusion and Future Study

Collaboration is part of a designer's daily experience, either during university, or when working within a project team. However, the collaborative scope is still little explored in the context of learning theoretical concepts at post-graduate level in Design.

This paper had the assumption that the Graphic Representations for Synthesis produced by postgraduate student groups in Design, after exposure to the content of theoretical aspects, provide a more significant and collaborative learning for them.

To this end, a qualitative study was developed during which, throughout eight weeks, a group of 18 students were observed during the production process, analysis and discussion of GRS. This GRS had been designed by the same group, taken from a postgraduate course in Design in Brazil, in which they were attending the discipline User-Centered Design.

As a result, this initial study indicated that, in fact, the collaborative context of production, discussion and analysis of GRS tends to produce more structured and significant learning by the students involved in the activities. The collection of informal interviews during classes, as well as the answers extracted from the questionnaire filled out by students at the end of the course, corroborates these claims.

As a future study we may also investigate more comprehensively the understanding of the collaborative production process of GRS and the proposal of the students' evaluation criteria in the collaborative process of these GRS. Finally, the delimitation of didactic advantages and disadvantages in the use of GRS for teaching/learning in the context of postgraduate in Design should also be investigated.

References

- BUXTON, B. 2007. *Sketching User Experiences: Getting the Design Right and the Right Design*. Morgan Kaufmann Publishers Inc., San Francisco, CA.
- CYRS, T. E. 1997. Visual thinking: let them see what you are saying. *New directions for teaching and learning*, n. 71, Fall: 27-32.
- DERRY, S. 1990. Learning strategies for acquiring useful knowledge. *Dimensions of thinking and cognitive instruction*. Hillsdale, N. J., Lawrence Erlbaum.
- EPPLER, M. J. & PFISTER, R.A. 2011. *Sketching at Work: A Guide to Visual Problem Solving and Communication for Managers, Consultants, Sales Professionals, and Trainers*. MCM Institute, St.Gallen.
- EPPLER, M. J. & PFISTER, R. A. 2014. *Comunicação Visual: como utilizar o design thinking para resolver problemas e se comunicar melhor em qualquer situação*. São Paulo: Elsevier.
- FERREIRA, A. B. H. 2004. *Novo dicionário Aurélio da língua portuguesa*. 3^a Ed. Curitiba: Positivo.
- HEEMANN, A.; LIMA, P. J. V.; CORREA, J. S. 2010. Fundamentos para o Alcance da Colaboração em Design. *Estudos em Design (Online)*, v. 18, n.2: 1338-1349.

- HEISER, J.; TVERSKY, B.; SILVERMAN, M. 2004. *Sketches for and from collaboration*. In <www.psych.stanford.edu/~bt/gestures/papers/vr04.pdf>, 25/03/2015.
- JONASSEN, D. H.; REEVES, T. C. 1996. Learning with technology: using computers as cognitive tools. In: *Handbook of Research on Educational Communications and Technology*. New York: Scholastic Press.
- MAYER, C. 2007. *Hieroglyphen der Psyche: Mit Patientenskizzen zum Kern der Psychodynamik*, Schattauer, Berlin.
- MCGOWN, A., GREEN, G.; RODGERS, P. A. 1998. Visible ideas: information patterns of conceptual sketch activity. *Design Studies*, v. 19, n. 4: 431-453.
- MOREIRA, M. A. 2008. A teoria da aprendizagem significativa segundo Ausubel. In: *Aprendizagem significativa: condições para ocorrência e lacunas que levam a comprometimentos*: 15-44. São Paulo: Vector.
- MOREIRA, M. A. 1999. A teoria da aprendizagem significativa de Ausubel. In: *Teorias de aprendizagem*: 151-166. São Paulo: EPU.
- NORMAN, D. A. 1991. Cognitive artifacts. In: *Designing Interaction*. Cambridge: Cambridge University Press.
- OWEN, C. A. 2001. The role of organizational context in mediating workplace learning and performance. *Computers in Human Behavior*, v.17: 597-614.
- PADOVANI, S. 2012. Representações gráficas de síntese: artefatos cognitivos no ensino de aspectos teóricos em design de interface. *Educação Gráfica*, v.16, n.2: 123-142.
- PFISTER, A. R. 2013. *The Benefits of Sketching for Management. Literature Review and Experimental Evaluation*. Dissertation of the University of St. Gallen, School of Management.
- ROAM, D. 2009. *The Back of the Napkin: Solving Problems and Selling Ideas with Pictures*. Penguin Group, New York.
- SCARDAMALIA, M.; BEREITER, C. 2006. Knowledge building: Theory, pedagogy, and technology. In: *Cambridge Handbook of the Learning Sciences*: 97-118. New York: Cambridge University Press.
- SIMONIN, B. L. 1997. The importance of developing collaborative know-how: an empirical test of the learning organization. *Academy of Management Journal*, v.40, n.5: 1150-1174.
- SINGH, G.; HAWKINS, L.; WHYMARK, G. 2009. Collaborative knowledge building process: an activity theory analysis. *VINE: The journal of information and knowledge management systems*, v. 39, n.3: 223-241.
- STAHL, G. 2006. *Group cognition: computer-support for building collaborative knowledge*. Cambridge: The MIT Press.
- SUWA, M. & TVERSKY, B. 1997. What do architects and students perceive in their sketches? A protocol analysis. *Design Studies*, v. 18, n. 4: 385-403.
- TVERSKY, B. & SUWA, M. 2009. Thinking with sketches. A. Markman (Editor), *Tools for innovation*. Oxford: Oxford University Press.
- VISSER, W. 2006. Designing as Construction of Representations: A Dynamic Viewpoint in Cognitive Design Research. *Human-Computer Interaction*, v. 21, n.1:103-152.
- VYGOTSKY, L. 1978. *Mind and Society*. Cambridge, Massachusetts: Harvard University Press.

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Chapter 7

Pioneering disciplines of History of Design in Brazil: the place of graphic design

Marcos da Costa Braga

keywords: history of design in Brazil, education design, pioneering disciplines, visual Communication

This study reviews the implementation of the first disciplines that dealt with the history of design in the pioneering design courses in higher education in Brazil and analyzes the place of the history of graphic design in the summary and in the contents of these disciplines. It is assumed that history is part of building a professional identity, intended to contribute to the understanding of the constitution of the graphic design field in academia by checking how the history of visual communication appeared in the syllabus of the subjects that first addressed the history of design in Brazil.

1 Introduction

The review of the implementation of the first disciplines that have addressed the history of design in the higher education courses of design in Brazil is the goal of research that has been going on since 2014. This paper presents partial results of this research and seeks to identify the place of graphic design history in the contents of these disciplines. A college degree in Graphic Design in Brazil was implemented as a qualification coming from industrial design courses in the 1960s. The official name of this qualification was ‘visual communication’. In the 1970s, various courses adopted the term ‘programação visual’ (visual programming). At that time, in Brazil, as in some international organizations, visual communication was considered similar to graphic design. The term *desenho* industrial eventually prevailed as a translation of industrial design, despite the fact that the word for *desenho* in the Portuguese language has a dubious meaning and can mean either a visual representation (drawing) or a shape in a design process (design).

Until the 1970s, undergraduate courses of design were predominantly disciplines such as art history and history of techniques, but not design history understood as a history of a project. That is why the subject of history was placed in the first minimum curriculum of industrial design approved by the Federal Council of Education in 1969. The overall objective of the subject History of Design in Brazil is related to one of the powers provided for by the National Curriculum Guidelines for graduate courses in Design approved in 2004 by the Ministry of Education: “historical and forward looking design area centered on socio-economic and cultural aspects, revealing awareness of the economic, social, anthropological, environmental, aesthetic and ethical implications of their activity”. In their Article 5, the Guidelines highlight the “study of the history and theories of design in their context” as part of the basic content of the compulsory curriculum of a bachelor’s degree in design.

The vast majority of design courses currently understand that knowledge of the History of Design provides a repertoire and references to practice in a project of design. However, in most of these courses, the professors teaching this subject also understand that this subject provides knowledge about the constitution of occupation and profession and the development in time of the concepts and boundaries of their field. In this sense, I understand that this discipline contributes to the consolidation of the social identity of the design profession, especially in Brazil. Unfortunately, this discipline in most of today's courses, for various reasons such as workload restriction, mainly in private institutions, cannot focus on the educational goal of developing critical thinking in students about the role and the insertion of design in society; nor can it focus on the implications and social, economic and cultural consequences of their professional practice. It is because of this range of possibilities that this discipline can contribute to the formation of the bachelor of design, which is why I consider the study of its history important.

The research is empirical, based on primary sources and qualitative methods of data analysis. To identify the courses that were pioneers in implementing this doctrine, the publication organized by Geraldine Witter was consulted, since it brings a survey on the situation of industrial design courses in Brazil in 1984. Witter makes a general assessment of existing courses in 19 institutions, located in seven Brazilian states, and shows tables with subjects and disciplines of their curriculum.

Only four courses had the subject, History of Industrial Design, in 1984, according to Witter (1985: 81). They were the courses of the Industrial Design School (ESDI), Catholic University of Paraná (UCP), Federal University of Paraná (UFPR) and Educational Foundation of Bauru (FEB). However, it was known that in 1973, at the Faculty of Architecture and Urbanism at the University of São Paulo (FAU USP), there was a discipline called History of Graphic Design. It probably was not recorded by Witter because it was not offered to students at FAU from 1981 on. As the FAU USP was included by Witter in her study as a school with an industrial design course, we decided to include this subject in the research. In 1962 FAU USP promoted a reform of its architecture course, in which sequences of design disciplines of industrial design and visual communication were implemented.

The syllabus, the summary and bibliographies of disciplines containing the subject History of Industrial Design were analyzed, and five of the six professors we identified were interviewed. In the case of ESDI, we could not get original documents from two of the three disciplines, but the syllabuses of those two disciplines were recovered through the memory of their two professors. Some former students of UFPR and FEB who attended the course at that time were also interviewed.

2 History in the First Minimum Curriculum

In 1962 the course in higher education of industrial design began with the introduction of design discipline sequences at FAU USP and the founding of the ESDI. Two years later, there was the official approval of the course of the Fundação Universitária Mineira de Arte Aleijadinho (FUMA). All of these courses were in the southeast of the country, where there was significant industrial and urban development in the 1960s.

In 1969, the Federal Council of Education (CFE) approved the first minimum curriculum for industrial design and visual communication courses. It was based on the curriculum that ESDI had sent in 1967 to the state of Guanabara for its recognition. To make up the minimum curriculum the CFE established 13 subjects, four of which were considered "core subjects". Among those was "Aesthetics and History of Arts and Techniques". The explanation of what this subject would be about is very short and vague: "Aesthetics is the discipline common to all art curriculums. Its study is in connection with the History of Arts and Techniques and gives special treatment to the manifestations that have taken place in Brazil." So there is no mention of a history of industrial design or of visual communication. The subject of history for the design courses was officially pegged

to the field of art and it did not specify what techniques would be used. Clearly, the shaping of the field of modern design went through the field of arts, especially during the modernist vanguards. But it is also true that this structure had other roots, even one of graphic design, highlighting the possibility of tracing a relatively specific story, even though in order to trace the subject it was necessary to go through the history of other fields, such as advertising.

In any case, the teaching of design in higher education begins in Brazil without an official study on the history of the professional activity, like a history of its project specificity. This situation can have several causes, such as ignorance of the duties of the profession by various sectors of local society. But what seems to have defined it in the resolution of the CFE was the understanding of the author that the industrial design and visual communication courses would be in the “art group”. And as a way to corroborate this interpretation, as it was recalled further in the text of its opinion, which occurred in the “Bauhaus, led by Gropius” and “School of Ulm, led by Max Bill”, there was a “generalization of art, an association between art and industry” (BRAZIL, 1969b.)

This fact may have contributed to the reason why the history of design was not included in the majority of courses of design until the next decade. As mentioned before, out of the 19 existing courses in 1984, Witter (1985) identified only four courses that had the subject of History of Industrial Design, to which was added the one at FAU USP. Four of the schools were public and one was private.

3 The History of Design in the Five Courses

ESDI

The course started classes in the city of Rio de Janeiro in 1963, with common and specific subjects for each of its two qualifications: Visual Communication and Industrial Design. The curriculum was inspired by the German Hochschule für Gestaltung school (Superior School of Form), in the city of Ulm, Germany, and it was divided into seven subject sectors. In the ‘Cultural Integration’ sector the discipline of the History of Technology was initially prescribed, but during the 1960s the teaching of Art History was added.

In 1968, the ESDI went into a phase of crisis and reconsideration of its role in society. It promoted debates about its syllabus and its relationship with the national scene amid student demonstrations in Brazil and in the world against authoritarianism and university policies.

In the midst of this process, a proposal for a course with the title “History of Industrial Design” was made by Frederico Morais, an art critic who came to be part of the direction and responsible for several activities at the Museum of Modern Art, Rio de Janeiro (MAM-RJ). Morais was a professor at ESDI in the late 1960s, and his proposal provided for three hours of lessons a week.

The history of design was not unknown to Morais. In 1962 he published a book entitled ‘Art and Industry’ in which he addressed the crisis in art of that time, criticized the imported models and advocated engagement of the artist in the industrialization process. To support this idea he mentioned the experiences of ‘Gropius and the Bauhaus’ and ‘Max Bill and the School of Ulm’.

In the syllabus Morais elected the Industrial Revolution as a starting point and then presented the Art Nouveau, modernist vanguards, Bauhaus, School of Ulm, industrial design in the United States, Brazil, in the Third World and in the socialist countries. There were also the topics ‘Good Shape’, ‘Styling’ and ‘Metadesign and new trends’. It is noted that the focus was on product design. Due to the period of instability in the classes of ESDI until 1969, and the lack of documentary records, it is not known for certain whether this discipline was ever delivered in full. However, there is a record of a joint effort with the discipline of Economics promoted by professors Liana Maria Lafayete & Antonio Carlos de Brito in the second half of 1971.

As far as it goes up to now, the 'History of Industrial Design' has been taught on a regular basis since 1972, when director Carmen Portinho invited the newly graduated Silvia Steinberg to take on that discipline.

As a student, Steinberg had participated in assembling an exhibition of ESDI at the International Biennial of Industrial Design in 1968 held at MAM-RJ. In 1969, she worked as an assistant at the office of the designer and professor at ESDI, Alexandre Wollner. And exactly in 1972 she started working as an assistant to the coordination of the Industrial Design Institute (IDI) MAM-RJ, where she developed research projects, publications, courses and exhibitions related to export packaging and school furniture demanded respectively by the Ministries of Industry & Commerce and Education.

Steinberg established a new program whose main objective was to place the history of design in the context of Brazilian industrialization. Artistic movements of the European vanguards and connections with the Modern Art Week of 1922 were discussed, as were the German history of the Werkbund, Bauhaus, and School of Ulm and, especially, concrete art in Brazil, presented as a background for understanding the link between the German schools and design in Brazil.

The political and economic context of Brazilian industrialization was discussed and related to the presence of the ESDI. The main references for the local field of design were made through the iconic material of the International Industrial Design Biennials, which took place at MAM-RJ in 1968, 1970 and 1972, the Journal 'Product and Language', edited by the Brazilian Association of Industrial Design (ABDI) and information collected with Alexandre Wollner. The definitions and concepts of industrial design used in the course were entirely based on the records of the Diseño Industrial Seminar held at the Universidad de Chile in 1970 and whose author was the German designer Gui Bonsiepe.

However, Steinberg sought to address both industrial design and visual communication, although the literature available at the time considered product design more. Due to bureaucratic problems, Steinberg left ESDI and followed a career focused on visual communication, the title of the discipline she taught at ESDI on her return in 1985 by public competition.

In 1977, Frank Anthony Dodd Barral started to teach 'the History of Industrial Design'. Barral had graduated from ESDI in 1974 and began his career as a professor, teaching History of Technology in 1976 for the architecture course and the newly opened course on industrial design at UFRJ. As he started the discipline, Barral changed the program and based it on the line he had taken for the discipline at UFRJ. The initial axis was the Industrial Revolution, continuing to the process of industrialization and technology. He addressed issues of consumer society and presented some topics that have become classics in the teaching of design history: The Arts & Crafts movement, Art Nouveau, Peter Behrens, Bauhaus, Russian Constructivism and De Stijl, Art Deco, School of Ulm and American Styling. However, he also made room to talk about Italian design, and addressed, at the end, the Brazilian path through the axis of concrete art and education from the 1950s: Max Bill in Sao Paulo, the course of MASP, the formation of ESDI, the Institute of Industrial Design (IDI) and the Biennials of Industrial Design at MAM-RJ.

Like Steinberg, Barral worked at MAM-RJ and in 1970 participated in the assembly of a part of the II Biennial of Design. And at the time he started teaching at ESDI, acting as the head of the Department of Exhibition Installation of MAM-RJ. Therefore, references to design in Brazil are similar in the two of them, albeit with different emphases. Barral states that "The history of visual communication in a global context was approached, but less deeply than the history of the product" and on the Brazilian part "was not unusual that they were treated with less detail than the previous content" as that part "was left to the last classes of the year". According to Barral, "typeface, posters, book covers and some signs were approached, but he admits that the "emphasis was on Product Design" (DODD, 2015). We must remember that although the program was extended, the

discipline was annual and with 3 hours per week, which allowed the consideration of many topics, as Barral did, or of many examples, like Steinberg sought to do.

FAU USP

In the 1960s and 1970s the architecture course of FAU USP was constituted by an equivalence in training in a project of architecture, urban planning, industrial design and visual communication. The subjects of these four sequences were compulsory, and in the final year, the student could choose one of those areas as a theme for the project-thesis, which had the status of a course conclusion work. The intention was to train an architect who could engage in Brazil's industrialization process, and so it was necessary to expand the field of its activities. The inspiration came, on the one hand, from the professional practice of Italian architects of the time, and on the other, from teaching at the Bauhaus and the design school of Ulm. The methodological paradigms that guided design at FAU came from the movements of German and English functionalism.

In 1972, Lucio Gomes Machado, an architect graduated from FAU Mackenzie University, was hired, along with other teachers, as an assistant professor to join the history department at FAU. The idea was to increase the offering of optional courses in the department. In the 1970s, Machado participated in the graphic industry events and carried out projects in the area of book covers. From 1972 to 1974 he worked as a collaborator in the graphic production of Editora Perspectiva in São Paulo. In 1973, Machado created and implemented the elective course 'Introduction to Graphic Arts' and in 1974 he got the position of supervisor of the Graphical Programming Laboratory (LPG), which had been created shortly before by the Director of FAU, Nestor Goulart Reis Filho. The LPG was in charge of the internal printing of FAU and had basic equipment for typesetting and printing.

This discipline was offered for the third semester of the course with two class-hours per week. It focused on the history of graphic technology and typography. In 1976, after buying new equipment for the LPG, he changed the course's name to 'Introduction: History of Graphic Project'. The discipline began its program with the name of "Graphic design and visual communication before the invention of printing." So even though he talked about Gutenberg's invention, he placed it neither as the starting point of graphic project nor did he find the start in the Industrial Revolution of the nineteenth century. It went through the axis of drawing and the production of books, and followed through with the precursors of modern typography and graphic arts of the twentieth century. For evaluation, the students delivered a survey that allowed discussion in class about "Brazilian graphic artists", after presenting seminars (MACHADO, 2015). We understand that this was a way to compensate for the limited literature at the time on graphic design in the country.

This is the only case, among the surveyed subjects, in which the program was entirely dedicated to the history of the graphic area and did not pinpoint the beginning of the program in the industrial revolution or modernism. This course was the first of its kind in higher education in Brazil that we have identified so far. This discipline offered a complementary training by means of the disciplines that dealt with visual communication. And to some extent it went against the wishes of some FAU professors who wanted to adapt the architecture course to the minimum curriculum of industrial design and visual communication of 1969, which called for technical history as a compulsory subject. Its approach to graphic techniques would meet this requirement.

On the other hand, the labor market in São Paulo was more promising for graphic design than for design and was the scene of major projects of visual identity and signs that encouraged some of the students from FAU to follow a graphic career. Prominent designers in the current professional field attended this discipline between 1973 and 1981, like Chico Homem de Melo and Ronald Kapaz.

FEB

In 1969 the Educational Foundation of Bauru (FEB), an institution created in 1966 and subsidized by the city of Bauru in the state of São Paulo, established its School of Arts and Communication (FAC). It opened a course of Industrial Design in 1975 in the Art Department. At first it was only offered in the evening, without a specialization, and lasted three years.

In 1977, the Industrial Design and Visual Communication degrees were created, and a common core of subjects was defined. Two professors who had attended a Master's degree in graphic design in the USA returned. One of them, Carlos Olicio Pelosi, had an influence on the creation of those specializations. Subsequently, the course duration became four and a half years. In 1979, federal recognition of these courses was established and in 1983 a new curriculum change was promoted. In August 1988, FEB was incorporated into the Universidade Estadual Paulista - Unesp.

In the process of creating specializations of the course, the group of aesthetic disciplines and art history were revised and the disciplines of Aesthetics I and II appeared. The professor responsible for this was Cleide Costa Biancardi Santos, who formulated the 'Aesthetics I' program to include and discuss historical and aesthetic aspects of Industrial Design.

Biancardi received her degrees at FEB in Design and Plastic Art Education (1971 and 1976). She began her teaching career in 1969 in the public schools of Bauru, where she taught geometric drawing and descriptive geometry in high school until 1983. In 1976 she joined the faculty of FAC teaching 'Aesthetics and Art History' in the higher education courses of Art Education and Industrial Design.

The compulsory subject 'Aesthetics I' was offered for the third semester of both degree programs from 1978 to 1983. There were five hours of classes a week, divided into two classes. Students were enrolled after one year of 'Art History'. This was the only discipline that addressed historical aspects of design, but the goal was "to know old aesthetic concepts and recognize the changes in those concepts since the industrial revolution", and "determine the importance of the industrial object as an element of consumer society culture through the aspect of form" (FEB, undated).

The program of this subject addressed Brazilian art from colonial times to contemporary art at that time, with some emphasis on this last topic in concrete art. The following part was dedicated to historical concepts and 'current' Aesthetics in Industrial Design and Visual Programming. The second half of the program was dedicated to design history in which some topics that have become classics were addressed: the First Industrial Revolution and its repercussions; the theories of W. Morris, Ruskin and Art Nouveau; Bauhaus and Styling and their influence on contemporary society. Beginning in 1982, after having contact with the Soviet avant-gardes through Walter Zanini's classes, during Biancardi's doctorate at the School of Communication and Arts (ECA) at USP, she incorporated classes about the Soviet posters of the 1920s and 1930s.

The movements of the modernist avant-garde and industrial design in Brazil were consolidated as part of the curriculum in the redefinition that occurred in the course in 1983. These two issues made up two of the six topics that were part of the discipline program in 'History of Art and Industrial Techniques' which replaced Aesthetics I. The focus on historical aspects and the other topics was based on the second half of the disciplines from the previous course program, with the exception of Styling.

To address both the content of visual communication and that of product design, Biancardi sought to balance the examples of the projects shown in the classroom, although there was less literature available to the field of visual communication, especially on the situation in Brazil. She brought together the history of visual communication with art history and sought to give information on Brazilian visual communication. And the solution adopted was similar to other courses, that is, based on research done by the students themselves who went to the market to talk to visual communication professionals, and then presented the material collected in seminars.

Biancardi (2015) points out that the city of Bauru “at that time already had several advertising agencies employing students as graphic production trainees”. Bauru had a tradition in graphic production and this situation stimulated the degree in the visual communication course, although historical information about the field in Brazil was scarce.

Curitiba and the Implementation of Design Courses in 1975

In the late 1960s, Curitiba, the capital of Paraná state in the south of the country, had an incipient professional field of design that would take off in the 1970s. Stimulus was provided by a context marked by the development of the Industrial City of Curitiba; increasing production of modern furniture in the state; the opening of cultural institutions; and urbanization projects which defined the administration of mayors from 1971 to 1983.

Urban reform included urban infrastructure projects and road signaling designed by architect Manoel Coelho. During this period, professionals from different areas were working with visual communication, especially with visual identity.

This scenario encouraged professors of the Federal University of Paraná (UFPR) and the Catholic University of Paraná (UCP) to propose the opening of design courses.

UFPR - Federal University of Paraná

In 1974, Adalice Araújo, an Art History professor at UFPR, inspired by the Bauhaus, created an Art Course, which included Industrial Design Courses, Visual Communication and Art Education.

In 1975, architect Manoel Coelho took over the coordination of Industrial Design and Visual Communication courses and, in reshaping the curriculum, canceled Art Education. Coelho worked with design and to carry out this reform he researched the courses at ESDI, FAU USP and UFRJ.

Coelho started the faculty with five graduates from ESDI and some design field exponents from Curitiba. The disciplines of the project were initially presented by the graduates of ESDI, and students of Industrial Design and Visual Communication attended them together, except for the last discipline of the project and the essay required for course conclusion.

In the original project of this course in 1974 there was a discipline called “History of Industrial Design” which was not included in 1975. However, an Art History discipline was established and taught by Professor Adalice Araújo. The first contact of students with the history of design was ‘Introduction to Industrial Design’ in the first period of the course, taught by Gracia Carvalho.

A graduate in Industrial Design from ESDI in 1974, Gracia Carvalho was hired as a designer by Consul, a manufacturer of household appliances in the city of Joinville, located in Santa Catarina, the neighboring state to Paraná. In that company she was responsible for the design department created in 1975, the same year she was invited to teach at UFPR.

From 1975 to 1979, Carvalho taught this discipline, which had five hours of classes a week, and was divided into four blocks: Art History, History of Technology, History of Industrial Design and History of Visual Communication. The classic topics “Arts and Crafts, Art Nouveau, Deutscher Werkbund, Bauhaus, Hochschule Für Gestaltung” were listed in the syllabus of the block of Industrial Design History. But the contents of the Visual Communication History were vague: “Determination of the visual signs for the evolution of human needs” (UFPR, 1978). And then, the course summary stated that there would be discussions through the “historical stages”, without defining what those stages would be.

Both contents provided for a study of the situation in Brazil. However, there was an observation in the case of Visual Communication: “Done through research for lack of professional literature” (UFPR, 1978). This leads us to believe that the instructor may have adopted the same procedures as other professors of this discipline in other courses due to the lack of literature on the subject.

In 1980, the 'Introduction to Industrial Design' was replaced by "History of Technical and Industrial Design" that had a higher workload of 90 hours in the semester and was divided into three blocks: History of Techniques, History of Industrial Design and Theory of Objects. The classic topics in the history of the previous design discipline were kept in the curriculum, except for the School of Ulm. Meanwhile the topics of Art Deco, Styling and Kitsch were added.

The professor of the new discipline was Fernando Antonio Fontoura Bini, who had won a public competition to teach Art History II in the Art Education course at UFPR the previous year. Bini was invited by Adalice Araújo to take over the new course. At that time, Bini was also teaching 'Art History' and 'History of Techniques' in the course of Industrial Design at UCP.

With a bachelor's degree in painting from the School of Music and Fine Arts of Paraná, Bini began his career in 1971 teaching Geometric Design and Perspective for the Decoration Course at the Federal Technical School of Parana. In 1973 he was in charge of the History of Art, in the same course, in which he included the topic on the history of modern art "subjects such as Art Nouveau, Bauhaus and School of Ulm, approaching design via Decorative Art" (Bini, 2015). This procedure was probably encouraged by the fact that Bini had also been working at Plastipar since 1971, a furniture accessory industry, participating in product development and graphic material projects. In 1974, along with a colleague from Plastipar, Savoy Douglas da Cunha, Bini was invited to assist in the preparation of the UCP design course.

UCP

Created in 1974, the course of Industrial Design was started in 1975 by the Department of Mathematics. It was an evening course, and the teaching staff consisted of professionals in the area of Arts, Architecture/Design and Engineering. Among them were Rubens Sanchotene, Edson Ogg and Ariel Stelle from Curitiba and Osvaldo Nakazato and Maria Gertrudes Bernardes from ESDI, who made an exchange of ideas possible with the course of UFPR. There were influences of functionalism arising from the School of Ulm, and the goal was to train professionals to work in industry and in the labor market of Paraná.

The course started with a three-year duration and in 1976 changed to a four-year course. There were no specializations, but it had one year of Graphical Analysis and one year of Graphic Expression, which reflected, in our view, the power of the visual communication field in Curitiba.

Following what he had done for the Decoration Course, Bini structured a great part of the syllabus of the discipline of "History of Art II" with topics of design history: industrialization, origins of Industrial Design, English Arts and Crafts, Art Nouveau and Bauhaus. There were 45 hours of class per semester and the discipline was offered in the fourth period of the course. In the second period the students had already studied the Industrial Revolution in the discipline "History of Techniques", also taught by Bini.

At the end of 'History of Art II', "Brazil and confrontation with industrialization" was addressed, which it was where he sought to provide information on the design field in Brazil. His references came from ESDI; the activities of MAM-RJ; architecture magazines where, at that time, most news about design was found; and through lectures given by guest designers. Research in the professional field was also carried out, involving interviews with designers and visits to the few design or advertising offices.

The library of the institution had subscriptions to foreign magazines in the design area, and professors contributed by recommending books or donating them. But Bini recognized that emphasis was placed on industrial design and justifies: "The biggest market for work" existed "for graphic designers, but most of the theoretical material" was "in product design" (Bini, 2015).

4 Final Considerations

Through interviews and the examination of the documents of the subjects, we can trace some considerations about the history of visual communication in 1970 in Brazil.

The minimum curriculum of 1969 only mentions 'History of Arts and Techniques', which was why most of the 1970s courses did not consider 'History of Design' a compulsory subject. The same happened with 'History of Visual Communication'. This situation continued for one more decade since this minimum curriculum lasted until 1987, when the proposed new minimum curriculum, drawn up by designers in 1979, was approved by the Ministry of Education. Even so, the latter minimum curriculum favored the term 'History of Art and Technology' to designate the subject 'History' in designing courses, and it used the term 'History of Industrial Design' as a sub-item, without mentioning a "History of Visual Communication".

This fact is partly a result of the structuring of Visual Communication/Graphic Design in the early decades of design in higher education as a qualification of Industrial Design. The understanding of most courses is that Visual Communication/Graphic Design is an activity that also involves a product project for industry: graphics. On the other hand, we must consider that design in higher education was established in large part inspired by the German schools in Brazil, which considered visual communication as a kind of specialization after a basic course that also served for architectural design and industrial object.

The history of Visual Communication was related largely to the history of Modern Art (with a focus on the modernist vanguards and concrete art), and the history of the professional field of industrial design inspired by the line traced by Nikolaus Pevsner in the book *Pioneers of the Modern Movement: from William Morris to Walter Gropius*. A Portuguese edition of this was published in 1962 in Portugal, and it is probably this issue that was referenced by six out of the nine researched subjects. Another text in Portuguese, but written by a Brazilian, could also have contributed to the adoption of this line at the time: Alexandre Wollner, a professor at ESDI, gave a lecture in 1964 to São Paulo businessmen, which was transcribed and published in 1965 in *Product and Language* magazine. This magazine circulated at ESDI and among some 1960s and 1970s design courses. The title of the text is 'Origins of Industrial Design' and it brings a narrative with a story supported by a sequence of topics that are mostly the same as those addressed by Pevsner. Wollner adds to these Styling, the graduates of the Bauhaus in the USA, and a brief mention of the German School of Ulm. Wollner attended this school from 1954 to 1958 and was one of the professionals most prominent in the field of design in Brazil. Despite being specialized in visual communication, that text does not refer to graphic design.

Thus, in most disciplines surveyed, the starting point was the Industrial Revolution or the Arts and Crafts of the Nineteenth Century, except for the focus assembled by Steinberg and the discipline at FAU, which dealt with an earlier origin for graphic production by focusing on typography, printing technique and the production of books. Machado adopted a specific bibliography that was totally different from the other disciplines surveyed. There were just five titles, all in English, of which four address the history of typography and printing presses that were published in the 1960s. This shows that available publications addressing the specific history of graphic design abroad were mostly relatively recent. Indeed, those about Graphic Design in Brazil were rare until the 1970s.

Steinberg (2015) considers that "product designers were circumstantially more attentive to exercising criticism of design and therefore produced records about the profession." And that in Brazil "a large number of professionals insisted on the controversial distinction between art x design and architecture x design". According to Steinberg, this discussion would be one of the causes that "generated a gap of 25 years of records" in the visual communication history of the country that also included "carelessness and ignorance in ephemeral archiving, for many years the only existing sources".

The existence of qualifications in visual communication and a demand for information on a professional field that was traditionally more promising for graphic design, led professors and students of the subjects surveyed to empirically seek information on the field because of the few publications on the activity in Brazil.

So far, we know that the first text written in Portuguese by a Brazilian on the specific history of graphic design in Brazil was published only in 1983. “The Pioneers of Visual Communication,” by Alexandre Wollner, was one of the chapters of volume 2 of “General History of Art in Brazil”, compiled by Walter Zanini. Before that, texts were found for the most part in stories and articles in magazines and newspapers with very defined themes in character or work, as happened with the Design/Designer column written by Ivens Fontoura between 1972 and 1973, and which was published in the newspaper ‘Diário of Paraná’.

We found through research that in the 1970s many designers were already interested in a ‘History of Design in Brazil’, although the courses with a discipline that addressed this content were still few in that decade. Most of them were from public institutions. This shows concerns with a social identity and the search for references to local operations in a profession considered ‘new’ and with little symbolic capital. Possibly, this search also reflected questions at the time about the relationship of training based on ‘foreign’ models of design with the Brazilian cultural and productive reality of the 1970s.

Finally, we note that some characteristics of the six professors of these subjects are similar to the profile of the majority of design history professors in the current situation in the state of São Paulo. They got their degrees in design, architecture or in arts, and most were beginning a teaching career when they started giving the course. Therefore, they had no previous training in history. However, these pioneering professors were able to structure their courses in most cases without reference to previous courses and were active and decisive proponents of the implementation of design history, even in disciplines which initially did not address this subject, thus contributing to the start of a consolidation of the search for the social identity of the local designer.

References

- APDINS-RJ, APDINS-PE and ABDI. *Draft Resolution on Minimum Curriculum*. Attached to the letter to Mr. Guilherme de la Penha, from October 20, 1979, signed by APDINS-RJ, APDINS-PE, ABDI and Gustavo Bomfim, coordinator of the special committee. Rio de Janeiro, 1979. 22 pages.
- DODD, *Frank Anthony Barral*. Interview by e-mail on 7 and 31 August 2015.
- BIANCARDI, Cleide Santos Costa. Interview by e-mail on May 15, 2015.
- BINI, *Fernando Antonio Fontoura*. Interview by e-mail on 17 and 26 August 2015.
- BRAZIL. Ministry of Education and Culture. Resolution No. 5 of July 2, 1969. *It sets the minimum curriculum for courses of industrial design and visual communication*. Federal Education Council. Brasília, 2 June, 1969.
- BRASIL. *Ministério da Educação e Cultura. Parecer 408/69*. Aprovado em 12 de junho de 1969. Conselho Federal de Educação. Brasília. 1969b.
- BRAZIL. *Ministry of Education and Culture. Legal Opinion 408/69*. Approved on June 12, 1969. Federal Education Council. Brasília. 1969b.
- FEB. *Program of the discipline of Aesthetics I*. Bauru: Educational Foundation of Bauru (FEB), No date. 2 pages.
- MACHADO, Lucio Gomes. *Interview given and recorded on March 26, 2015, one hour and 18 minutes long*. São Paulo, 2015.
- STEINBERG, Silvia. *Interview by e-mail on August 21, 2015*.
- UFPR. *The syllabus of Introduction to Industrial Design*. Curitiba, 1978. 4 pages

WITTER, Geraldina (org). *Desenho Industrial: uma perspectiva educacional*. São Paulo: Arquivo do Estado de São Paulo; Brasília: CNPq/Coordenação Editorial, 1985.

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Chapter 8

From Mapping to Data Visualisation: Re-evaluating Design Education at the Royal College of Art

Teal Triggs

keywords: information, experience design, data visualisation, pedagogy, design history, Royal College of Art

In 1967, the Experimental Cartography Unit (ECU) launched at the Royal College of Art and was funded by Britain's Natural Environment Research Council (NERC) with the main aim 'to advance art, science, technology, and practice of making maps by computers.' (Rhind 2008) The ECU was also tasked with working on new ways of communicating cartographic information. (Coppock 1968) Amongst the innovative approaches to emerge was a stereographic or anaglyph method for representing in three-dimensions statistical data on maps. Such advances in automated cartography techniques contributed significantly to the growing field of computer-assisted information visualisation. Nearly fifty years on, the connection between technology, science and design continues to be a central focus for RCA students and researchers. However, as shifts in technological, informational and socio-political environments take place, so too has the need to re-evaluate the role design education and research plays in addressing these new contexts. Using the ECU as a paradigm, this paper will explore how the art school context and its affiliation with science and industry continues to inform the development of design research and the curriculum. In particular, the ways in which students and researchers are transforming information into experiences through design. Examples will include student projects from MA Information Experience Design and the Creative Exchange Hub. The context for the ECU is, of course, historical but the challenges remain the same.

1 Introduction

In 1967, the Experimental Cartography Unit (ECU) launched at the Royal College of Art and was funded by the Natural Environment Research Council (NERC) with the main aim to 'advance art, science, technology, and practice of making maps by computers.' (Rhind 2008: 135). The ECU was also tasked with working on new ways of communicating cartographic information. (Coppock 1968) Amongst the innovative approaches to emerge from ECU's researchers was the development of a stereographic or anaglyph method for representing spatially statistical data on maps. Such advances in automated cartography techniques contributed significantly to the growing field of computer-assisted information visualisation.

Nearly fifty years on, links between technology, science and design continue to be a key focus for Royal College of Art (RCA) students and researchers alike. In particular, the ways in which students and researchers are 'transforming information into experiences through design.' As shifts in technological, informational and socio-political environments occur, so too has the need to re-

evaluate the role design and education plays in addressing these new contexts. This paper will outline the current pedagogical challenges faced by the School of Communication, RCA, and explore both relevant and forward thinking design curricula within an art school context.

The paper is divided into two parts. Firstly, I'd like to explore some of the key themes, which have emerged over the last few years in relationship to design education and its future. This includes taking a broader look of what the paradigm shifts might be and what impact this has on ways in which we develop curricula context and frameworks. This leads us to the second half of the paper. Here I will explore using specific examples from the RCA's School of Communication and its postgraduate offer, how we are engaging with new ways of thinking about design education, and within an art school context. We are grappling with new kinds of interdisciplinarity and multi-institutional collaborations – particularly with our affiliations with science and industry. Ways in which this in turn informs the development of design research and the curriculum will also be touched upon; specifically the ways in which students and researchers are transforming information into experiences through design. Examples will include student projects from our MA Information Experience Design programme as well as examples of PhD research undertaken as part of the Creative Exchange Hub – an AHRC funded collaboration between Lancaster University, Newcastle University and the Royal College of Art.

Earlier this year, I was invited to speak on the subject of design education for a conference sponsored by the University of Ljubljana in Slovenia, held on the occasion of the Academy of Arts and Design's 30th anniversary. This prompted the organizers, designers Petra Oven and Barbara Predan, to use the event as an opportunity to create a forum to evaluate where design had been situated historically (particularly within their own academy), and to propose a new model for design education for the future. Drawing upon the work of the French philosopher Jacques Rancière, a 'model of emancipation' was introduced where 'the educational process must transcend the mere transfer of knowledge.' (Oven and Predan 2015: 12) In order to make this manifest, Oven and Predan, like Rancière before them, ask three key questions: 'What do you see? What do you think about it? What do you make of it?'¹

My answers were as follows:

Q. What do you see?

A. Things around us are changing. Different kinds of demands are being made on designers. The communication design profession itself is moving from designing artefacts to designing tools, systems and experiences. Industry is now seeking editors, curators and visualisers of digital information.

Q. What do you think about it?

A. It is clear that we need to review where we are. With this shift new pedagogical challenges have emerged in order to ensure the relevancy of current design curricula within a context of social, political, economic and cultural transformation.

Q. What do you make of it?

A. We have reached a pivotal point in the history of design education. I would argue that in education as well as the profession there isn't one single way to teach ways of thinking and making. We remain eager to hang on to the principles of basic design; our foundation courses still teach core skills and aesthetics. At the same time, we must embrace a space where new technologies are

¹ The one-day conference 'Design Education: What do you see? What do you think about it? What do you make of it?' was organized by Petra Cerne Oven and Barbara Predan in 2015, celebrating 30 years of the Academy of Fine Arts and Design at the University. In their introduction, Oven and Predan acknowledge the work of Jacques Rancière and his predecessor Jean-Joseph Jacotot who both question the means by which knowledge is transferred in education.

transforming how we think as designers which calls for an advancement of new skills and processes (e.g. coding and programming, interdisciplinarity and social science methods) in order to address the complexities offered by contemporary and future challenges and contexts. The boundaries of our profession in communication and information design have necessarily blurred as the challenges become more complex, the means of production alter, and the users/audiences become more sophisticated in their expectations.

Oven and Predan's three questions provoked both speakers and the delegates to reconsider their current positions with regard to design education and those 'tools that have been proven over time to facilitate the delivery and acquisition of knowledge.' (Oven and Predan 2015: 8) Within this context of new complex problems, Oven and Predan argue for a 'radical transformation' in design education. That is, a move beyond the continual cycle of changes that take place in education, and toward a rethinking of 'the very framework of traditional educational methods'. (Oven and Predan 2015: 10) This means a significant pedagogical shift from relying on a 'classical model' of passive learning, to a more engaged or active model where students are 'enabled' in their independent learning. (Oven and Predan 2015: 12) Such an 'emancipation' occurs where 'students are able to decide whether they will acquire knowledge when they choose to...' (Oven and Predan 2015: 14) This would most certainly require a framework for learning that supports students in moving toward their own means and methods for independent learning,

This proposal also presumes that students recognize the need to become willing participants in this new kind of acquisition of knowledge. This implies students will look to being more flexible in their learning and critically engaging in processes of production, research, experimentation, testing, prototyping, and so forth, in order to increase their depth and breadth of knowledge as independent learners. Whether the reader fully agrees with this model or not, it was apparent that the debates which followed the conference presentations showed that many of the delegates were experiencing similar concerns about the development of infrastructures and curricula within own institutions.

2 Context of UK Education

The RCA has not been immune to external pressures. Economically as well as technologically, paradigm shifts in industry and the profession have triggered a re-evaluation of traditional methods, practices, techniques and user/audience expectations. This has an impact on course development, both in terms of exploring the range of new offers, but also refreshing or updating current programmes. In addition the role of design research is increasingly key to strategic plans that support the development of intellectual and research in terms of design and innovation. The importance currently placed on collaboration and partnerships, nationally and internationally, institutionally and with industry, by the Research Councils UK is significant. Funding opportunities are now premised on the bringing together of interdisciplinary and multi-institutional research teams, which is shaping new forms of discipline collaborations. This runs across doctoral training, start-up businesses, as well as knowledge exchange and public engagement. The Research Council UK's 'Framework of Principles' states that for UK funding bodies:

'Complex interdisciplinary research projects increasingly need to be tackled through multi-institutional proposals which bring together the necessary expertise to address challenging research problems.' (Research Council UK 2015)

Whilst this may force our hands for funding to work across disciplines, for communication and information design, this seems entirely the right direction to be going in. At least research, which crosses different disciplines, may now be adequately supported through funded projects. This in itself is a shift in

government policy, which has been beneficial to communication/information design researchers.²

Back in the classroom, however, in the UK, the recent election of an all-Tory government has meant further entrenchment of conservative views on education policies and in its election manifesto laid out additional funding cuts. The broader economic environment, in which education is situated, has resulted in the implementation of ‘austerity’ measures by the UK government. For example, calls for a 33% cut up to 2018-19, for non-protected government departments. The impact on education has already proven financially significant, with further job losses, consolidation of institutional resources, increased tuition fees, and so forth. The new Immigration Act has also placed additional stresses on the ability of universities to recruit and maintain overseas students – including restrictions on student visas. In her piece ‘What a Tory Government Means for Universities’ for *The Times Higher Education*, Nicola Dandridge, argues that education must make a powerful case to Cameron and his Cabinet which ensures ‘investment in skills and our world-leading research – on which much of the UK’s long-term growth potential depends – [and] to enable the sector to contribute even more to the economy and society.’ (Dandridge 2015) This too, has been a catalyst for radical change.

3 Views on Design: Norman and Friedman

Rethinking design education is very much on the agendas of design writer Don Norman – who writes a regular column on design for *Core77*, and Ken Friedman, who researches at the intersection of design, art and management. Norman and Friedman have raised concerns about education in relationship to the shifting paradigms of design in an increasingly global economy. Whilst they both refer primarily to the field of industrial and product design, it is nonetheless worth assessing their positions in relationship to communication and information design.

As communication and information design have broadened in scope, dealing with greater complexity of issues or ‘wicked problems’, this suggests a greater need for revising our curricula in order to provide a greater ‘depth of knowledge’. Norman argues that students have little or no understanding of ‘statistics and behavioural variability,’ ‘unconscious biases,’ or the ‘necessity of control groups.’ (Norman 2010: 3) He calls for a greater awareness of the interrelatedness of the ‘behavioural science, technology and business’ and calls for ‘training in science, scientific method, and experimental design.’ (Norman 2010: 1)

Friedman summarizes both his and Norman’s positions in the paper ‘Models of Design: Envisioning a Future Design Education’ for *Visible Language* (2012). Friedman observes:

‘Design is an interdisciplinary profession serving multiple needs. Designers work in transdisciplinary teams whose nature and constituency changes according to the project at hand. For this reason, it is difficult to argue for a definitive range of skills or even a specific series of knowledge domains. In educational terms, these change depending on the location and focus of the program and curriculum. Even so, it is possible to suggest a typical taxonomy of domains that one might expect to see in a strong, contemporary design school.’ (Friedman 2012: 143)

Friedman goes on to propose that design education is experiencing a shift from craft-led approaches to designers developing strategic tools (e.g. ‘models, simulations, decision theory and systems thinking’ [Friedman 2012: 148]). Meanwhile Norman advocates for the teaching of behavioural and social sciences as design moves increasingly toward services, interaction and experience. It is worth

2 In January 2014, the UK Higher Education Academy issued a commissioned report on ‘Flexible Pedagogies: technology-enhanced learning’ which proposed e-learning as providing new markets for part time learners, accumulation of credits toward ‘...the prospect of lifelong learning in a scalable way.’ (Gordon 2014: 2)

noting that Norman still believes that the design profession will always need designers trained in materials and production as well as styling. (Norman 2010: 5)

The change that Friedman and Norman are proposing is already taking place in many institutions. However, college staff, in particular, has expressed a need to update their own knowledge bases. Norman is critical. He comments: 'The uninformed are training the uninformed.' (Norman 2010:3) Within existing academic structures, catering for staff to develop more experimental, behavioural or social science methods may not be so easy to integrate. On undergraduate courses in the UK, for example, it is common for staff to find themselves already stretched with existing government requirements for delivering core curricula and vocational skills, let alone teaching behavioural and social science methods. If something new is incorporated into the curriculum, then the first thing staff will ask is 'what gets left out of my teaching?'

Perhaps we need to consider alternative ways of taking into account what the future of our curricula might be, by asking what they are intended to deliver: to whom, for whom and by whom?

4 Design and 'Pedagogical Flexibility'

Norman and Friedman call for more of an alignment with engineering and science, but they also caution that educators must not discount what is good about what and how they currently teach. Norman remarks: 'the artistic side of design is critical: to provide objects, interactions and services that delight as well as inform, that are joyful.' (Norman 2010: 6) For me, this is where the art school context just might come into its' own. How might we employ what the art school context might provide in terms of an ethos, core skills and a philosophical position as we move toward innovation?

Neville Brody, designer and Dean of the School of Communication RCA, has argued on many occasions for designers to be more agile. And he refers to education as the basis for fostering 'skilled dangerous minds.' That unique approach of being 'radical' or 'disruptive' is particularly valuable in the conceptual phase of the design process where 'thinking outside the box' is a necessity. (Simpson 2013) At the same time, design is an applied profession. There is a context, a client brief and users to take into consideration. However, I agree there is room for exploration, experimentation and thinking differently when the brief requires new and visionary ways of thinking, including criticality and an understanding of material and digital processes. Designers today certainly cannot be complacent.

In June 2014, Ronald Barnett delivered a report 'Conditions of Flexibility' for The Higher Education Academy in the UK, where he called 'for serious attention to be paid to radical, imaginative educational innovation and experiment in order that HE providers do justice to the faith their students put in them in preparing them for living and working in such a world and for shaping its future.' (Barnett 2014: 4) Barnett distinguishes flexibility in how it is applied to both 'systems flexibility' and 'pedagogical flexibility'. This might mean a review of systems to be more flexible in delivery models, including e-learning or part-time study as well as lifelong learning post degree.³ On the other hand, 'pedagogical flexibility' responds more clearly to 'human beings who are themselves flexible, able to respond purposively to new situations and ideas.' (Barnett 2014: 9).

Barnett's report also expands into the 'emerging forms of flexibility in relation to research processes which he calls 'epistemic flexibility' reflecting the ways in which knowledge has a more fluid character. This brings us back to Oven and Predan's observation on the ways in which knowledge and knowledge production is changing. Barnett offers a direction for thinking about knowledge in this new global context:

3 This is echoed in the Design Council's White Paper 'Design for Innovation: Facts, Figures, and Practical Plans for Growth'.

‘Not only is flexibility a matter of the ways in which disciplines might open themselves to each other (in transdisciplinarity; in pluridisciplinarity) and of the ways in which researchers are expected to work (in transnational teams, in new forms of ‘publication’) but it is a matter evident at different levels of knowledge production.’ (Barnett 2014: 26).⁴

Barnett’s report outlines the ways in which research is positively feeding into the curricula of undergraduate programmes, and the contribution research is making to underpin learning of methods and approaches. At the same time, the reciprocal relationship between teaching and research is coming under scrutiny within the academy. Staff increasingly, have been designated as either ‘research active’ or ‘non-research active’, as universities push toward increased funding from industry-based projects and consultancy. Research is increasingly collaborative, operating in academic-industry partnerships, even expanding into international domains; and, financially this is of benefit to institutions increasingly as they are asked to locate third-stream funding opportunities.

Barnett’s 88-page report is a rich resource in the way it highlights and puts into a contemporary pedagogical context many of the challenges we are currently facing in the teaching of design. The solution to the diversity of goals – student, staff, institution, industry, and government – may remain in understanding differing definitions of ‘flexibility’ within and amongst other contexts: markets, student expectations, employability, and discipline-based value systems. (Barnett 2014: 35-39). Barnett refers to flexibility as a ‘trope’ ‘...for imagining and then realising new potential that may be glimpsed for the student as *person-in-the-making*.’ (Barnett 2014: 73) A laudable goal, which I am sure as educators, we all share.

5 Educating ‘Flexible’ Designers: Royal College of Art

I would now like to turn to the learning undertaken by students at the Royal College of Art. By way of an introduction, the College recently celebrated 175 years since its inception in 1837 as the Government School of Design, whose goal was to ‘improve the education of designers, which, it was assumed, would in turn improve the output of British industry.’ (Oshinsky 2006) In 1948 the School of Graphic Design was founded, led by Professor Richard Guyatt, with the sole intent to ‘reimagine education for the 20th century’. The emerging post-war context led Guyatt to an approach, which brought together the ‘relationship between the fine arts, the applied arts and crafts,’ as a way of articulating his views on the nascent profession of ‘commercial art.’ This way of thinking he positioned as: ‘Head, Heart and Hand’; which continues to inform the core values fostered by the School of Communication’s learning and teaching approach (Triggs 2015: 94).

In 1967, the RCA was granted a Royal Charter with university status and still today remains the world’s only wholly postgraduate institution of art and design. I mention this as our history still frames the way we approach learning and teaching at the College, but also the research and innovation links we maintain with industry. Throughout the College’s history, collaboration has featured amongst the students who seamlessly move across programmes, working with others who may bring knowledge from different disciplines or professional backgrounds as relevant, to their projects. Equally, the connection between technology, science and design continues to be a central focus for RCA students and researchers. As shifts in technological, informational and socio-political environments take place, so too has the need to re-evaluate the role design education and research plays in addressing these new contexts.

The second part of this paper will draw from early examples of the Experimental Cartography

⁴ Ronald Barnett goes on to mention what is meant by the idea of the student as ‘global citizens’ – a concept which has long been considered by design educators such as Jan van Toorn and Jorge Frascara, for example.

Unit (ECU) in the 1960s and then bring this approach up to 2015 with work by students from the Information Experience Design (IED) programme and PhD candidates on the Creative Exchange hub, whose research intentionally draws upon collaborations with industry and academia in order to explore new forms of design innovation.

6 Experimental Cartography Unit (ECU)

In 1967, the Experimental Cartography Unit (ECU) launched at the Royal College of Art and was funded by Britain's Natural Environment Research Council (NERC) with the main aim 'to advance art, science, technology, and practice of making maps by computers.' (Rhind 2008) The Unit was also tasked with working on new ways of communicating cartographic information. (Coppock 1968) Amongst the innovative approaches to emerge was a stereographic or anaglyph method for representing in three-dimensions statistical data on maps. This included the use of red-green glasses to introduce a 3-D effect to the spatiality of the maps.

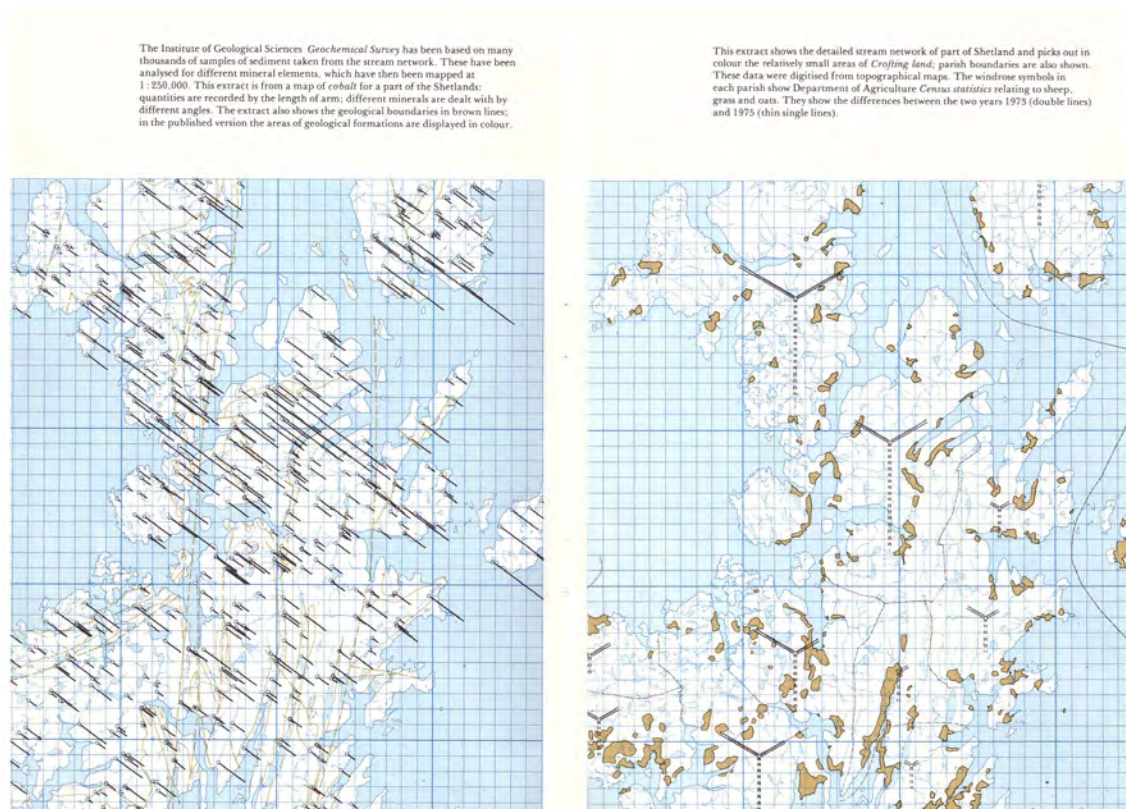
Such advances in automated cartography techniques contributed significantly to the growing field of computer-assisted information visualisation. The role the RCA played came about as its first Director, David Bickmore, saw the potential for designers to develop new graphic conventions in order to 'convey information meaningfully'. (Margerison 1976: 4) Tom Margerison, who later became founding Editor of the magazine *New Scientist*, wrote an essay 'Computers and the renaissance of cartography' for an RCA-published booklet. Margerison observed that: 'a map is the simplest, most elegant and informative way of presenting data which vary across a surface.' (Margerison 1976: 3) He proposed that maps were 'pictorial' and that they provide both quantitative and qualitative information. ECU was founded in response to recognizing the limitations of two-dimensional maps for representing specialised information. The Unit was able to digitise data sets in order to 'replay and plot them with the required accuracy', thereby allowing cartographers the flexibility to 'draft the parts of the map [they are] interested in.' (Margerison 1976: 6)⁵

Whilst I am not a specialist in computer or cartographic history, the examples of maps produced using this process illustrate a range of possible uses of data sets and methods of visualisation. It is not the purpose of this paper to go into any depth into digitisation, but to use these examples as evidence of the intent of the collaboration, which Bickmore had envisaged between computer scientists and graphic designers in the production of these maps.

In this example we see an abstract from the *Atlas of Global Seismology: 1909-1969*. The visualisation was generated using a 'large digital data back of seismic records held by the Institute of Geological Science.' The caption reads: 'The seismic information for each 'square' is plotted directly by computer in bars of different thickness, orientated N-S; E-W and diagonally. A brown tint shows areas in which some activity has been recorded during the total period. – e.g. on maps of other time periods.' (Margerison 1976: 11). Other maps in the booklet included visualisations of Vegetation Boundaries in the Shetlands – 'compiled using air photographs and the vegetation categories arrived at from their survey'; Ecological Habitat in the Shetlands, based on analysis of the Unit's own field work; contours of the eastern Atlantic from the Institute of Oceanographic Sciences; details of an Experimental Geological Map of London reflecting geological patterns; and Land Use Mapping with local authorities, in which 'the locations and the rateable values of all commercial properties in central Winchester' were illustrated. The ECU existed until the late 1980s and was the forerunner to the ways in which scientists and designers have been involved in scientific collaborations external to the College.

5 Other accounts of the processes developed by ECU provided alternative discussions of the work undertaken by the Unit's scientists. See for example, Coppock and Rhind (1991).

Figure 1. Mapping of cobalt quantities (left) and detail of stream network (right) in the *Shetlands from the Atlas of Global Seismology: 1909-1969* reprinted in T.A. Margerison (1976) *Computers and the Renaissance of Cartography*. London: Experimental Cartography Unit, Royal College of Art: 10-11. © Royal College of Art, reproduced with permission.



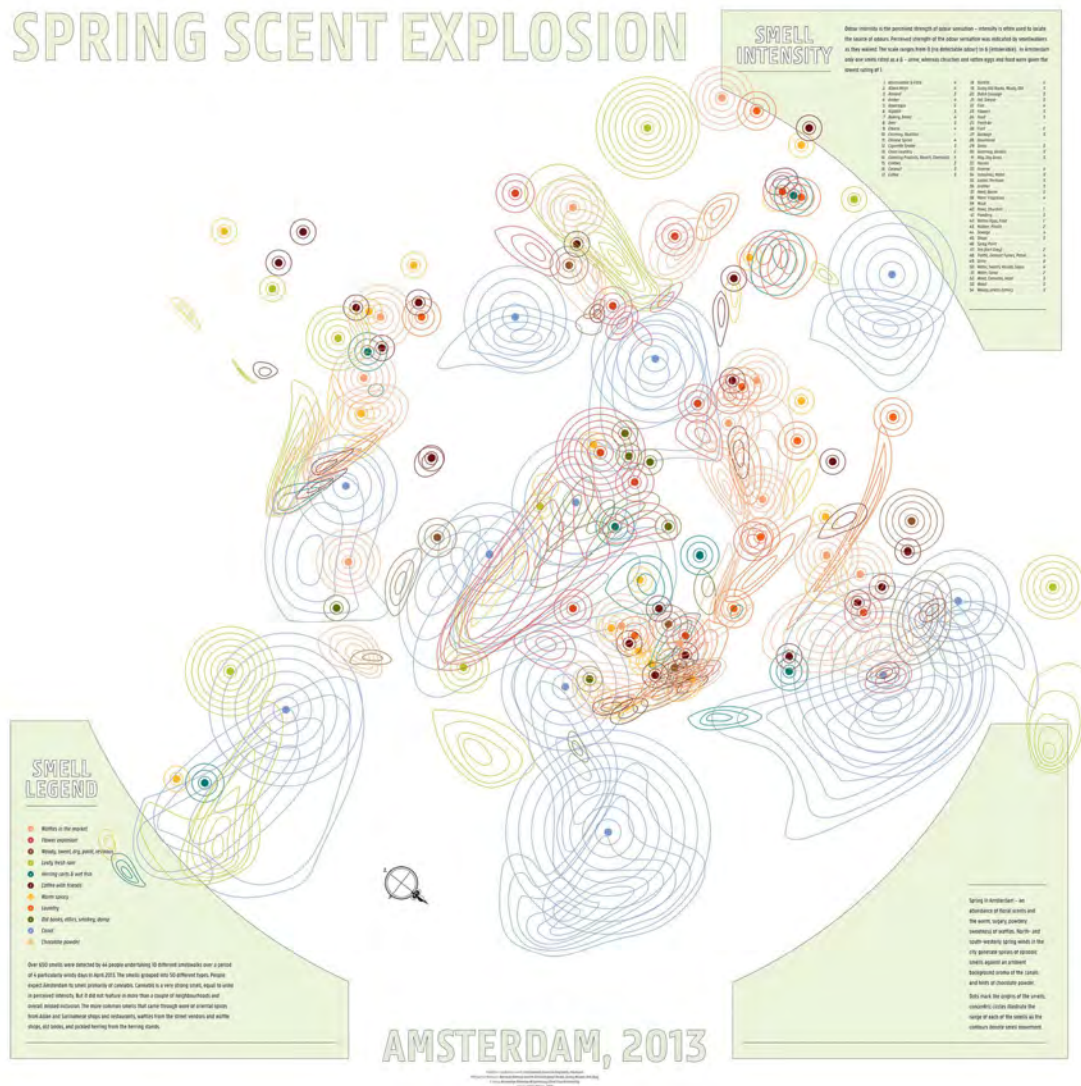
7 RCA Researchers

I'd now like to look at a few examples of work undertaken more recently by PhD students and also students from the MA Information Experience Design programme, which started in 2012. These examples of research processes and outcomes reflect the ways in which designers at the RCA have joined in partnerships with industry, with researchers from other disciplines or from across the RCA in different departments. I will provide brief descriptions of the project work by way of an introduction to the kinds of research students at the RCA are involved. Most of the students whose work I will show here have websites, which I would encourage you to visit for more detail. I won't be able to give the work the detailed discussion that it deserves during this presentation. However, through the visual clues on the screen, what I hope emerges is an indicator of the kinds of research practices that are being undertaken, and their applications.

As we began with maps from the Experimental Cartography Unit, I'd like to continue by showing you more contemporary versions of cartographic research. This first example is from Kate McLean, a PhD candidate whose research has focused on human perception of urban 'smellscapes'. McLean has created smellmaps from Brooklyn to Edinburgh, and has recently been working with Fifth Sense, a UK charity for those suffering from anosmia (the inability to smell), to create and facilitate meaningful conversations through shared smell experiences, between normosmics and anosmics, using 'smellwalks' and watercolour paintings of imagined and recalled smells. In an earlier example, she has visualised the results of a study undertaken with 44 participants on ten 'smellwalks' through the city of Amsterdam.

Smellmaps capture the smells as recognised by the participants as they go on a guided, walk through a city. The research walk was collaboration with industry partner Bernardo Fleming of International Flavours and Fragrances. The resulting smellmap depicts 650 smells detected by 44 people undertaking 10 smellwalks over a period of four days in April 2013. Over 50 categories of smells were identified, based on the written descriptions of the smellwalkers, including ‘an abundance of the ‘warm sugary powdery sweetness of waffles’, oriental spices, pickled herring, and old books. (McLean 2014: 144) Additional data comes from a range of observations of the designated urban space including colour, movement, range, and evaporation. The dots are the original sources, the concentric circles indicate range of the smell sources and, movement is recorded from local wind direction at the time of data collection. (McLean 2014: 145) Once the data is translated into two-dimensional maps, McLean then creates an animated visualisation – these are at once informational and magical in providing a sensorial experience of the city.

Figure 2. *Spring Scent Explosion*, Amsterdam (2013) is a visualisation of a smellmap designed by Kate McLean as part of her PhD research at the Royal College of Art. Image courtesy of Kate McLean.



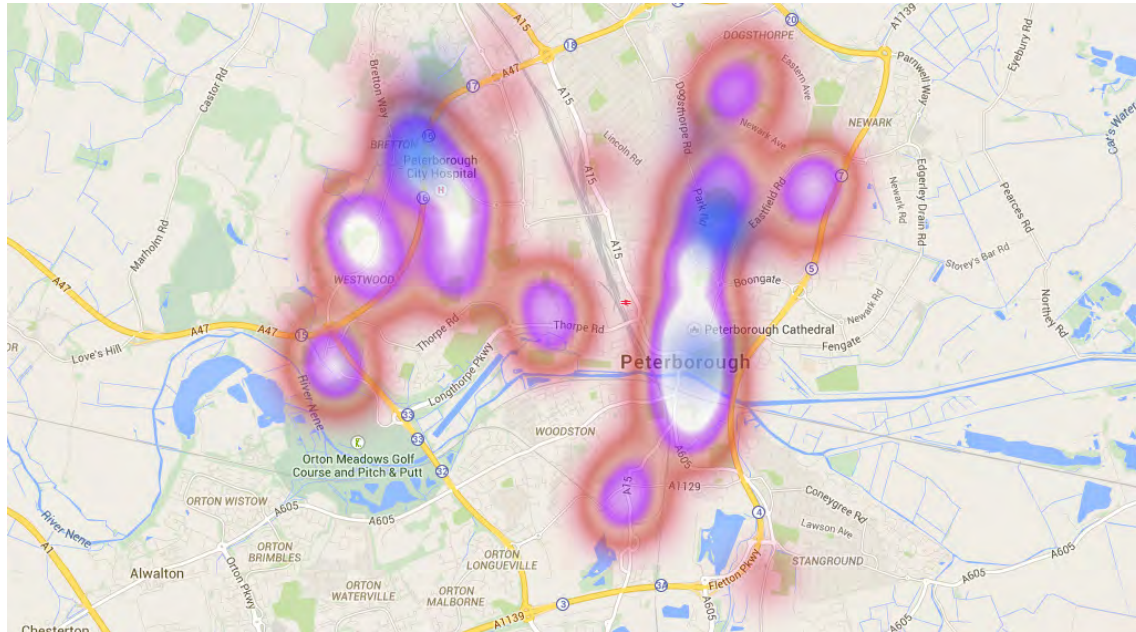
My next example of PhD work emanates from what we are calling the Creative Exchange Hub (CX). The emphasis that government agencies and funding bodies are placing on strategic collaborations with industry partnerships is evident in an Arts and Humanities Research Council-supported initiative. CX is a four-year knowledge exchange hub for the creative economy led by Professor Rachel Cooper at Lancaster University along with co-investigators from Newcastle University and the Royal College of Art.⁶ This inter-institutional project draws on complementary specialist research expertise under the umbrella of digital public space – a term which has prompted debate as to its exact definition. The three partner institutions have agreed that ‘digital public space’ is focused on making accessible ‘previously inaccessible and private data’. (Myerson 2015) This means exploring new and innovative ways in which the public might engage with digital spaces, and to follow on considering what the policy implications might be.

A key aim of the Creative Exchange Hub is to develop a community of individuals skilled in design research and knowledge exchange. One way in which this is being achieved is through the development of a cohort of 21 PhD students undertaking practice-led/based doctoral training in the fields of design. The CX PhD model positions the student at the centre of the knowledge exchange process emphasising the development of expertise in generating ideas, engendering exchange, managing cross-sector relationships and developing collaborative design-based research. CX PhD students work with a variety of academic and non-academic partners in the course of their studies and through short-term projects, developing knowledge and skills in their individual specialisms while simultaneously bringing new insights to the social, commercial and cultural organisations they collaborate with. Not only is new knowledge being generated through partnerships (research *through* knowledge exchange), but also a new model for the design PhD is explored. (Dalton, Jacobs, Simmons, Triggs 2014)

Whilst time does not permit showing the work of all the PhD students involved in the CX Hub, I’d like to briefly describe two different ways in which students at the RCA in particular, are working with industry and other academics to foster innovation in the creative industries. In each example, these students bring to a series of collaborative industry and academic projects different understandings of ‘digital public space’, each equally valid, and each focusing on different forms of public engagement. The first example is a project from Jimmy Tidey, a web developer by training and a member of the technology community. Tidey has worked extensively with local governments and applies his experience to using ‘physical representations of digital information to increase social cohesion within communities.’ (Tidey n.d.) In particular, Tidey has partnered with the Department for Communities and Local Government, the Royal Society of Arts Manufactures and Commerce (RSA) and software development company TableFlip. Tidey is working with organisations that have a public facing remit in order to test and expand the functionality of LocalNets – ‘an innovative social media digital analytics tool created to drive community action and promote the take-up of community rights.’ (Tidey n.d.) Tidey has been using the LocalNets app to stage a series of interventions intended to improve low take-up for community rights in the Bretton Parish of Peterborough, UK. Participants for the Bretton Buzz project’s community meeting were discovered and invited through his social media analysis. The resulting visualisations using ‘community asset discovery’ have yet to be completed. However, the potential exists for these to be returned to community spaces in physical form in order to help ‘understand community concerns and issues more efficiently’. (Tidey n.d.)

6 Professor Rachel Cooper, OBE at Lancaster University is Principal Investigator and Director of the Creative Exchange Hub. Professors Neville Brody and Jeremy Myerson, based at the Royal College of Art, are two of the Hubs nine co-investigators. Full details of all three universities and the 21 CX PhD researchers and their projects, are available online: <http://www.thecreativexchange.org/>

Figure 3. Visualisation of findings from the digital analytics tool LocalNets developed by Creative Exchange PhD researcher, Jimmy Tidey, at the Royal College of Art. Image courtesy of Jimmy Tidey.



The PhD research of architectural designer Benjamin Koslowski is an example of how innovative solutions in the area of health and wellbeing emerge out of collaborative partnerships. In this case, Koslowski partnered with the Foundation for Art and Creative Technology, or FACT Liverpool, to research and design a series of projects contributing to the 2015 exhibition ‘Group Therapy’. The exhibition explored, with works ranging from art installations to documentary interviews, ‘mental distress in a digital age’ and highlighted the relationship between mental wellbeing and technology. His involvement in this project informed his own PhD research into paradigms around privacy and the public; actor and audience, and the spatial relationships between the digital and physical.’ (Koslowski 2015)

In this particular project titled ‘States of Mind’, Koslowski’s collaboration was extended to include an interactive platform designed with Brendan Dawes and Claire Cook of Nexus Productions Interactive Arts team, a London-based company which explores storytelling and design to create interactive experiences; and, academic partners Roberto Botazzi from the School of Architecture, RCA and Karen Ingham from the University of Wales, Trinity Saint David.

A console in the exhibition asked visitors to respond to the question: ‘What does your mental health look like right now?’ Through manipulating a series of knobs and dials, the user is able to generate a digital object, which becomes an abstract representation of their state-of-mind. An image is generated which is externalised onto a large screen publicly displayed in the foyer of the gallery – thus making public what is essentially a private emotion. The project harnessed Koslowski’s ability to test the effectiveness of the visualisation of intangible notions, such as wellbeing and its private positioning, transformed into a publicly shared version using a vocabulary of abstracted rhizomes. Such visualisations could be expanded in order to map the ‘emotional landscape of the city’ through the ‘gathering of narrative experiences.’ (Koslowski 2015)

The work of our PhD students is not limited to involvement in the Creative Exchange Hub but also reflect shared research interests around data visualisation, narrative and knowledge exchange and collaboration. Here we might return to the idea of ‘pedagogical flexibility’, which enables platforms for ‘radical, imaginative educational innovation and experiment.’ (Barnett 2014: 4) In part, we believe this can be supported through the exchange of research knowledge between our PhD and MA students.

Figure 4. 'States of Mind' (2015) was a collaboration between Brendan Dawes, Claire Cook, Roberto Botazzi, and Karen Ingham led by Creative Exchange PhD researcher Benjamin Koslowski, at the Royal College of Art. Image courtesy of Benjamin Koslowski. Photo: Brendan Dawes.



8 Data Manifestation Workshops

Communication, and the methods by which we facilitate or mediate this act of conveying information, is by necessity undergoing changes in the design of processes, methods and modes of dissemination used to convey complex information. In a forthcoming paper 'Data Manifestation: A Case Study', Karin von Ompteda, who is a PhD candidate in Visual Communication with a background in Biology⁷, describes the learning experience students from across the RCA have experienced on an annual week-long workshop she has run since 2010 on 'data manifestation'. Von Ompteda defines data manifestation as 'a design practice involving the communication of data through objects, installations and experiences, with the purpose of stimulating dialogue on important and timely topics.' (von Ompteda 2016) In this way, the students are liberated from what are now seen as conventional approaches to data visualisation (for example, the nevertheless excellent work of statistician and artist, Edward Tufte; and David McCandless who refers to himself as a data journalist)⁸.

Students in von Ompteda's workshops come from a range of different MA programmes in the College, which means the knowledge of disciplinary practices from Product, Information Experience Design, Visual Communication, Architecture, and so forth, combine to generate effective, if not innovative, solutions to workshop briefs. With the students involved, the representation of data was no longer confined to two-dimensional solutions but naturally broadens out. Von Ompteda's brief asks students to 'to translate the data into an object, installation or experience that stimulates dialogue and has the potential to shift peoples views on an important of timely topic – a practice which is visual, physical and experiential.' (von Ompteda 2016) This opens up the ways in which experimentation; interpretation, curation and the ethical implications of working with online open-access datasets (in this case data from the World DataBank and the World Values Survey) might be handled. Equally as important, the brief asks students to explore and test through different means the ways in which selected data could manifest itself to a broader public audience.

⁷ Karin von Ompteda has recently joined as an Associate Professor the Faculty at Ontario College of Art and Design, Toronto where she is teaching similar approaches to data manifestation to undergraduate students.

⁸ Edward Tufte is perhaps best known for his series of books on information design including, *Envisioning Information* and *The Visual Display of Quantitative Information* (Graphics Press). David McCandless' book *Information is Beautiful* (Harper Collins) and his infographics for *The Guardian* newspaper brought data visualisations to a broader public consciousness.

Nurturing the relationship between communication design and fine art practices facilitates the way in which more abstract or conceptual ideas might provide a ‘hook’ for the interpretation of data. Students, in cross-disciplinary groups, were asked to take an authorial position on their selected datasets, which included complex issues concerning the environment, gender, race, religion, politics, and so forth. (von Ompteda 2016) Von Ompteda, in a description of the workshops, acknowledges the subjectivity of this project, but argues for its emphasis as:

‘...a way for students to take ownership through their specialist areas of interest and to explore the ways in which data might entice a conversation with its viewer. These projects are introductions to the subject and critically engaging with process and interpretation through data visualization...’ (von Ompteda 2016)

This brings us back to Rancière and his ‘model of emancipation’ where we might be asking questions which expand the otherwise limiting boundaries of design practice: ‘What do you see? What do you think about it? What do you make of it?’

Von Ompteda’s knowledge as a research degrees student in design and her training as a scientist informed her project framework through which these MA design students have engaged in learning. I would also argue that this approach is informed by an art school context; where models of learning already foster collaboration, experimentation, and interdisciplinarity. These contexts and juxtapositions for approaching data and its exploration have resulted in thought-provoking outcomes. By critically engaging with data, von Ompteda’s intent is to also introduce students to the potential problems surrounding data if accepted at face value.

One example in which the multiple ways in which data is questioned and communicated is exemplified in *My Life Don’t Mean A Thing If It Ain’t Got That Swing* - a collaborative project between Polly O’Flynn (Visual Communication); James Pockson (Architecture), and Peter Shenai (Information Experience Design). In this project von Ompteda asked students to take as their starting point data from the World Value Surveys Association (2015).

Figure 5. *My Life Don’t Mean A Thing If It Ain’t Got That Swing* (2015) was a collaborative project between Polly O’Flynn, James Pockson, and Peter Shenai for a workshop led by tutor Karin von Ompteda. © Royal College of Art. Photo: Dominic Tschudin.



The question asked of participants of the survey was: ‘All things considered, how satisfied are you with your life as a whole these days?’ (World Values Survey Association, 2015). Von Ompteda describes this project in some depth in her paper, as an example of the way in which students had reconsidered the data relationships to what happens when you ‘see’ information and then, what happens where information is ‘experienced’. The resulting outcome was the construction of a life-sized swing set, which eagerly invited viewers not only to engage with statistical data, which was visualized on the set’s frame, but also through the act of swinging where ropes were adjusted in relation to the percentage of satisfaction. (von Ompteda 2016) Whilst many of the solutions to von Ompteda’s brief may not be seen as viable in the short term as ‘real world’ applications, the learning undertaken through the act of collaborating, making, research and experimentation has given students the confidence to undertake data visualisation projects into more applied contexts in the future. At the same time, the exposure to new multimodal forms to communication may ideally one day be integrated fully into the information landscape.

9 MA Information Experience Design (IED)

Students on MA Information Experience Design (IED) under the programme head Dr. Kevin Walker, provide my final set of examples. Walker explains that ‘IED is about transforming information into experiences’ which is achieved through research and experimental practices. Such explorations are made manifest through for example, through data visualization, installations and investigative design. (RCA 2015) The programme launched in 2012 and had its first graduating class in 2014.

Pivotal to this programme is the way it has embraced the shifting paradigms of the broader questions around the call for learning associated with design, social and behaviour. Walker, whose own background is in social science and journalism, places an emphasis on research methods in which students engage with interdisciplinary and participatory processes, explore behavioural and socio-cultural contexts, and develop their skills in decision-making and critical thinking. The curriculum encourages students to engage critically in making and hacking through a range of materials, exploring data visualisation, installations and exhibitions and experience design, using both physical and digital tools and materials (Information Experience Design 2012). Here we come back to Professor Guyatt’s intersection of art, craft and applied contexts – ‘with the fine artist learning from his heart, the designer learning from his head, and the craftsman learning from his hand.’ (Guyatt 1976, 3)

Students from across the RCA in Innovation Design Engineering, Information Experience Design and Design Products explored the notions of data transparency in their project *Birth of the Digital Egg*. The project was an outcome of one of von Ompteda’s ‘data manifestation’ workshops where students were asked to ‘explore global statistics to tell their stories’. (von Ompteda 2014) In this case, students asked, ‘As we increasingly connect virtually, are we gradually disconnecting from reality?’. The use of the egg as a metaphor became the starting point for their exploration into representing data based on ‘the inverse relationship between birth rates and Internet usage in various countries.’ (Walker 2014) The final result was the creation of a series of exquisitely crafted opaque and translucent eggs designed to convey their makers’ position on the ‘hollowness of light-speed digital communication’ and ‘the solidity and natural form of organic life’.

9 MA students at the RCA who collaborated on the ‘Digital Egg’ project were: Sungwhoon Cho (Innovation Design Engineering), Thomas Essl (Innovation Design Engineering), Carrolynn Hsieh (Information Experience Design), Jae Kyung Kim (Information Experience Design), Kevin Smeeing (Design Products).

The combination of craft, technology, and critical thinking is an approach that forms the basis of much of the work produced by students in the programme. At the same time collaboration is often essential for the realization of the works. For example, the piece titled *Change Ringing* (2014) was a successful collaboration between IED student Peter Shenai and composer Laurence Osborn. Each brought relevant skill sets to the realization of their intent, which was to craft and document the shapes and sounds derived from climate change data. A series of cast bronze bells representing climate data in various decades of the 20th Century then formed the basis for a large orchestral composition.

Figure 6. *Birth of the Digital Egg* (2015) was a collaborative project between Sungwhoon Cho, Thomas Essl, Carrolynne Hsieh, Jae Kyung Kim, and Kevin Smeeing for a data manifestation workshop led by tutor Karin von Ompteda. © Royal College of Art. Photo: Dominic Tschudin.



Another project demonstrates new ways of thinking about the invisible transactions from excess data as a product of our daily urban existence. *Colony*, 2014, was a cross-disciplinary collaboration between IED student David Hedberg and Printmaking student Gabriele Dini with Orestis Tsinalis and Dr Koen van Dam from the Digital City Exchange programme at Imperial College London. The project utilised live data from tube journeys, office power usage and tweets, rendering each in summary as dripping honey from a large handcrafted honeycomb. The intent was to ‘create meaningful connections between data and the citizens of London’¹⁰. The project was shown at the London Design Festival, V&A Museum, and proved very popular with viewers.

¹⁰ *Colony* formed part of a larger project undertaken by Karin von Ompteda and funded by the Sustainable Society Network+ (<http://sustainablesocietynetwork.net/>).

Figure 7. *Colony* (2014) was a cross-disciplinary collaboration between David Hedberg, Gabriele Dini (Royal College of Art) with Orestis Tsinalis and Dr. Koen van Dam (Imperial College London). Image courtesy of David Hedberg.



10 Conclusion

Returning to Oven and Predan's earlier question: 'What do you make of it?', I would suggest that we need a fresh look at design education and its curricula; agility, criticality, collaboration, and interdisciplinarity are now key to this process. This paper has explored how the art school context, especially with an affiliation with science and industry, continues to inform the development of design research and curricula. Taking the work of the Experimental Cartographic Unit in the 1960s as a starting point, it has demonstrated how the ethic of bold collaboration has endured into the 21st century; and in particular, the ways in which students and researchers are transforming information into experiences *through* design. Arjun Appadurai wrote in the foreword to *Design as Future-Making*, that 'Design is fully conceived as a practice that continuously reimagines its own conditions of possibility.' (Yelivich and Adams 2014: 9) This act of reimagining is where fluidity resides. It is where new paradigms come into view and conventional boundaries are broken down. This, coupled with

advances in digital technology, is fostering new kinds of communication practices, which have the potential to impact on not just education but society at large.

I'd like to end this paper with an example from David Hedberg's final degree show (MA IED) project *Smile TV* (2014).

Figure 8. *Smile TV* (2014) project by David Hedberg as part of his final Degree Show at the Royal College of Art. Image courtesy of David Hedberg.



The project began as an aesthetic response to poor television reception from ineffective TV antennae. Hedberg argued for a new kind of receptivity, which was responsive in its form as two-way communication. *Smile TV* uses facial recognition technology embedded in a TV set (inspired by televisions from the past century). By presenting a clear image only when the viewer smiles the TV screen, the invention prompts us to reconsider the viewer's engagement and how content is accessed. (Hedberg 2014.) This parallels the spirit in which we should be viewing a future for design education; the way we can imagine and realise new potential. I am smiling.

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References

- APPADURAI, A. 2014, 'Forward'. In *Design as Future-Making*, edited by Susan Yelavich and Barbara Adams, pp. 9-11. London: Bloomsbury.
- BARNETT, R. 2014, '*Conditions of Flexibility: Securing a More Responsive Higher Education System*', York: The Higher Education Academy, June.
- COPPOCK, J.T. 1968, '*Royal College of Art Experimental Cartography*', *Scottish Geographical Magazine*, 84 (1): 66.
- COPPOCK, J.T. and RHIND, D.W. 1991, 'The History of GIS'. In Maguire, D. J., Goodchild, M. F. and Rhind, D. W. (eds) 1991, *Geographical Information Systems: Principles and Applications* (Vol. 1). Harlow: Longman Group: 21-43. Available online: http://www.geos.ed.ac.uk/~gistea/ilw/generic_resources/books_and_papers/Thx1ARTICLE.pdf (Accessed 29 August 2015)
- DALTON, B., JACOBS, N., SIMMONS, T., TRIGGS, T. 2014, '*Research Through Knowledge Exchange: The Creative Exchange PhD Model*', AHRC KE Hubs Conference, 30-31 October 2014, unpublished paper.
- DANDRIDGE, N. 2015, 'What a Tory Government Means for Universities'. *Times Higher Education*. Available online: <https://www.timeshighereducation.co.uk/content/queens-speech-2015-universities-uks-reaction> (Accessed 29 August 2015)
- EXPERIMENTAL CARTOGRAPHY UNIT. 1971, *Automatic Cartography and Planning*. London: Architectural Press.
- DESIGN COUNCIL. 2011, *Design for Innovation: Facts, Figures, and Practical Plans for Growth, December*. London: Design Council.
- FRIEDMAN, K. 2012, 'Models of Design: Envisioning a Future Design Education'. *Visible Language* 46 (1/2): 132-153.
- GORDON, 2014, *Flexible Pedagogies: Technology-enhanced Learning*, January. York: The Higher Education Academy.
- GUYATT, R. 1976, 'Head, Heart and Hand'. *Two Lectures. RCA Papers No. 2/ 1977*. London: Royal College of Art: 2-5.
- HEDBERG, D. 2014, '*Smile TV*'. Available online: <http://www.davidhedberg.info/smile-tv.html> (Accessed 29 August 2015).
- KOSLOWSKI, B. 2015, 'Group Therapy'. *Creative Exchange Hub*. Available online: <http://thecreativeexchange.org/activity/group-therapy> (Accessed 29 August 2015).
- MARGERISON, T.A. 1976, *Computers and the Renaissance of Cartography*. London: Royal College of Art and the Natural Environment Research Council/Experimental Cartography Unit.
- MCLEAN, K. 2014, 'Smellmap Amsterdam: Olfactory Art & Smell Visualisation' in Forbes, A & Chevalier, F. (eds), *Proceedings of the IEEE VIS 2014 Arts Program, VISAP'14: Art+Interpretation*, Paris, France, 9-14 November: 143-145. Available online: <http://visap.uic.edu/2014/program.html> (Accessed 06 January 2016)
- MYERSON, J. 2015, 'Considering Digital Public Space: A Report'. The Creative Exchange, June. Available online: <http://thecreativeexchange.org/activity/considering-digital-public-space-report> (Accessed 30 August 2015).
- NORMAN, D. 2010, 'Why Design Education Must Change' *Core77: Design Magazine & Resource*, pp.1-20. Available online: http://www.core77.com/blog/columns/why_design_education_must_change_17993.asp (Accessed 28 August 2015).
- OSHINSKY, S. J. 2006, 'Design Reform'. In *Heilbrunn Timeline of Art History*. New York: The Metropolitan Museum of Art, 2000-. Available online: http://www.metmuseum.org/toah/hd/dsrf/hd_dsrf.htm (October 2006) (Accessed 29 August 2015)
- OVEN, P.C. and PREDAN, B. 2015, 'He will learn what he wants, nothing maybe' in Oven, P. C. and Predan, B. (eds). *Design Education: What do you see? What do you think about it? What do you make of it?* Ljubljana: University of Ljubljana: 8-20.

- RESEARCH COUNCIL UK. 2015. 'Principles for Funding Multi-Institutional Collaboration in Innovation and Research'. Available online: <http://www.rcuk.ac.uk/funding/principles/> (Accessed 29 August 2015).
- RHIND, D.W. 2008, 'Experimental Cartography Unit' (ECU). In Kemp, K. (ed.), *Encyclopedia of Geographic Information Science*. Thousand Oaks, CA: SAGE Publications, Inc.: 136-137.
- SIMPSON, V. 2013, 'Interview: Neville Brody on the Changing Face of Graphic Design.' *Design/ Curial*, Blueprint. Available online: <http://www.designcurial.com/news/ahead-of-the-curve/> (Accessed 29 August 2015)
- TIDEY, J. (n.d.) 'Bretton Buzz', *The Creative Exchange Hub*. Available online: <http://thecreativeexchange.org/projects/bretton-buzz> (Accessed 15 April 2015).
- TRIGGS, T. 2015, 'Mapping Futures for Graphic Design Education' in Oven, P. C. and Predan, B. (eds), *Design Education: What do you see? What do you think about it? What do you make of it?* Ljubljana: University of Ljubljana: 92-111.
- VON OMPTEDA, K. (n.d.) 'Workshops'. Available online: <http://karinvonompteda.com/Workshops> (Accessed 15 April 2015).
- VON OMPTEDA, K. 2016. 'Data Manifestation: A Case Study'. In Triggs, T. and Atzmon, L. (eds), *The Graphic Design Reader*. London: Bloomsbury. (forthcoming)
- WALKER, Kevin. (n.d.), 'Birth of the Digital Egg'. (Accessed 15 April 2015). http://ied.rca.ac.uk/?attachment_id=812
- WORLD BANK GROUP 2015, *World DataBank*, Available online: <http://databank.worldbank.org/data/home.aspx> (Accessed 19 July 2015).
- WORLD VALUES SURVEY ASSOCIATION 2015, *World Values Survey*. Available online: <http://www.worldvaluessurvey.org/wvs.jsp> (Accessed 19 July 2015).

About the Author

Teal Triggs is a Professor of Graphic Design and Associate Dean, School of Communication, Royal College of Art, London. She is also an Adjunct Professor at RMIT, Australia. Previously she was co-Director, Information Environments – a research network across University of the Arts London as well as Acting Course Director, MRes Information Environments and Course Director, MA Design Writing Criticism. As a graphic design historian, critic and educator she has lectured and broadcast widely and her writings have appeared in numerous edited books and international design publications. Her research has focused primarily on design pedagogy, self-publishing, and feminism. Teal has received several project grants for her work on feminism and design (AHRC) and more recently, she was recipient of a Harry Ransom Center Fellowship for the Humanities, University of Texas at Austin, where her research focus has been on the American editor Fleur Cowles and her influential lifestyle magazine *Flair* (1950-1951). Her research has also extended into community-based learning projects including 'A Sense of Place: Life Histories of Residents on the Aylesbury Estate' funded by the UK's Department of Business, Innovation and skills, as well as 'Creative Connexions: Thinking about Thinking', exploring craft and design education at the National Institute of Design, India. She has also led a number of interdisciplinary research teams in developing methods combining social science and design-led solutions including co-Investigator on Designing for the 21st Century Research Cluster: 'Digital Design, Representation, Communication and Interaction: Screens and the Social Landscape' (AHRC). Teal is also Editor-in-Chief of *Communication Design* (Taylor & Francis/ico-D) and co-editor of *Visual Communication* (Sage) and Associate Editor of *Design Issues* (MIT Press). Teal has just completed her first children's book titled *The School of Art* (Wide Eyed Editions) and is currently co-editing with Leslie Atzmon *The Graphic Design Reader* (Bloomsbury). Her previous books include: *Fanzines* and *The Typographic Experiment: Radical Innovations in Contemporary Type Design*, both published by Thames & Hudson. She is a Fellow of the International Society of Typographic Designers, the Royal College of Art and the Royal Society of Arts. <teal.triggs@rca.ac.uk>

Section 3

Methods, theories and new design approaches

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Chapter 9

Semiotics and information design. <metabolisme.design> an interactive tool for designers

Bernard Darras

keywords: Artifact, Habit, Information Design, Metabolism, Pragmatic semiotics, R&D, Stakeholder, Tools.

Since Charles. S. Peirce's work on graph theory and, later on, the work of Otto Neurath and Gerd Arntz on isotypes as well as Jacques Bertin's research on the semiotics of maps and graphics both semiotics and information design have been closely linked. This presentation is in line with this tradition, while at the same time trying to provide semiotics with the readability and efficiency that it so often lacks the <metabolisme.design> tool and its dedicated website were therefore created using analysis and expertise tools notably aimed at designers. This semiotic tool applied to the study of the meaning of artifacts, Research & Development and project management is the fruit of pragmatic semiotics, notably the habit theory, the stakeholder theory, the Actor Network Theory and the 'AGILE' development methodology. After highlighting the project of valorisation and usability of semiotics, the tool itself and its main paradigms will also be presented, as well as their future developments. The presentation will conclude with a study on the impact of information design on the development of this tool.

1 Making Semiotics Accessible and Useful

In general, semiotics is accused of being a too abstract theoretical discipline, inaccessible and not usable enough. Today, this view is shared by a growing community of semioticians who recognize that these defects hinder the development and applications of their discipline even if the demand for analysis and advice on the meaning of discourses, images, objects, interfaces and data practices continues to grow.

The designers that I am talking about today are very often trained in semiotics, but this training is obviously too short and its content is not always suited to their fields of expertise or updated.

Fortunately, in most cases, the impact of this training is real and helps develop their analytical, critical, creative and above all communication capacities.

I have taught semiotics to design students for twenty years, and I have found that they are rather good in understanding and using this theory, which helps them produce more meaningful artifacts but, in general, they expect tools that are more suitable for their activity.

It is in this perspective that my laboratory has developed tools to model the production of the meaning of artifacts by adapting pragmatic semiotics. In most cases, these tools have been developed with students following courses for a Professional Masters in Digital Design, as well as doctoral students and doctors.

The tool that I will present in this chapter is intended to accompany the follow-up of changing distributed meaning. It is called ‘Metabolisme,’ from the Ancient Greek μεταβολή, *metaboly*, which means ‘change,’ ‘transformation’.

It is part of a philosophy of project management that is very similar to participatory design and the AGILE method¹¹.

Firstly, I will present it as an analytical tool but also as a project piloting tool for designers, and secondly I will discuss the information design issues we are now facing.

1.1 Metabolisme: a Tool to Study Communication and Distributed Meaning

The introductory text of the online application <metabolisme.design> states:

“This tool is designed to study the process of communication and collective and changing construction of the distributed meaning of any artifact (images, products, websites, etc.). It also helps support and pilot a project by focusing on the production of meaning. This interactive tool concerns all stakeholders of a project and it also allows for the study of the evolution of their agreements and disagreements and, if necessary, for their mediation.”

The term stakeholder refers to any human or non-human agent, individual or collective, that is more or less actively engaged in the production of common meanings and activities.

In a project, each stakeholder can act as a carrier, producer, distributor or user of meaning. These four stakeholders are directly or indirectly interlinked and organised in a circuit. In most cases, the dynamics of meaning are the result of transaction and co-determination loops between partners of meaning.

In the pragmatic theory that is behind this tool: “The meaning is the result of signs in interaction and transaction. The meaning can be seen as an adaptive tool that is mobilized or fabricated during individual and collective experiences with living beings or artifacts. The meaning is therefore designed as an adaptive tool to orientate and organise oneself, to act or interact individually and collectively in a given milieu. The meaning tends to stabilize itself in the form of belief-habit. Any belief-habit is sensitive and vulnerable to vagaries and doubt.”

“Beliefs-habits are therefore practical and cognitive tools which allow one to act by giving meaning to one’s actions.”

<metabolisme.design> is therefore a synthesis of theory and theoretical definitions, a model of the production process of changing meaning and an interactive device for the visualization of this model. As a tool, <metabolisme.design> is at the service of expertise (analysis and advice); it is useful to research, particularly to R&D (modelling, theory, and case studies) and the production of new artifacts, as well as to the mediation of knowledge and study results.

It serves as a reference in the discussion with the client and as a teaching tool in the training of students and professionals.

Information design has been constantly involved in the production of the various stages of research and development of *metabolisme*.

It has notably been very useful as early as the modelling phase by contributing to the constant reference to theory. It was often used during the visualization and modelling phases and in the production of dynamic and interactive diagrams that led to the online launch of the tool.

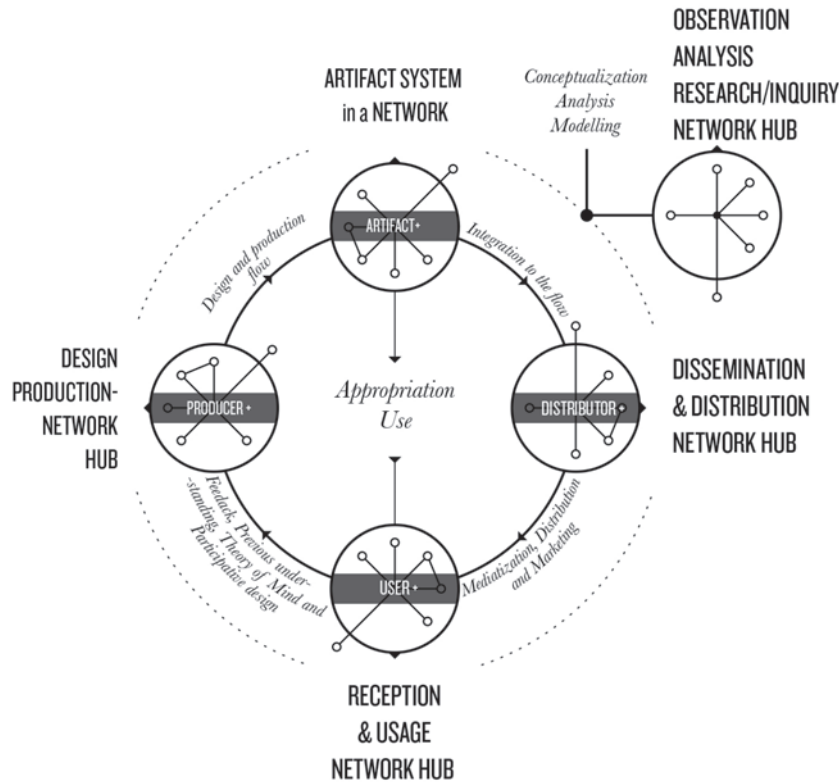
The tool is currently available online in French, English and Portuguese. The development and implementation of Version 2 will provide access to a self-assessment tool able to measure and compare the metabolism of thinking of each stakeholder.

11 See for instance <<http://www.blackstonemedia.com/agile-development/>>

2 Modelling the Circuit of Stakeholders

2.1 The Stakeholders' Centers

Figure 1. Modelling the circuit of stakeholders (Darras & Belkhamssa 2013)



In line with studies derived from Stuart Hall's stakeholder theory and circuit of culture (Du Gay et al., 2013), our model preserves the links between the so-called partners or stakeholders who are engaged in the same exchange, meaning and circuit of action. This circuit consists of producer, distributor, recipient and user hubs and we do not conceive their relationships according to the canonical linear model that goes from production to use, but rather as a progressive circuit of more or less dense relationships.

Consistent with Uexküll (1984) and Law (2004, 2009), we consider that each stakeholder builds their version of reality but that these versions of reality are subject to transactions (Dewey, 1946), co-determinations (Varela, 1991), translations (Akrich, Callon and Latour, 2006) and above all empathetic projections processed by the theory of the theory of mind (Premack & Woodruff, 1978) and that it is possible to develop methodological tools to observe, describe, understand and even improve these relationships (Law, 2004).

Our conception of these stakeholders or agents pays particular attention to the flow of relationships and transactions they are deploying and forging within their communities of interpretation, competence and action, as well as between the stakeholders in the circuit.

In keeping with holistic and systemic epistemology and particularly with the theory of network stakeholders that John Law (2009, 142) prefers to call material semiotics, we focus on the study of the reticular predispositions of agents and stakeholders and their relational properties, whether they are human or non-human.

The artifacts, which we have placed at the top of this model, are thus intended to be dynamic network entities whose meanings transform themselves into systems and networks of artifacts on one hand, and on the other, into networks of stakeholders that also belong to a network, including with the artifact systems.

Semiotically, an artifact is a device that potentially carries meanings and concentrates 'materialized habits.' But I will come back to the definition of habit later.

The artifact most often plays the role of delegate of human and sometimes non-human functions with other artifacts or living beings. The artifact has more or less complex interfaces that can afford, facilitate and maintain relationships of action (make-make) with users of meanings within its human and non-human milieu.¹²

The various stakeholders in each hub, who share an action and interpretation relationship, constitute human communities (business, agency, family, social networks, etc.) articulated with many delegated artifacts, companions, prostheses, etc., organised in artifact systems. The figure 1 summarizes our vision of this circuit of networks.

In addition to the four hubs of the circuit of stakeholders that we have just described, the fifth hub represents the person who created the model of the device studied. This is the 'translation' and interpretation hub of researchers, observers and analysts.

2.2 The Relationship Between the Hubs

All hubs in our model share more or less dense transaction relationships and they exchange flows of matter, energy, information (according to M-E-I's systemic vocabulary) and therefore flows of meaning, both internally and externally, at different times, in different areas and at different levels (according to the systemic terms used by Time, Space, Form: T-S-F) (Le Moigne, 1994). The exchanges are not permanently activated; some events may trigger the whole loop while others only trigger parts of it.

The production hub designs and produces artifacts that are initially collected, stored and inserted into the flow by the operators of the dissemination hub who are in charge of their mediatisation, marketing and distribution to potential users, who, in turn, receive these artifacts and use them.

For digital images and interfaces, the disseminator remains active; this is also the case for items such as public or rented objects. However, when the object becomes personal property, the disseminator is generally no longer active.

In general, in models and line diagrams, end users of an artifact are disconnected from the production hub from which they are separated by disseminators then by the uses of the artifact considered as 'autonomous.' Yet many links remain: the user manual, the manufacturer's warranty, the after sales service, the hot-line and more symbolically the brand, the identity, the identification to the brand, the style, the system of objects, etc.

Whether during initial use or in case of operational problems, the end user convenes the knowledge accumulated during his previous experiences (previous understanding) with artifacts from the same family or related artifacts.

Sometimes, users ask themselves more or less explicitly about the communication intentions of the production community, the engineer and the designer. They then project what cognitive psychology calls a 'Theory of mind.' When the relationship is positive, there is a kind of 'fusion of horizons' between the knowledge deposited and materialized in the artifact by the producer and the skills of the recipient-user.

One of the great challenges of information design is precisely to ensure the quality of data processing so the end user can understand this data easily and unambiguously in order to use it successfully.

Since the emergence of the fourth generation of R&D, the relationship between the production

12 Here I have decided to use the terminology used by the biologist and semiotician Jakob Von Uexküll (1984), which I cross-referenced with Peirce's theories of pragmatic semiotics and John Law's material semiotics (2009).

hub and the end user is no longer limited solely to testing and customer feedback, it has intensified by engaging representatives of the end user at the early stages of the design process and throughout the following phases. (Darras, 2014)

This is the purpose of participatory design and co-design, which experience a new type of transaction with the development of Fab Labs, crowd sourcing and crowd funding.

2.3 The Metabolism of Change within the Hubs

What happens in the hubs in terms of habit change and conservation, which is what interests me here?

To answer this question, we have drawn inspiration from the work of the mathematician, philosopher and semiotician Charles S. Peirce (1931-1935 and 1982-1996), who was also a chemist. It is indeed from chemistry that he borrowed the term metabolism to name the different operations of change that continuously enable thoughtful and meaningful action.

In chemistry, the term 'metabolism' encompasses all molecular changes within a (chemical) body. The concept was subsequently extended to physiology to include the changes in an organism, then to semiotics to address changes in the operation of sign systems¹³.

According to Peirce, "Pragmatism makes thinking to consist in the living inferential metaboly of symbols whose purport lies in conditional general resolution to act." (Peirce, 5.402). This general and conditional resolution to act is what Peirce called 'habit' and, more specifically, 'habit of action,' which is a predisposition to act.

As we will see later, we think that meaning is not only limited to representation or to the general and conditional phase of resolution to act that falls within the general deliberation phase but also directly within action and particularly habitual action. Peirce also held the opinion that action is generalized in the habit of action in act, that is to say, during a meaningful relationship produced during the experience of a user of meaning in a milieu (umwelt). That is to say, in the complexity of relationships, alterations, reactions, interactions, co-determinations, vagaries, etc. that contribute to the life of a milieu in an environment of milieux.

2.3.1 Habit

Habit is a phenomenon that has always intrigued humans and notably researchers. As Terrance MacMullan wrote (2013) "While habit has an ancient philosophical lineage stretching back at least as far as the work of Aristotle, it only achieved the apex of its philosophical impact in the nineteenth century within North American pragmatism." For Peirce, habit is a general principle that starts right from the organisation of matter:

"At any rate, it is clear that nothing but a principle of habit, itself due to the growth by habit of an infinitesimal chance tendency toward habit-taking, is the only bridge that can span the chasm between the chance-medley of chaos and the cosmos of order and law." Peirce: CP 6.262

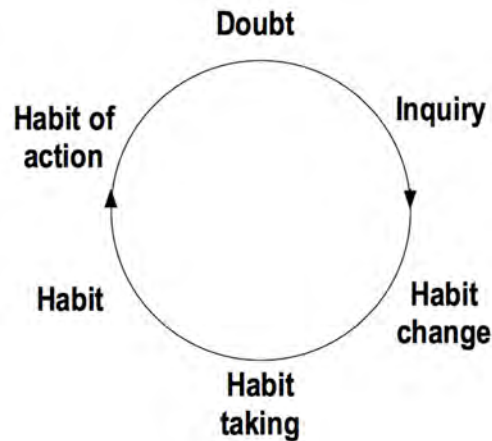
The fundamental ability to take habits (habit taking) is readily observable in living beings and in particular humans. It was noted both by William James and later John Dewey who was quoted by MacMullan: "habit plays its greatest role in the works of John Dewey, who sees habit as the proper seat of not just moral philosophy (in much the same way as Aristotle) but also as the conduit linking past memories to present experiences to anticipated events, and also as the necessary point of contact between the individual and her society and culture."

¹³ Etymologically, metaboly is a term that comes from the Greek *metabolé* meaning 'displacement' then from the Latin *metabola*, *metabole*, which means 'change' and 'exchange'.

If, for Peirce, the tendency to take habits (habit taking) presided over the emergence of all rules, it is also the semiotic and practical finality of these rules, since habit and the habit of action are the destination of the metabolism of thought.

Let's return to the various hubs that make up our model. We did not simply represent internal relationships and transactions statically; we have given them a kind of dynamic cursor that represents the state of the internal semiotic metabolism of each of the agents in the network and, by extension, of the whole community of interpreters and users of this agent.

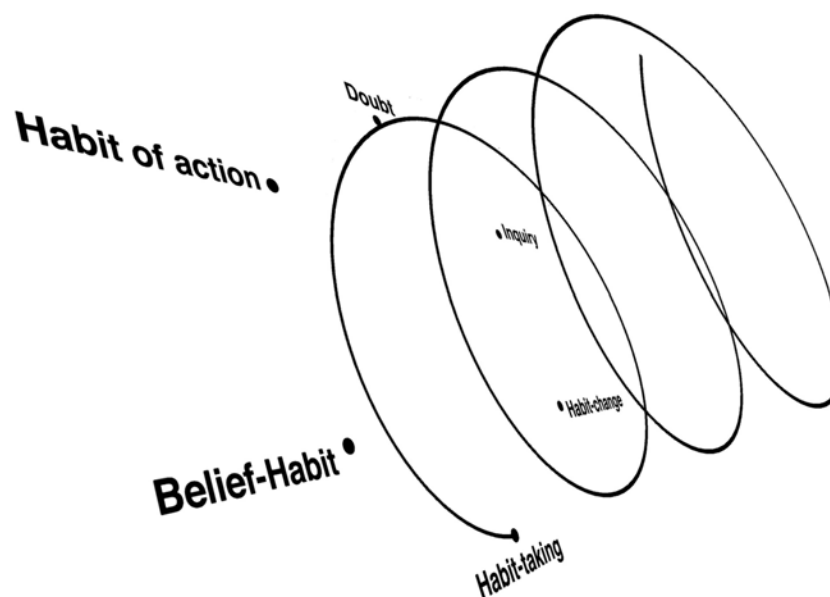
Figure 2. Diagram of the metabolism of thought, based on C. S. Peirce's concepts



“Habit taking, belief-habit, habit change, habit of action, inquiry and doubt are Peirce’s concepts that we organised in a circular and dynamic diagram to represent the various phases of the metabolism of thought.

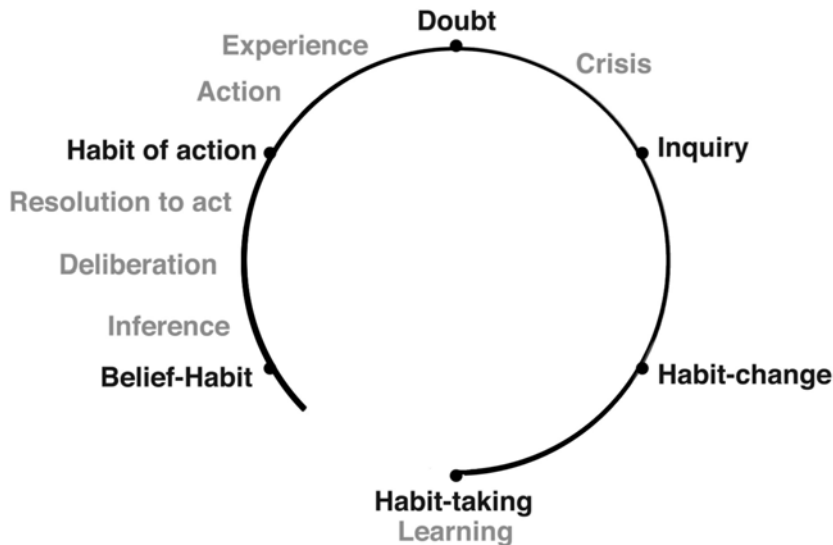
A new habit turns into a belief-habit that then becomes a habit of action, until it is disturbed, causing a phase of doubt, which generates a solution search phase whose result leads to a change of habit, then to the adoption of this new habit, etc. endlessly. If the phases are repetitive, the thought that passes through them is scalable and regular, with a meliorative purpose.

Figure 3. Diagram of the spiral (Darras, 2015)



One must therefore not consider this circuit as an eternal and regular repetition of the same circuit but as a spiral whose old habits tend to fade and then disappear, so that future habits can be subject to prediction and abduction. Thought is dynamic. It transforms itself, mutates, temporarily stabilizes itself as a habit then evolves endlessly, going through the same phases of the spiral of the metabolism of thought-sign-action.

Figure 4. The completed diagram



We completed the initial diagram by adding complementary phases: the inference process that is at the origin of the sign; the deliberation that precedes action; the resolution to act; action itself and the experience it provides; the crisis of meaning that follows doubt and hinders deliberation and inhibits action; the learning phase when the inquiry finally produces a new solution that remains to be integrated into the more or less coherent and united world of beliefs-habits.

This representation of the states of the metabolism of thought and action corresponds to the circuit of the semiotic and pragmatic metabolism of stakeholders but also to the metabolism of their community of interpretation, competence and action.”

Compared to their milieu, network or relationship to the device, the agent or stakeholder may be in the semiotic phase of routine and habit, that is to say, in the pragmatic phase where meaning occurs as a predisposition to act or in a habit of action.

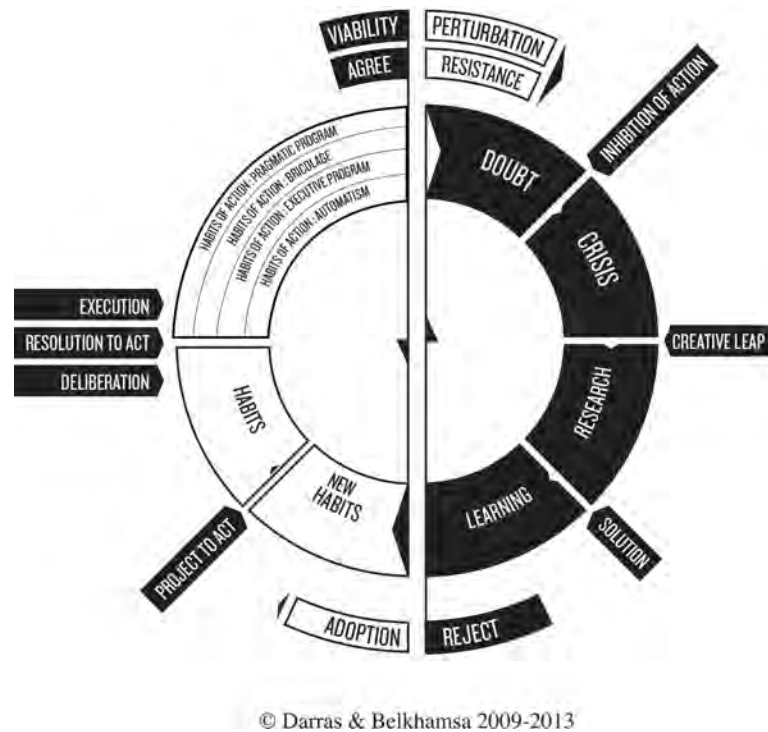
The agent may also be in a failure phase of his/her habit of action and experiencing a loss of meaning, this is the phase of doubt. The movement between habit and change of habit is not a simple oscillation but a more or less rapid chronological sequence of changes. I will return to this point in due course.

2.3.2 The Semicircle of Change and the Designers

During our research, we have completed Peirce’s cycle of semiotic metabolism (see below Fig. 5) and used it in a general perspective. Darras and Belkhamisa 2009, Belkhamisa and Darras 2009, Darras 2011, Darras 2013, Darras 2014.

In this paper, I will present it from the designer’s point of view.

Figure 5. Cycle of the metabolism of habits inspired by C. S. Peirce's theory, augmented by B. Darras and S. Belkhamza.



2.3.3 The Individuals in their Community

One must remember that this model is general and therefore suitable for studying the semiotic metabolism of an agent or a community of agents¹⁴.

Accordingly, it is possible to interlock these metabolic cycles into one another and thus represent the metabolic state of an agent in relation to the habits or habitus in their community of interpreters and users. By extension, it is possible to represent a particular state of the material, visual or digital culture of a community, and the interlocking of several stakeholders. This is precisely the approach of distributed meaning and the concept of <metabolisme.design>

Figure 6 shows a diagram where two elements are interlocked. Here, the agent and his/her community are both represented in the inquiry phase, pending a creative leap. This configuration is typical of that of a designer in a design agency.

Figure 6. Diagram of the metabolic states of an agent and the metabolic states of his/her community of interpreters and users.



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Our conception of collective habits is very similar to Pierre Bourdieu's concept of habitus.

Several methods of investigation help to determine the metabolic state of an individual and of his/her community of interpreters and users in relation to the meanings of an artifact or a project.

We believe in the virtues of the “first impression” that allows to determine the level of the metabolism in a very short time, at least if the expert is well informed and a good observer. However, this first impression deserves to be argued by various inquiries such as individual interviews and focus groups.

<Metabolisme.design> offers an online questionnaire to measure and to hierarchise the intensity of the stakeholders’ replies.

This questionnaire follows the organization of the cycle. (The questionnaire will be implemented in the version 2 of <metabolisme.design>.)

- The first question concerns the left-right partition of the cycle: are you in a routine phase or are you in the process to change your habit?
- In the first case, the questionnaire helps to determine whether the respondents are in a step of reflection and deliberation, about to act or already in action, Etc.
- In the second case, the tool helps to determine whether they are in a phase of doubt, crisis, research or learning.

Simultaneously, the multiple choices help to refine and hierarchise the responses of the stakeholders. Regarding the step of the “executive program” for instance, the choices are:

1. I know how to do
2. I am skilled
3. I have efficient routines
4. I am a technical expert

2.3.4 Description of the Operation of the Circuit

As we have represented it, the cycle of metabolism consists of two distinct zones, which refer to complementary experiences of life.

The white semicircle or semihelicoid on the left shows stable beliefs and habits¹⁵. The semicircle or semihelicoid on the right shows the destabilization of beliefs-habits, the doubts and crises that accompany them, the inquiry and changes that result from it.

In principle, the activity of designers is more likely to be situated on this side of change – this is the area of “high risk projects that could lead to a breakthrough” (techno push). However, the operations represented in the semicircle on the left side also refer to it. They address their ordinary activities. This is notably the area of incremental projects resulting from studies with clients (market pull).

2.3.4.1 The Designer and Change

Doubt and crisis

If, in ordinary life, doubt is generally considered a difficult, disturbing and irritating phase that one wishes would end sooner rather than later — this is indeed how Peirce, then James and Dewey¹⁶

¹⁵ One must remember that for Peirce a belief is an entity which one does not doubt and that: “The essence of belief is the establishment of a habit; and different beliefs are distinguished by the different modes of action to which they give rise” (CP 5.398 [1878]).

¹⁶ In *The Quest for certainty* (1926), Dewey showed how the quest for security is what leads humans to strive for the certitude of belief.

presented it — in the professional life of every designer, as well as that of any researcher, doubt is the necessary starting point of any inquiry. Without this initial doubt, there is neither any possibility of inquiry nor of novelty, even by accident.

‘Good’ designers and ‘good’ researchers are therefore amateurs and professionals of doubt and even of the crisis that follows it, when no solution is quickly found¹⁷.

It is actually the social role of designers and researchers to offer solutions to the doubts and crises that arise regularly in society when habits and beliefs are destabilized.

By broadening their role, they are even the cause of some of these doubts and crises, as they have become generators and accelerators of change, causing many doubts and crises in society.

Research and the Creative Leap

Obviously, for the moment, it is more rewarding to present designers and researchers as creatives rather than generators of doubts and crises¹⁸. When Richard Florida (2012) attempted to bring together all the professionals of the industry into the same category, he chose the valorising name ‘creative class’ even though the majority of professionals that make up most of the creative class are driven as much by doubt and crisis as they are by creativity and inventiveness¹⁹.

For Peirce and for all pragmatists, doubt is the result of a destabilization of meaning and of the meaning stored in the habit and the habit of action²⁰. A habit that has become inadequate loses its meaning because it no longer ensures the proper operation of a relationship.

Doubt is also the irritation that motivates the move towards the interrogation, investigation, research and inquiry phase, whose goal is the discovery of a viable solution that can replace the now failing habit.

The research of a breakthrough solution is therefore supposed to preside over exiting the crisis.

In our model, we called this aspiration ‘the creative leap’ because change can only develop when the inertia, inhibition and resistance of old habits give way to the search for new solutions, that is to say, freed from a past relationship.

Learning

I don’t have the time here to develop the phase dedicated to learning new habits that result from innovation and breakthrough, but it is clear that the importance of this habit-taking phase in supporting change and the construction of new beliefs and habits is crucial.

It is not enough to write a good user manual or tutorial for learning to succeed, one must above produce with intelligence artifacts that facilitate usability, accessibility and inclusion (Darras, 2009).

Habits at the service of Change

As I have presented them in line with the philosophy and pragmatic semiotics of Peirce, habits store our predispositions to act and they give them meaning. Any successful change is therefore intended to turn into a habit, that is to say, according to Peirce, into a general and conditional resolution to act.

In this sense, the designer cannot escape habits, even when they are used to produce change, novelty and eventually new habits. They provide designers with expertise, knowledge, solutions, processes and tricks, as well as their heuristics according to the theories of reasoning (Houdé, 2014),

17 This is also the case of ‘good’ artists. Which explains the closeness between all these social stakeholders that meet as early as during their period of training and work and/or live in close proximity.

18 The terms ‘doubt-maker’, ‘dubious’ or ‘crisis-maker’ won’t at any time become positive descriptions of a profession.

19 This idea is partly similar to those of Paul H. Ray and Sherry Ruth Anderson (2000) on ‘cultural creatives.’

20 As action sign, the habit has to be relational and contingent. It depends of the ‘habitual’ state of its milieu and results from the co-determination relationship between the stakeholders.

but also their tools and all the artifacts of their profession, which are nothing but materialized habits (computers, software, cameras, etc.), that is to say, materialized predispositions to act.

The Two Paths

The left part of the diagram of the metabolism of habits and their change shows two different paths.

On one hand, it represents the different maturation phases of a new habit that becomes a habit, then a habit of action by becoming operational.

On the other hand, the diagram shows two major phases of the metabolism of thought: the deliberation phase and the execution phase, both being linked to actions, cognitive and linguistic actions for the first, and actions in the world of stakeholders and artifacts for the second.

The deliberation phase is essentially an operation of thought in the reflexive and rational phase (although often irrational and emotional). This is the phase where the subject measures and weighs the pros and cons of facts and arguments, trying to find a balanced and measured solution that will allow them to try to anticipate the risks and consequences of their decision to act.²¹

The successful deliberation (habit) prepares to act by giving meaning to this prefigured action.²²

This preparation to act can remain speculative and not lead to real action in the world. In this case, thought projects its action on a possible future and memorises it without having to act in the present, in a particular situation and milieu. The deliberation phase is really a planning phase.

The execution phase is generally the realization of the deliberation phase. The 'project' becomes a creation and a product by being 'realized.' It is carried out during the implementation process. On this occasion, it is no longer managed through ideation or intellect (act of thought, speech act, concept, scenario, script, plan, diagram, etc.) but tangibly confronted with the things and artifacts of the world, causing much improvisation and feedback.

This is the moment when the Proof Of Concept (POC) becomes a mock-up, then a prototype or a test, and even more so when it becomes a pilot put in relation to, transaction and confrontation with the 'real' milieu of the circuits of stakeholders for which it was designed and in which it is tested in actual size.

From Deliberation to Execution

In our model, we are precisely focused on the phases of the process, which allow one to move from deliberation to execution. This is the case of the pragmatic programme (manual, recipe, script, etc.) during its tangible implementation by trial and error during the 'executive bricolage' phase²³ which mobilizes a large part of the creativity to act, and then, if necessary, during the systematization of this successful bricolage into an 'executive programme' and in heuristics that can turn into an 'automated programme.'

All these operations, even if they are routine, mobilize distributed intelligence. They demand permanent, intelligent and creative cooperation between all stakeholders involved in the action, the creativity of the act and the production to manage the contradictions and especially the unknown elements that deliberation had neglected or ignored²⁴.

21 Two etymological interpretations coexist for the term 'deliberate,' the first and oldest refers to libra: the scales; the second, more modern, refers to liber: free.

22 This preparation can obviously use testimonies and documentation that do not belong to the knowledge already developed by the individual who is deliberating.

23 We use the term bricolage in the sense given by Claude Lévi Strauss in *The Savage Mind* (1962) and as it is used in the sociology of uses.

24 The international PISA 2012 survey conducted by the OECD added a new indicator to test students' abilities to solve problems in daily life by mobilizing extra-curricular knowledge and skills. The results show that the creative abilities, resourcefulness and bricolage are indeed used by most students. <http://www.oecd.org/pisa/keyfindings/PISA-2012-results-volume-V.pdf>

When they manage to combine internal and external distributed habits, agents are one with the world and at peace with it (Darras and Belkhamsa, 2008), but this dynamic ‘harmony’ most often calls for permanent adjustments, tricks and improvisations.

Thanks to habituation and appropriation processes, but also, more fundamentally, to enaction, co-adaptation and co-determination loops, internal and external habits operate as second nature.

Like all experts, designers have developed such habits but also help refine, improve and perfect those that are already working. These meliorative processes that define incremental design help make the world more accessible and more inclusive by increasing efficiency and usability²⁵.

3 Prejudices in the Fields of Modelling and Information Design

In this third part, I will further explore the role of information design. As you know, the model of distributed communication we produced is the result of a strong interaction between the theoretical, pragmatic and practical issues governed by the challenges of R&D and education on one hand, and the production of tools in the form of dynamic and interactive diagrams on the other.

Information design was therefore central to our approach and certain visual issues were at the heart of major theoretical debates, while certain visual solutions have contributed to advances in modelling... but also sometimes to the creation of new problems.

I will now discuss some of the problems we have encountered, which relate to information design in general.

3.1 Visual Translation

Like all designers, we were faced with the issue of the translation of one world into another. As we mainly dealt with modelling and relationships, the challenge was not only to shift from a world of concepts to a spatial world, but also to transform certain visual solutions, already stabilized, into habits and models.

As recalled by John Law (2004:5):

“To translate is to make two words equivalent. But since no two words are equivalent, translation also implies betrayal: ‘traduction, trahison’. So translation is both about making equivalent, and about shifting. It is about moving terms around, about linking and changing them.”

3.2 General Topology

To address the relationships that are at the core of our models, general topology seems sufficient to represent relationships of limit, continuity and closeness.

But on several occasions, the translation of the open and closed concepts raised the issue of visual borders, intersections, continuities and discontinuities, and particularly the choice of shapes.

- As previously shown, for readability purposes, relations of closeness were represented by juxtapositions and inclusions, more than by superimpositions or intersections. Yet we believe that the production, dissemination and use hubs are both continuous and discontinuous.

²⁵ These are the meliorative moments of praxis and poesis in the sense given to them by Aristotle. Praxis is focused on the internal movement of action while poesis focuses on the product of this action. Both use reflection, intelligence, habit and creativity.

- The representation of change raised the issue of the representation of time by visual means, both fixed and animated. As I mentioned before, the cycles and circuits were represented by circles and spirals. The representation of simultaneous changes in the agents and their milieu, as well as the comparison with changes in the stakeholders was represented by interlocking cycles.
- As for the changes in phases and dynamic data indexing, they have often been represented by spatial means and chromatic and value-based solutions (for printing purposes).

3.3 The Geometrisation of Shapes: a Strong Trend in Information Design

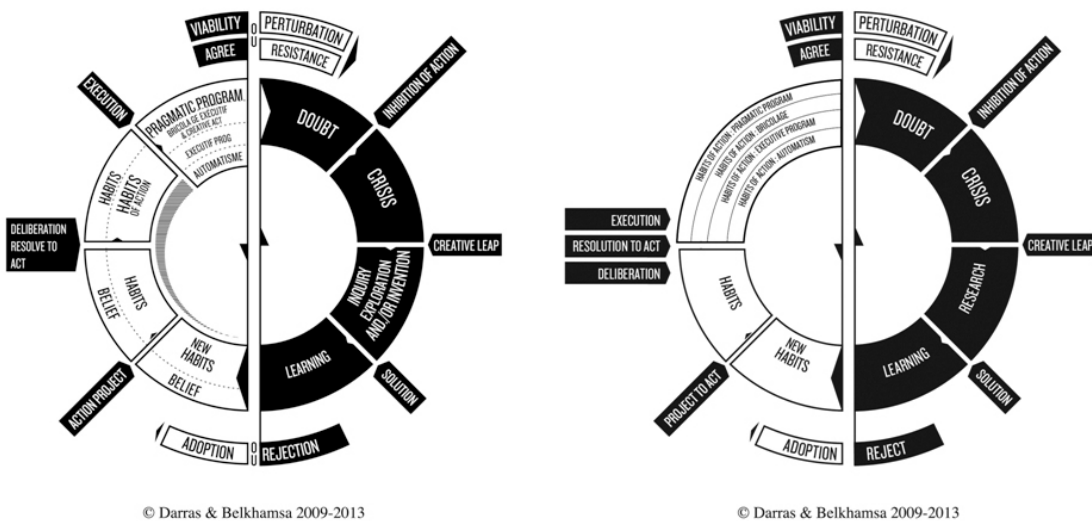
As you will see, this geometric pressure led us to focus on regularity and to smooth out the differences that were first considered negligible for reasons of clarity and readability.

In our model, we adopted the circle, and thus the disk and the crown but also the helicoid. There is nothing better than a circle to break with linear thinking and represent a cycle: this is a very ancient visual habit that offers multiple opportunities in information processing and architecture. For our model, the creation of a centre and of one or several peripheral areas was useful to represent the overall similarity of all cycles, whether they concern an artifact or an isolated or collective agent: his/her community.

The partition into shares, whether equal or not, allowed us to represent the different phases.

On this point, for a time we opted for a kind of left/right symmetry by producing as many parts on the left as on the right, which is questionable and continues to raise theoretical issues, particularly to combine the operations concentrated in the habit of action.

Figure 7. Symmetry or not?



The effects of lateral and vertical symmetry offered us the opportunity to address the world of habits on one hand, and, on the other, the world of habit change, as well as the world of deliberation and action.

This posed hierarchical problems (top/bottom, left/right, centre/edge), which were – and still are not – easy to resolve.

For example, what to place at the top and therefore at the bottom?

One does not create the same effects of meaning when focusing on doubt or habit taking and yet, theoretically and epistemologically, it makes sense, but also pragmatically when primarily addressing designers.

Deliberation Precedes Action

Similarly, as I have shown earlier, when one follows the cycle clockwise, deliberation precedes action, which not only reflects the dualism between thought and action, but also reaffirms that thought precedes action, which is not the case when habits are heuristic or automated (on this subject, see Darras, 2014).

One can also consider that all points situated on the circumference are equal to one another. This is the solution we have adopted as it is visually easier but this decision is questionable theoretically as it gives the impression that all phases are equal, which is not the case.

All these advantages are offered by the circle, which is a highly regular and continuous shape that imposes an equally regular and continuous view of the world. Neither a square nor a triangle could offer the advantages of the circle, whose choice was therefore self-evident.

3.4 Traditional Versus Baroque

However, it is unlikely that the metabolism of habits is as regular as a perfect circle. Certain crisis or learning phases for example can be very short or very long, experience ups and downs and vary in intensity.

As a result of the irregularity of these phases, a potato or polygonal shape comprising of convex or concave areas would have been figuratively better suited to represent the probable state of most metabolisms. But if the circle has imposed itself, it is because it helps neutralize and stabilize all possible variations. Excluding any concavity, it represents the most ideal possible case of a very balanced, symmetrical, smooth and harmonious metabolism.

The regularity of the circle embodies a general and ideal rule. It smooths out and neutralizes any singularities and accidents.

By choosing the circle, we let all its visual properties impose themselves on us and impose the representation of a predictable change, under control.

If that did not bother us that much, it is because we have also succumbed to the belief and habits based on the prerequisite of order, regularity, symmetry and even harmony that can be found in most traditional diagrams that are very far from the 'Baroque' style of disordered, irregular and asymmetrical potato or polygonal shapes.

We have therefore produced a smooth model as a pure and disembodied theory, while the real and unstable world of the practices and uses that we are studying comprises of 'hairy' objects, to use the metaphor suggested by Bruno Latour (1995).

Were we right or wrong to opt for a regular diagram?

Both right and wrong, actually. As our aim is to present a general model of the communication and distributed production of meaning, it would be better if it did not represent a specific case. What specific case should have been chosen, if any?

However, since this model is intended to represent singular situations, field studies and case studies, it is 'at rest' in basic situations.

In terms of information design, the choice of regularity allowed us to perform the complex interlocking of annulus, as shown in this synthetic diagram of <metabolisme.design>.

Although we did not try this solution, it is unlikely that this diagram would have been as readable with potato or polygonal shapes.

This smooth and regular neutralization still hinders the representation of the different levels of intensity in which agents are engaged in a phase.

This model indeed allows us to report that a particular agent or community of agents is in a particular phase of his/her metabolism, habit of action or inquiry, for example. But, if properly conducted, the surveys carried out about stakeholders also make it possible to estimate or even measure the intensity of adhesion to a particular phase.

One can assess the depth of doubt or crisis, the intensity of inquiry and learning, the strength of a habit, etc.

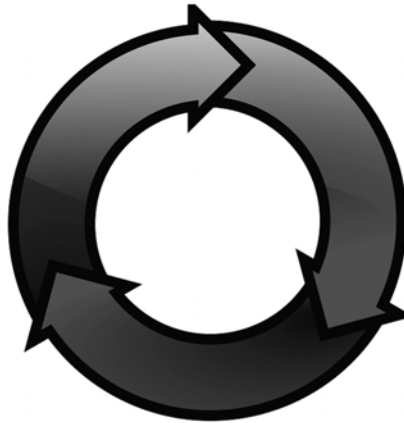
A 'Baroque' diagram would make it possible to show these intensity levels through variations of shape while a traditional diagram only provides chromatic variation solutions, which require colours with a broad spectrum of values (excluding yellow, for example).

This data could be translated in the diagram and provide valuable information on the stability or potential change of partners. (The version 2 has resolved this problem.)

3.5 Recycling Process: from the Circle to the Helicoidal Spiral

During our modelling work, the circle has imposed itself not only due to its hyper regular continuity but also to the metaphor for constant renewal that abounds in the representations of time and recycling facilities. This recycling process indeed accurately characterizes the lifecycle of the artifacts that we deal with.

Figure 8. recycling and lifecycle



During a certain period of our research, this metaphor was a representation-obstacle that clouded the evolutionary dynamics of change. To avoid falling into this visual trap, we needed to both stabilize the phases of metabolism and remember that the flow of change kept producing new habits, new doubts, etc.

The spiral first imposed itself as a 2 dimensional solution but it posed more problems than it solved.

Figure 9. The Spiral Clock by Will Aspinall and Neil Lambeth



The helicoid was the solution as it offered the opportunity to include not only the evolution but also time.

However, this 3D solution challenged the visibility and legibility of the text. Once created, it had to give way to the disk and its interlocked crowns.

3.6 Helicoid and Lateralization

When we gave our instructions to the designer and 3D animator, we did not mention a direction to deploy the spiral in space. In the still images that we used until then, the transformation movement was upwards, which maintained the convention of orthogonal projection and profile view.

Figure 10. 2D diagram

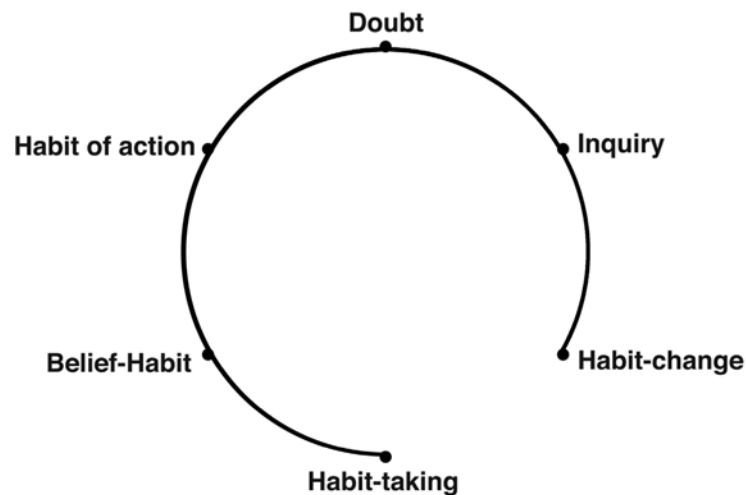
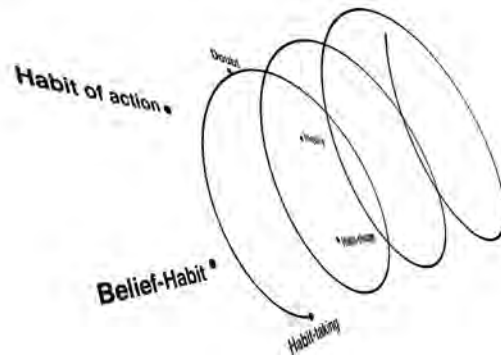


Figure 11. The helicoid diagram



We were thus surprised by the suggestion of the designer who opted for a slightly upward movement from left to right.

Figure 12. The 3D and animated helicoid



We selected his design as it allowed us to figuratively represent both the oblivion and anticipation of habits.

We asked him about his design, and here is the answer he deftly gave us to explain his choices:

“In an explanatory diagram, whether animated or not, the aim is above all clarity. The space must be used as efficiently as possible. The axis of rotation chosen for the 3D helicoid is fairly standard. It allows items that are longer rather than wider to effectively occupy the space limited by the rectangular format of the screen. The direction of the helicoid, which must represent temporal progression, is naturally towards the right, as the audience mainly uses a left-to-right writing system. In advertising, it is even recommended to give it a slight upward movement to create a positive impression. The deliberately slow pace of the animation makes it easier to understand and interpret the diagram, as well as constantly repeating the animation cycle.”

4 Conclusion

Information design is a permanent tension between many priorities on one hand, the translation of the wealth of information to be made visible and, on the other, the semiotic and aesthetic biases induced by this translation.

In the case of <metabolisme.design>, complexity also depends on the constraints of interactivity.

The development of this complex tool, which we wanted to be usable, required a real effort in designing the users' experience, notably by guiding them in all operations and continuously providing them access to information on the concepts and functions they are using.

Usability tests showed us that the passage from the diagram of the stakeholders to the diagrams of the artifact lifecycles and the cycle of the metabolism of agents was not intuitive.

We were therefore faced with a User Experience (UX) design issue.

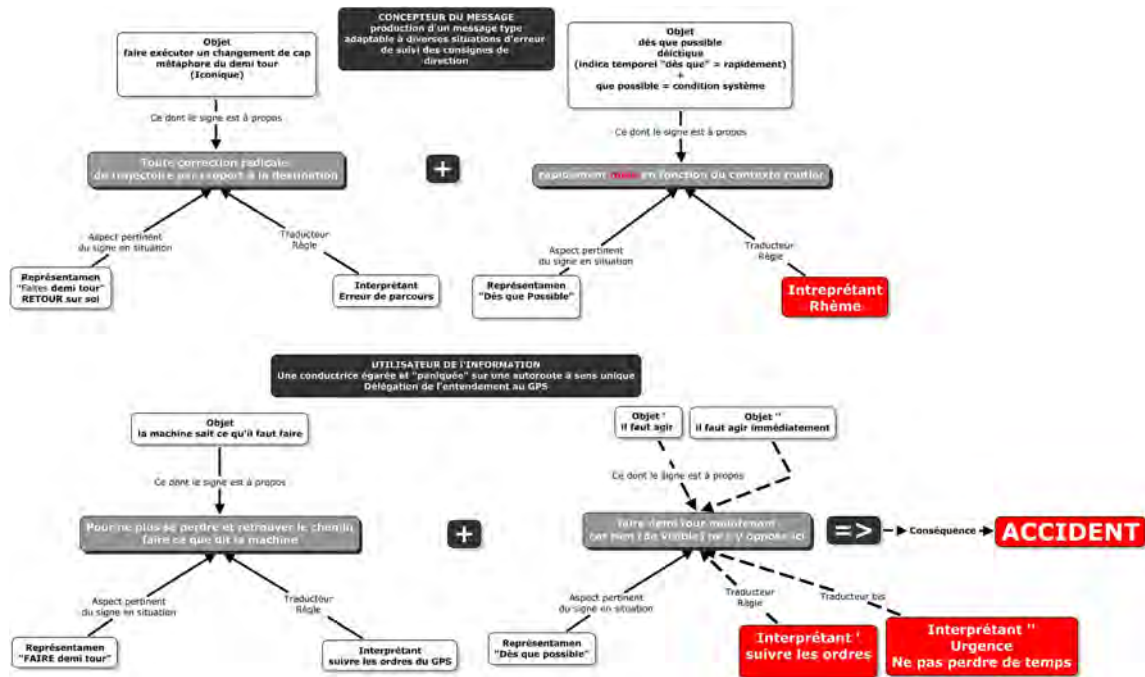
From the start we wanted to create a zoom effect to access the layer of the metabolism study, but we have temporarily given up on this idea for interactive programming reasons.

This problem arises again with the inclusion of the layer of the interface and tool that provides access to the microsemiotic and mesosemiotic studies of the phases of metabolism.

Indeed, even if the first impression is often accurate, only field studies can lead to the conclusion that a particular agent is in crisis, in a phase of inquiry or in a phase of habit of action and executive programme, and above all to understand why he/she is in this phase and what is its meaning to him/her.

As shown in this diagram of a microsemiotic study on a man-machine communication issue (GPS), many information design challenges are still to be met.

Figure 13. Diagram of a microsemiotic study 'Make a U-turn as soon as possible.'



On this point, being a semiotician specialised in design makes it easier to identify the gains, losses and biases brought about by a solution proposed by the designers and developers whom I have had the chance to work with. But the best way to evaluate this tool remains its use.

References

- AKRICH, M., CALLON, M., & LATOUR, B. 2006. Sociologie de la traduction: textes fondateurs. Presses des MINES.
- BELKHAMSA, S. & DARRAS, B. 2009. L'objet et le cycle des habitudes et des changements d'habitude. Approche sémiotique. In B. Darras & S. Belkhamssa. *Objet et Communication*. MEI 30-31. Paris: L'Harmattan. p. 147-160
- DARRAS, B. 2007. La tâche aveugle. Approche sémiotique et systémique du paradigme de l'agency. In Bernard Darras (Dir.) *Etudes Culturelles & Cultural Studies*. MEI 24-25. Paris: L'Harmattan p. 57-69
- DARRAS, B. & BELKHAMSA, S. 2008. Faire corps avec le monde. Étude comparée des concepts d'affordance, d'enaction et d'habitude d'action. *Recherche en communication*, No. 29. p. 125-145
- DARRAS, B. & BELKHAMSA, S. 2009. Modélisation dynamique de la communication de l'objet, approche systémique et sémiotique. In B. Darras & S. BELKHAMSA. *Objet et Communication*. MEI 30-31. Paris: L'Harmattan. p. 160-184
- DARRAS, B. 2009. Usabilidade, Design cognitivo e design participativo nas hipermidias. In V. Ribas Ulbricht & A. Theresingha Cybis Pereira. *Hipermidia um desafio da atualidade*. Florianopolis, Pandion editora. PP 31-49 (ISBN 978-85-60946-24-2)
- DARRAS, B. 2011. Design and pragmatic semiotics. *Collection # 3*. p. 7-21
- DARRAS, B. 2012. Qui sont les sémioticiens et que font-ils ? Enquête sur leurs relations avec le design et des médias. *Signata*, 3/2012. p. 27-46

- DARRAS, B. 2013. Modelização geral das relações humanas com os artefatos: estudo semiótico e sistêmico das interações. *Líbero* – São Paulo – v. 16, n. 31, p. 51-68
- DARRAS, B. 2014. Le design entre la conception et la pratique, la fin du dualisme. Approche pragmatique. Darras, B. and Findeli, A. *Design : Savoir & Faire*, Nîmes, Lucie Editions. P. 13-47
- DARRAS, B. (in the process of being printed). Design du codesign, axiologies et méthodologies du design participatif. In Claude Courtecuisse, Éric Vandecasteele (dir), *D'un territoire l'autre*, Presses Universitaires de Saint-Étienne.
- DEWEY, J. 1929. *The Quest for Certainty, A study of the relation of knowledge and action*. New York: Minton, Balch & Company.
- DEWEY, J., & Bentley, A. F. 1946. Interaction and transaction. *The Journal of Philosophy*, 505-517.
- DU GAY, P., HALL, S., JANES, L., MADSEN, A. K., MACKAY, H., & NEGUS, K. 2013. *Doing cultural studies: The story of the Sony Walkman*. Sage.
- FLORIDA, R. L. 2012. *The Rise of the Creative Class: Revisited*. Basic books.
- HOUDÉ, O. 2014. *Le raisonnement*. Paris, PUF. *Que-sais-je?*
- LATOUR, B. 1995. Note sur certains objets chevelus. In *Nouvelle revue d'ethnopsychiatrie*, No. 27, p. 21-36.
- LAW, J. 2004, *After Method: Mess in Social Science Research*, London: Routledge.
- LAW, J. 2009. Actor network theory and material semiotics. In Bryan Turner, (ed.), *The new Blackwell companion to social theory*, Wiley – Blackwell publisher. p.141-158.
- LE MOIGNE, J. L. 1994. La théorie du système général: théorie de la modélisation. jeanlouis le moigne-ae mcx.
- LÉVI-STRAUSS, C. 1962. *La pensée sauvage*. Paris: Plon.
- MACMULLAN, T. 2013. The fly Wheel of society. Habit and social meliorism in the pragmatist tradition. In Bell, J., Crossley, N., Stephens, W. O., Sullivan, S., Leary, D., Watkins, M., ... & Casey, E. 2013. *A History of Habit: From Aristotle to Bourdieu*. T. Sparrow, & A. Hutchinson (Eds.). Lexington Books.
- PEIRCE, C-S. (1931-1935). *Collected papers*. Cambridge: Harvard University Press.
- PEIRCE, C. S. (1982-1996). *Writings of Charles Sanders Peirce. A Chronological Edition*, edited by the "Peirce Edition Project." Bloomington. Indiana University Press, vol. 1-6.
- PREMACK, D., & WOODRUFF, G. 1978. Does the chimpanzee have a theory of mind?. *Behavioral and brain sciences*, 1(04), 515-526.
- RAY, P. H.; ANDERSON ; S. R. 2000. *The Cultural Creatives: How 50 Million People Are Changing the World*, New York: Harmony Books.
- VARELA, F.; THOMPSON, E. & ROSCH, E. 1991. *The Embodied Mind*. Cambridge, MA: MIT Press.
- UEXKÜLL, J. 1984. *Mondes animaux et monde humain; followed by Théorie de la signification*. Paris, Denoël.

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Chapter 10

Methods and practices of Brazilian designers in digital projects

Paula C. L. de A. Faria, Virgínia Tiradentes Souto

keywords: digital design, methodology, creative process

Nowadays, we can find literature on different design methodologies, each one with its own model and methods. The understanding of the design process is important both to manage the design activity and to aid the improvement of products and their overall efficiency (Howard et al, 2006). According to these assumptions, this article aims to describe the status quo of the methods and practices in the design process used by designers in Brazil. Therefore, a questionnaire was carried out with Brazilian designers that work with digital projects. The results were analyzed considering studies on methods and processes available in the literature. From the results, there is a conclusion that Brazilian designers follow several different models, that they adapt methodologies to meet their preferences, and that the practical application is not always identical to the theory.

1 Introduction

Historically, from the Bauhaus to contemporary society, any reader is able to find a wide variety of processes available to designers, both in books and in academic articles. Even with an emphasis on graphic design and product design, many processes and design methodologies can be applied to the development of digital media products. In short, designers who design new digital products have access to different methodologies, and have to decide which ones they will use in their projects.

The speed and current dynamism of today configure a moment that highlights the need for new design approach, process and production that are appropriate to the current context (Vieira, 2007). According to Vieira (2007), it is important to find design methodologies that support the complexity of new products and that promote agile, efficient and effective development.

The understanding of the design process is important both to manage the design activity and to aid the improvement of products and their overall efficiency (Howard et al., 2006). According to Flusser (2007), with regard to the design process, the verb - to design - means to plot, to draw, to structure and to proceed strategically. Still on the relationship between design and process, there is the definition from IIID (2000), in which design is the identifying of a problem and the intellectual creative effort of an originator, manifesting itself in drawings or plans, which include schemes and specifications.

Even with the presence of several studies on methods and processes in the development of digital products in the literature, there were no findings about the methodologies that are being put into practice by designers in Brazil today.

This article aims to describe the current situation for methods and practices of design processes in digital projects used by designers in Brazil. This aim is justified by the intrinsic

relationship between design and process, by the new digital products of this information era and by the importance of the design practice for the quality of these products and of the designers who create them.

To this end, a comparative study of methods available in the literature was conducted, followed by a survey with Brazilian designers of digital projects in order to compare the results.

The next section of this article discusses the design processes and methodologies of the studies considered. The third section describes the chosen method – a survey with Brazilian designers of digital products, followed by the results found, and the last section presents conclusions and the discussions proposed.

2 Studies on Creative Processes and Methodologies

To Panizza (2004), when discussing projective methods it is first necessary to define concepts. The author presents the definitions in the Aurélio Portuguese Dictionary on “method” - a process or teaching technique or way of proceeding, and on “methodology” - the treatment of methods (Buarque, 1994-95). Further, Freitas et al. (2013) states that design methodology is a set of procedures for the development of a particular product, linking methods, techniques and tools.

Methods and creative processes have been discussed and investigated for some time. According to Bonsiepe (1984), methodology is an aid to the project’s process, providing techniques and methods for each step.

As for Baxter (1995), future designers need to be deeply committed to systematic design methods. According to Lobach (2000), the entire design process is a creative process and it is also a troubleshooting process. More recently, the Design Council (2006) reports that an essential part of good design is a process based on an iterative cycle of development and testing.

On the range of the methodological approaches to study, two comparative studies were considered (Panizza, 2004 and Howard et al., 2006), about existing processes and authors in the field, as described below. The studies were chosen because of their recent dates of publication and the number of relevant authors mentioned.

Regarding creative processes, Panizza (2004) observed the work of seven authors: Ostrower (1984); Torrance (1976); Kneller (1978); Oech (1997); Osborn (1987); Peterson (1991) and Estrada (1992). From the observed work, the author developed a synthetic model of the creative process that consisted of four stages:

- Definition of the problem - the basis of directed thought, with the objective to be achieved;
- Data accumulation - the collection of sufficient data, knowing what to ask;
- Incubation and Ideation (or enlightenment) - the time for the mind to process information, even if not consciously;
- Verifying - criticism of the idea, which can return to previous stages.

According to the author, an idea that comes unexpectedly is a myth, since all ideas, even if unconsciously, go through the first three stages, at least. For the author, the process stages work in a spiral, with the author returning to previous stages with another point of view, until the end of the process.

Table 1 shows the creative processes of the authors investigated by Panizza (2004).

Table 1: Adaptation of Panizza's table (2004).

Authors/ Stage of creative process	Delimitation of problem	Data accumulation	Incubation + Ideation	Verifying
Ostrower (1984)	Insight	Insight	Elaboration	Inspiration
Torrance (1976)	Preparation	Preparation	Incubation Illumination	Revision
Kneller (1978)	First apprehension	Preparation	Incubation Illumination	Verifying
Oech (1997)	Germination Stage	Germination Stage	Germination Stage	Practical Stage
Osborn (1987)	Orientation	Preparation Analysis	Ideation Incubation	Evaluation Synthesis
Peterson (1991)	Saturation	Saturation	Incubation Illumination	Verifying
Estrada (1992)	Questioning	Data Accumulation	Incubation Illumination	Elaboration Communication

Howard et al. (2006) developed a comparison of creative processes in a table with 19 models (eg Helmholtz, 1826; Guilford, 1957; Couger et al, 1993; Shneiderman, 2000) dated from 1826 to 2001, divided into four phases:

1. Analysis - know the problem;
2. Generation - find ideas;
3. Validation - find solutions;
4. Communication / Implementation - delivering results.

Like Panizza (2004), the authors argue that the creative process would end in the third phase of evaluation. Table 2 shows some types of creative processes and their phases compared by Howard et al. (2006).

Table 2: Adaptation of a table in the study of Howard et al. (2006).

Models/ Phases of the creative process	Analysis phase	Generation phase	Evaluation phase	Communication/ Implementation
Helmholtz (1826)	Saturation	Incubation Illumination	X	X
Guilford (1957)	X	Divergence	Convergence	X
Couger et al. (1993)	Problem definition	Generating ideas	Evaluation ideas	Implementation
Shneiderman (2000)	Collect	Create and relate		Communicate

As well as the creative processes, design methods also take different forms in literature. Howard et al. (2006) analyzed various design methods that were put in place at the time of the investigation. Among the various design methods that then existed, dated from 1967 to 2006, the authors developed a table with 23 models in order to define the limits and highlight similarities and differences between their methods and their component phases. Among the authors cited in this study are Booz et.al (1968); Archer (1968); Svensson (1974), Wilson (1980); Cooper (1986); Baxter (1995) and Cross (2000).

The authors found numerous and remarkable differences in the models, especially the differences between the linear processes and divergent / convergent processes. Linear processes (that proved most the results of study) follow consecutive phases, from start to completion. Evolutionary models (which was shown in only two instances) follow evolutionary phases, like the model in “Double Diamond” Design Council (2006).

In the evolutionary model from the Design Council, the principle of project development is prototyping iterations and applying the concept to get as close as possible to the product (DESIGN COUNCIL, 2007). The lessons learned in each iteration cycle are disseminated to the team and to customers through formal and informal communication, ensuring the evolution of the product.

It is important to report that even a linear method contains its iterative phases. Panizza (2004) discusses Munari’s linear architectural design method (1983), in which the author argues that the practice shows that it is unlikely that project development goes always (and only) forward, since comings and goings are frequent. The author stresses that this does not invalidate the author of the scheme, as it is only an example of linear scheme.

One of the similarities between the 23 models described by Howard et al. (2006) was the division into stages. Thus, the table contains columns containing six basic phases for comparing models: Establishing a Need, Task Analysis, Conceptual Design, Embodiment Design, Detailed Design and Implementation.

These studies were analyzed to be confronted with the answers of Brazilian designers about the processes they practice in their professional environments. With the studied theories, the next step was to determine the method in which the data about the designer’s practices would be gathered.

As reported by Bonsiepe (1997), practice always takes priority when put in relation with the theory that, at first sight, always comes too late. Examined further, however, this interpretation is wrong, because the theory permeates the entire practice. (Bonsiepe 1997: 184).

The results of the studies were considered in the preparation of a questionnaire regarding the processes that were carried out by designers, and they will be described later.

The next section describes the method by which the research was conducted, with the main objective to verify how Brazilian designers put processes into practice.

3 Research Methods

The chosen method for the survey was the online questionnaire. It was considered the most appropriate method, as it allows the collection of a larger amount of data, and even responses from different parts of the country.

The questionnaire was based on the Google Forms tool, and the link to the online survey was released in design groups in social media, along with a text inviting Brazilian designers to participate. The questionnaire was available from December 2014 to February 2015. The objective was to get the same number of participants by gender, so the questionnaire was available only until it reached 20 female participants and 20 male participants.

The questionnaire included some questions about gender differences in relation to the creative process. However, for this study the issue of gender was not addressed.

There were 29 questions in the questionnaire, with a combination of different types of questions: 20 questions were closed, with multiple choice options, and seven questions were open. The open question format was used because of the qualitative nature of the research in order to gain more understanding of the feelings, experiences and perceptions of the participants. Mack et al. (2005) discussed the advantages of this method. As he describes:

“One advantage of qualitative methods in exploratory research is that use of open-ended questions and probing gives participants the opportunity to respond in their own words, rather than forcing them to choose from fixed responses, as quantitative methods do. (Mack et al., 2005).”

The content of the questions is described below.

4 Questions of the Survey

The questionnaire had questions related to personal information such as gender, age, place of work and questions related to their academic background and their experience in the market as designers. The first questions were related to personal information, and the other questions were about their creative processes, considering phases, stages and activities.

Then questions about their working practices sought to understand the type of method they use (i.e linear or evolutionary), number and order of phases and steps.

An optional e-mail box was available at the end, if the participant wanted to receive the results of the study.

The objective was to collect data that would indicate the contexts and the current practice of design methods in Brazil. The results are described in the next section.

5 Results of the Survey

The survey had 40 participants from ten different states of Brazil, 20 male designers and 20 female designers.

It was considered unnecessary to recruit new participants, since the similarity of the responses suggested that it was unlikely that new theoretical or empirical subsidies would be obtained with the continuation of the interviews.

At the beginning of the questionnaire, the participants were asked to name their profession. Participants named their profession in various ways, such as: designers, graphic designers, editorial designers, web designers, interaction designers, interface designers, user experience designers, product designers, industrial designers, information architects, design thinkers, teachers and design researchers.

In relation to academic education, 40% of participants reported that they were post-graduates, 40% were graduates, 15% were PhDs and 5% had technical education. Most designers were between 21 and 40 years old.

As for the time they had worked in the design field, 40% reported that they had been working for a period between one and ten years, while 60% reported working for over ten years. When asked if they were doing research in design, only 20% reported that they do not do research.

The questionnaire presented questions about the creative process, methodologies and results of digital products. The first question was referring to the beginning of the creative process: is it chaotic and drafted or organized and documented? While 51% said chaotic and drafted, 49% responded organized and documented, with a similar result (Figure 1).

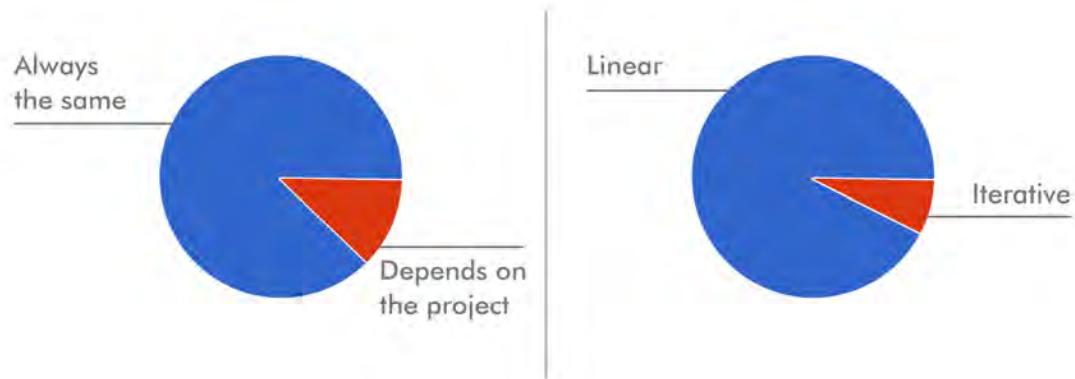
Figure 1. Answers regarding the beginning of creative process.



When arguing about their creative process, around 60% of respondents reported that the basis of their creativity is often a balance between emotional and rational ideas. Twenty-five percent responded that their ideas are more rational than emotional, and around 15% said that emotional ideas are the ones that most occur (Figure 1).

Participants were asked to explain about their creative process, mentioning if there were any stages and what the activities of these stages were, from inception to project delivery. In response, 18% reported that their creative processes depend on the product itself, ie, the stages and activities would be dependent on the specifications of each product to be developed. The majority, 82%, reported following a single creative process (Figure 2).

Figure 2. Answers about the creative processes the designers follow.



About the number of stages, the responses varied from two to 14 stages, and the average quantity resulted in six stages. Panizza (2004: 182) explains that when searching for categorizations on the creative process stages a multitude of them may appear, yet they are all composed of the same elements: 'The creative process has a structure that is common to all people, while being unique to each.'

Of the reported cases, only 10% reported that their procedure is iterative or cyclic: returning to previous stages according to the need of the project (Figure 2). The vast majority, 90%, reported following the stages sequentially until the final delivery.

Seventy-three percent of participants mentioned that they do research and analysis in the early stages; however, only 40% specifically mentioned to do research like benchmarking, market analysis or searching for references in similar markets.

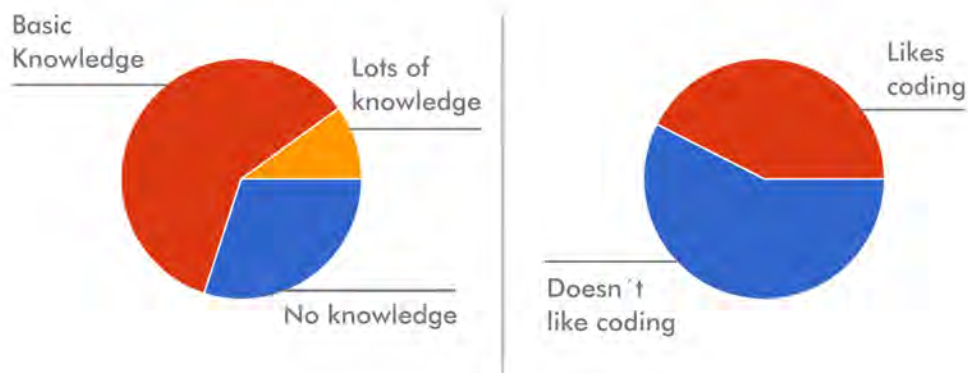
It was observed that 85% of the participants responded that during the creative process they prefer to work alone in some parts and in a team in other parts of the project. The individual working part is intended for the phases of ideation and programming, while the part of teamwork would be with activities such as brainstorming sessions. Ten percent said that their creative process works best when it all happens individually and only 5% prefer working together with a team from start to finish.

For the Design Council (2007), delivering high quality new development requires a range of skills and competencies, and is a truly multi-disciplinary process. Multi-disciplinary teams are relevant and very common, seen in many companies' design processes. Teams with diverse skills are essential in a product finishing stage, when information and advice from different areas enrich the development phase.

It is noteworthy that the importance of team work was mentioned in the designer's answers concerning the important factors for a good product. However, this topic was not among the three major factors.

About code programming (considering any language), the participants were asked to describe their level of knowledge and how much they appreciated the activity. The answers revealed that most designers program some language, and half of them said they like the activity while the other half said they didn't like programming (Figure 3).

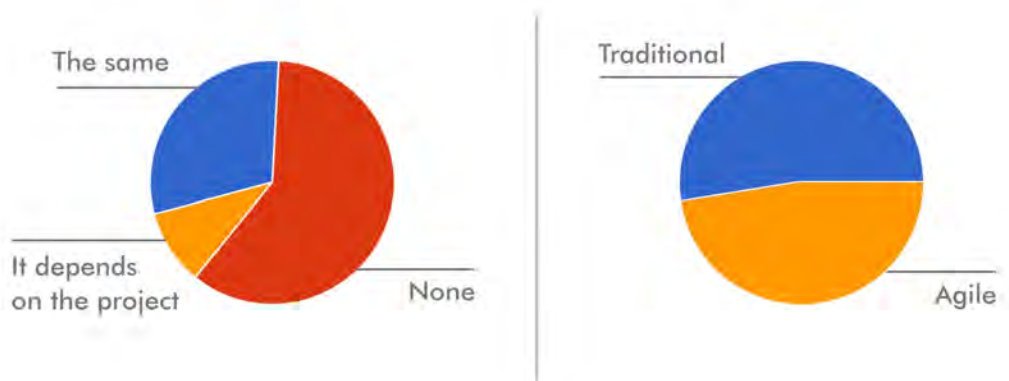
Figure 3. Answers about code programming.



About the methodologies they use, 35% said they do not use any methodology (Figure 4). Of those who follow methodologies, some reported that the type of project determines which method is to be applied, as a participant mentioned: "It varies according to the project, there is nothing predefined. Lately I have been developing digital products based on user feedback."

Forty-five percent of those who use methods described agile methodologies (Figure 4), and some participants reported mixing methods. They mentioned methodologies like Design Thinking, Inductive Method, Social Design, Vision in Product Design, Waterfall, Agile, Scrum and Lean UX.

Figure 4: Answers about methodologies used in digital products.



The authors mentioned in the answers about methodologies come from different disciplines. Table 3 shows the origins of the disciplines of the authors cited.

Table 3: Authors cited by participants

Authors cited	Disciplines of the authors cited
Gui Bonsiepe, Vijay Kumar, Itiro Iida, Mike Baxter, Paul Hekkert, Louis Rosenfeld, Tai Hsuan-an, Theodore Cook	Graphic Design, Product Design, Digital Design, Art
Goethe, D'Arcy Thompson, Buckminster Fuller, Nassim Haramein	Science, Mathematics, Literature
Jean Piaget	Psychology, Education

This diversity of different backgrounds, methods and authors is recognized by researchers. Vieira (2007) states that it is known that design brings together knowledge from different fields and moves from abstract domains and communication - characteristic of the arts – to technical areas like science and engineering. Figure 5 shows a word cloud that compiles responses from participants and the methodologies that they usually use.

Figure 5: Word Cloud of terms related to the methodologies the designers use.



For innovation resources, participants answered that they use books and specialized websites for searching for references, they make sketches and drafts and they also interview users to know about needs. It was found that designers use a mix of technologies (eg software, devices, websites) and physical objects (eg pen, paper, post-it notes, papers, coffee).

When asked to mention the three most important factors in the development of a digital product, the number one factor mentioned by the participants was the user: to know who the user is, his contexts, behaviors and expectations. The second most mentioned factor was a clear definition of the purpose of the product, to meets the user's needs. The third most mentioned factor was a tie between usability and graphical interface of the product. Other factors mentioned were technological issues such as devices, infrastructure and tools used by programmers, as well as issues related to human resources (eg team management, trained professionals and communication among members).

Regarding teamwork, Lana (2011) states that people from different disciplines (eg marketing, management, IT) contribute to the development of design projects. The author mentions Moggridge (2008), who states that when teamwork flows, there are possibilities for various creative viewpoints. Figure 6 shows the most used terms mentioned by participants in the answers about the three most important factors in the development of a digital product: user, usability, interface and definition.

Figura 6: Word Cloud with the three most important factors for a good digital product.



About deadlines, it was asked if designers usually meet the deadlines and deliver their products on time. Only 8% said they could not usually meet deadlines.

At the end of the questionnaire, 65% of participants informed their emails in order to get the results of the study.

6 Results and Discussion

Regarding methodologies, it is concluded that Brazilian designers use several models nowadays, and most of them adapt existing methodologies to meet their personal preference.

About the authors mentioned by the participants, there were names from different disciplines, from the arts to mathematics. We concluded that the adaptation of methodologies used by Brazilian designers comes from different disciplines.

Half of the participants who use methodologies said they used agile methods; however, only 10% mentioned evolutionary stages, one of the characteristics of agile methods. As most of the participants said they deliver their products on time, a hypothesis that would justify this disagreement would be tight deadlines determined for the products, preventing the designer from applying methodologies according to best practices. Comparing these data with the 2006 study, it was concluded that agile methodologies are becoming more frequent.

Still comparing the results with the study by Howard et al. (2006), it appears that the most used methodological stages are similar to the six mentioned in the study, with the addition for Brazilian designers of a testing phase with users at the end, showing a user-centered design trend.

The designers reported an average of six stages in the creative process. They generally use the same process on projects, regardless of the product being created.

Many designers mentioned the importance of multi-disciplinary teamwork, well-trained professionals and with good communications to obtain the quality of a good product. Thus, it is concluded that there is willingness by Brazilian designers to work together with the various disciplines of the professionals that contribute to the project.

The 'user' factor as the most chosen for the success of a digital product was found to be in accordance with the question which argued if the designers usually apply user research in their projects. In response, 85% of designers said they usually do research with users in their projects. However, in the description of the stages of the methodology, only 25% entered a phase related to user testing. The same amount, 25%, mentioned producing high or low-fidelity prototypes as a constituent stage, which would be crucial for user testing. It infers that user testing is not being applied in practice as much as the designers would like to.

It is noticed that designers see great importance in research with users, by their quotes in the answers, and it appears that they seem prepared to apply it. However, it can be concluded that the user testing stage is not widely used. One reason for the low use of tests during the creation process may be related to the project development deadline. The deadline for the project development is usually tight, which prevents user testing and data analysis from being put into practice. Another reason may be related to budget. Depending on the type of test with users, this can increase the cost of development of the project and therefore it is excluded from the process.

This study found methods currently used by Brazilian designers. The results and findings of the study pointed to some weaknesses in the practical application of methods and processes, and drew attention to the need for reviewing processes for digital design project development. The intention is to strengthen the arguments so that, in the future, methodological theories can actually be applied to market practices, thereby aiding designers in the process of creating a digital product.

Among the points suggested to have a review in processes, are:

- Deadlines - Observe the deadlines for digital product delivery, so as to allow a minimum activity cycle to be guaranteed;
- Multi-disciplinary team - Ensure a team with diverse disciplines and skills to contribute to the quality of the process and the final product;
- Communication - Ensure that communication between the members of the team happens during all stages of the project;
- Prototypes - Ensure that prototypes of the digital products are developed for the user testing phase, regardless of the types of prototype fidelity (high or low);
- Tests with users - Ensure that users are involved in the processes of digital product, for user-testing, regardless of the types of tests;
- Cyclic processes - Apply iterative processes, which enable the evolution of the product throughout the development.
- It is considered that the results of this study can be used to assist designers with the choice of processes and definition of phases and stages of a digital design product.

7 Final Remarks

In future studies we intend to ascertain the level of satisfaction of the designers with the methods they apply to create digital products, and to verify which main limitations and difficulties are encountered in the development of these projects, knowing why and when they happen.

Still regarding the digital product designer and his or her relationship to methods and processes, it also seems important to identify the level of involvement of the designer with the areas of design research. This statement comes from the hypothesis that designers that are not researchers know less about theoretical methods, which could lead to different results for researchers and non-researchers. Based on this hypothesis, a survey would be instructive, with comparative results between researchers and non-researchers.

It has been noted that the search result can prove more beneficial with the monitoring of a team working during the entire process of a digital design product project. Following the designer since the beginning of the project to the moment it is released, with the observation of the practice, there is a greater chance to get even closer to the practice exercised in reality. Thus it would be possible to reduce doubts about the terminology and concepts that can happen with online questionnaires, but that can be resolved in face to face interviews. In addition, on-site observation research could decrease the possibility of so-called “correct answers” instead of the answers that really describe their reality.

8 References

- ARCHER, L.B. 1968. *The structure of design processes*. Royal College of Art, London.
- BAXTER, M. 1995. *Product design*. CRC Press.
- BONSIEPE, G.; KELLNER, P.; POESSNECKER, H. 1984. *Metodologia experimental*. Brasília: CNPq.
- BONSIEPE, G. 1997. *Design: do material ao digital*. Florianópolis: FIESC/IEL.
- BOOZ, E.; ALLEN, J.; HAMILTON, C. 1968. *Management of new products*. Booz, Allen & Hamilton Inc., New York.
- BUARQUE, A.H.F. 1994-95. *Dicionário Aurélio básico da língua portuguesa*. São Paulo: Folha de São Paulo: Nova Fronteira.
- COOPER, R.G. 1986. *Winning at new products*. Addison-Wesley Publishing Co., Reading, Mass.
- COUGER, J.D.; HIGGINS, L. F.; MCINTYRE, S.C. 1993. (Un)Structured creativity in information systems organizations. *MIS Quarterly*, v.17 n. 4. 375–398.
- CROSS, N. 2000. *Engineering design methods strategies for product design*. Wiley, Chichester.
- DESIGN COUNCIL. 2006. In: *The design process*. <http://www.designcouncil.org.uk/news-opinion/design-process-what-double-diamond>, 20/03/2015.
- _____. 2007. In: *11 lessons: a study of the design process*. <http://www.designcouncil.org.uk/news-opinion/design-process-what-double-diamond>, 20/03/2015.
- ESTRADA, M.R. 1992. *Manual da criatividade – os processos psíquicos e o desenvolvimento*. São Paulo: Ibrasa.
- Flusser, V. 2007. *O mundo codificado: por uma filosofia do design e da comunicação*. SP: Cosac-Naify.
- FREITAS, R.F.; COUTINHO, S.G.; WAECHTER, H.N. 2013. Análise de Metodologias em Design: a informação tratada por diferentes olhares. *Estudos em Design* (online). Rio de Janeiro: v. 21, n. 1:1-15.
- GUILFORD, J.P. 1957. *A revised structure of intellect studies of aptitudes of high-level personnel*. University of Southern California, California.
- HELMHOLTZ, H. 1826. *Vortrage and reden*. H. Eysenck (Ed.), Genius, University Press, Cambridge.
- HOWARD, T.J.; CULLEY S.J.; DEKONINCK E. 2006. Describing the creative design process by the integration of engineering design and cognitive psychology literature. *Design Studies*, v.29, n.2: 160-180.
- IIID. 2000. *International Institute for Information Design - Definitions*. Vienna, 2000. <http://www.iiid.net/home/definitions>. Accessed on 29 Oct. 2015.
- KNELLER, G.F. 1978. *Arte e ciência da criatividade*. Tradução V. Reis. São Paulo: Ibrasa.
- LANA S. 2011. A complexidade dos métodos em Design. *Cadernos de Estudos Avançados em Design*, UFMG. <http://www.tcdesign.uemg.br/pdf/Metodo_completo.pdf>, 20/03/2015.
- LÖBACH, B. 2000. *Desenho Industrial – Base para configuração dos produtos industriais*. São Paulo: Edgar Blücher.
- MACK, N., WOODSONG, C., MACQUEEN, K. M., GUEST, G., & NAMEY, E. 2005. *Qualitative Research Methods: a Data Collectors Field Guide*. <<http://www.ccs.neu.edu/course/is4800sp12/resources/qualmethods.pdf>>, 20/03/2015.
- MOGGRIDGE, B. 2008. *Innovation through design*. In: *International design culture conference – Creativeness by Integration*, Kyoto, Japan.
- MUNARI, B. 1983. *Das coisas nascem coisas. Apontamentos por uma metodologia projetual*. Barcelona: Editora Gustavo Gili.
- OECH, R. V. 1997. *Um toc na cuca*. Rio de Janeiro: Cultura Editores Associados.
- OSBORN, A. 1987. *O poder criador da mente*. São Paulo: Ibrasa.
- OSTROWER, F. 1984. *Criatividade e processos de criação*. Petrópolis: Vozes.
- PANIZZA, J.F. 2004. *Metodologia e processo criativo em projetos de comunicação visual*. Dissertação de

mestrado USP. São Paulo, SP.

PETERSON, W. A. 1991. *A arte do pensamento criativo*. São Paulo: Editora Best Seller.

SHNEIDERMAN, B. 2000. Creating creativity: user interfaces for supporting innovation. *ACM Transactions on Computer–Human Interaction*, v.7, n.1, 114–138.

SVENSSON, N. 1974. *Introduction to engineering design*. Pitman, Bath.

TORRANCE, E.P. 1974. *Pode-se ensinar criatividade?* São Paulo: Epu.

VIEIRA, G.B.B. 2007. Design e Inovação: Projeto orientado para o mercado e centrado no usuário n.º 4. *Convergências: Revista de Investigação e Estudo das Artes*, n.12.

WILSON, D.R. 1980. *An exploratory study of complexity in axiomatic design*. Massachusetts Institute of Technology.

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Chapter 11

Basic ID-theories

Rune Pettersson

keywords: theory, design, information

Information design has practical as well as theoretical components. We may view information design as a combined academic discipline. Here the whole is greater than the parts. So far information design has incorporated facts, influences, methods, practices, principles, processes, strategies, and design tools from many other fields. However, we also need to borrow and incorporate theoretical approaches from already existing theories. This essay presents seven theories applied to information design.

1 Design

We live in a world of designed artefacts, some are abstract and others are concrete. Together with the natural world, these designs make up our reality. This reality includes the beautiful and the ugly, the good and the bad, and sometimes even the dangerous (Nelson & Stolterman, 2003, p. 267). Every day we use, or struggle with, designs of every function, shape and size. These designs are a natural part of our daily lives.

Modern design emerged in response to the Industrial Revolution. Reform-minded artists and artisans tried to impart a critical sensibility to the making of objects and media (Lupton & Miller, 1999, p. 67). Design took shape as a critique of rather dull industrial products. Today design is dispersed across a network of institutions, services and technologies. Lupton (2009, p. 6) noted: “Design is visible everywhere, yet it is also invisible-unnoticed and unacknowledged.”

The term *design* refers to the identification of a problem and the intellectual creative effort of an originator, manifesting itself in drawings or plans, which include schemes and specifications to solve the problem (Simlinger, 2007, p. 8). However, the term design also represents the outcomes of each *design process*, such as products, processes, services, and systems.

On a theoretical level the intention of an overall design process might be the same regardless of the specific *design area*. A well-designed information material makes everyday life easier for people who need the content, and at the same time it grants good credibility to the senders or sources.

Design areas and design disciplines can be classified in six design families, or design groups: 1) artefact design, 2) message design, 3) performance design, 4) systems design or systems development, 5) environment design, and 6) design philosophy (Pettersson, 2014, p. 14). Regardless of what we design there are common problems related to the various design processes, design principles, and design tools.

The second group, *message design*, deals with the design of different kinds of messages. A number of definitions of the concept *message* may be summarized as: “A message is information content conveyed from a sender to a receiver in a single context on one occasion.” This group includes 1) graphic design, 2) information design, 3) instruction design, 4) mass design, and 5) persuasion design. Here the main components are words, visuals and forms. Some representations also have movement and sound.

Graphic design is a *process* as well as a *result* of that process. Although we may not think about it, the practice of graphic design is as old as recorded history, and we see the results of graphic design every day. The main objective for graphic design is to provide aesthetic, functional, and organised structure to all kinds of information sets. The individual information interpreters might be seen as “readers.”

Information design comprises analysis, planning, presentation and understanding of a message—its content, language and form. The main objective for information design is to provide information materials needed by the interpreter in order to perform specific tasks. The individual information interpreters might be seen as “doers.”

Instruction design is an umbrella term for a number of areas dealing with *instruction*, such as instructional message design. The main objective for instruction design is to provide courses, lessons and materials intended for learning. The individual information interpreters might be seen as “learners.”

Mass design, or *entertainment design*, is an umbrella term for mass design areas, such as mass-communication, and journalism. The main objective for mass design is to provide entertainment, news and views to large audiences. The individual information interpreters might be seen as “relaxers.”

Persuasion design is an umbrella term for advertising, planned communication, and propaganda. The main objective for persuasion design is to persuade the interpreter of the message to buy a product or a service, or to change his or her behaviour. The individual information interpreters might be seen as “possible buyers,” or “prospects.”

2 Information Design

There have been many views about information design. Some claim that it is a practice. Some claim that it is a combined discipline. Some claim that it is quite impossible as a concept at all. Jacobson (1999, p. 3) noted: “there is no agreement that a practice called information design actually exists.” Jacobson concluded:

“... we need a reliable lexicon and a tried-and-true theory backed up by case studies. At present, the theory is sketchy and the case studies are scarce. Too few studies of information design have been carried out to support any broad generalizations about its practice.”

Jacobson (p. 6) concluded that it would take some time for a “compelling theory of information design” to be developed. This book was published in 1999. However, information design certainly exists in many countries – both as a practice and also as an academic discipline.

Some Definitions

There are many definitions and descriptions of information design, ID. The Information Design Journal started in 1979. According to Waller (IDA, 1997) the IDJ was intended to be a counterpoint to the corporate identity and glitzy graphics that seemed to take over traditional graphic design in the 1980s. From the beginning IDJ used a distinctive meaning for the term information design:

“... to apply processes of design (that is, planning) to the communication of information (its content and language as well as its form).”

In my own work I have used the following definition of information design (Pettersson, 1998, p. 27):

“In order to satisfy the information needs of the intended receivers, information design comprises analysis, planning, presentation and understanding of a message—its content, language and form. Regardless of the selected medium, a well-designed information material will satisfy aesthetic, economic, ergonomic, as well as subject matter requirements.”

The International Institute for Information Design (IIID) appointed an international group of information design faculty. This group made the following definition of information design (Simlinger, 2007, p. 8):

“Information design is the defining, planning, and shaping of the contents of a message and the environments in which it is presented, with the intention of satisfying the information needs of the intended recipients.”

As well as many other definitions these definitions include key words like: intended receivers, information needs, design processes, message contents, and information material.

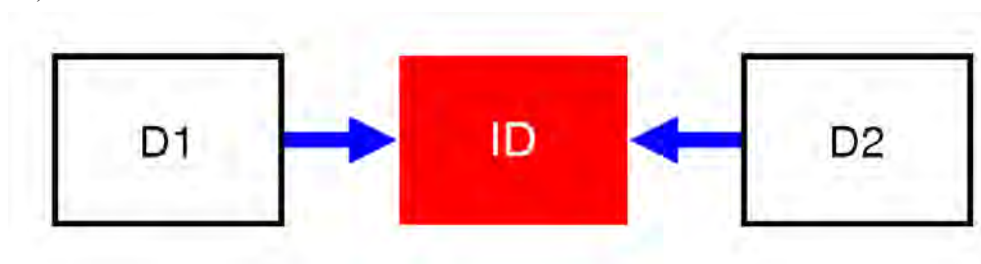
The concept of information design is a more widely embracing one than the concept of instruction design. From a cognitive point of view, information design is less demanding than instruction design. In instruction design the receiver is to (usually) learn from the message. However, in information design the receiver only has to be able to understand the message in order to use the information in a “one-time practical situation.” In many situations this will, of course, also result in learning, but here learning is usually not required. Should the need arise to once again deal with a specific practical situation the user can always read the manual again.

In the future we will focus more on the information content, the actual *message*, rather than on the traditional information materials as such. We need access to data and information required for maintenance of a machine, not necessarily for a printed document with this information. Many traditional printed documents have already been replaced by on-line services. We see a paradigm shift.

ID is Inter-Disciplinary and Multi-Disciplinary

Multi-disciplinary knowledge is associated with more than one existing academic discipline or profession. More than fifty established academic disciplines and practices provide information design with facts, influences, methods, practices, principles, processes, strategies, theoretical approaches, and tools (figure 1). Such *contributing disciplines* have been sorted in the following six groups of base disciplines: 1) art and aesthetic disciplines, 2) cognitive disciplines, 3) communication disciplines, 4) design disciplines, 5) information disciplines, and 6) language disciplines.

Figure 1: Information design (ID) receives contributions from more than fifty established disciplines and professions (here represented by D1 and D2). The received contributions may be facts, influences, methods, practices, principles, processes, strategies, theoretical approaches, and tools.



From a process perspective new “applications” develop within new academic disciplines and professions. *Inter-disciplinary knowledge* develops between or beyond existing academic disciplines or professions. *Multi-disciplinary knowledge* is associated with more than one existing academic discipline or profession (figure 2). Some examples of inter-disciplinary and multi-disciplinary fields of knowledge are architecture, culture, design, economics, gender studies, teaching, and visual literacy. At the same time established areas of knowledge become less important. All academic disciplines change over time, and eventually some of them will disappear, but so far there has been a huge increase in the total number of disciplines.

Figure 2: New applications (A1) develop between information design (ID) and existing disciplines and professions (D1). New applications (A2) also develop within other disciplines and professions (D2). In addition new applications develop within information design itself.



An Academic Discipline

A traditional academic discipline, or *field of study*, is a branch of theoretical knowledge that are researched and taught in higher education. A limited part within a field of study is a sub-branch, or a sub-discipline. Today several academic disciplines may be defined as *fields of knowledge*. A field of knowledge is the sum of combined knowledge gained from practice and from theory. A limited part within a field of knowledge is an *area of knowledge*.

The boundaries of an academic discipline mark what falls *within* its breadth, and also what it *excludes*. Academic disciplines are often defined and recognized by university departments and faculties, by learned societies, and by academic journals. The criteria for the status as an academic discipline differ between universities, even within a single country. Academic disciplines usually have several parts. However, the distinguishing lines between these parts may be both ambiguous and arbitrary. Furthermore a discipline may “belong to” different faculties at different universities.

Information design of today has its origin and its roots in 1) graphic design, 2) education and teaching, and in 3) architecture and engineering, or rather construction and production. Today information design education ranges from short courses to several years long programs. The discipline is also named *communication design*, *document design*, and *presentation design*.

Information design is a young academic discipline, but it is not at all a new field of knowledge. It was not “divided away” from another discipline. Rather it was deliberately “put together” with elements from several different sources of experience and knowledge. Basically this happened in the late 1990s in different parts of the world. I was responsible for this activity at Mälardalen University in Sweden, where information design got the status as an academic discipline 1999-02-15. The same year I became the first professor of information design in Sweden.

Today information design education range from short courses to several years long programs, some even reaching PhD-level. The discipline is also named communication design, document design, and presentation design. In the future it is quite possible that some universities will introduce very similar design subjects and choose to use other names.

3 Information Design Theories

In this context a *fact* is seen as something known to be true, by experience or by observation. Hypotheses are propositions accepted as highly probable in the light of agreed and established facts. A *postulate* is something fundamental that is assumed without proof as a basis for theoretical reasoning. According to Palmer (1999, p. 46) a *theory* is an integrated set of statements (hypotheses) about underlying mechanisms or principles that not only organizes and explains known facts, but also makes predictions about forthcoming information and news.

I have previously presented seven information design theories in the *Journal of Visual Literacy* (Pettersson, 2014). The seven information design theories consist of one *internal theory* and six *external theories*.

The internal theory is called *infology theory*. It is based on research within information design. The six external theories are based on research within the six groups of base disciplines, and applied to information design. The six external theories are called 1) aesthetics theory for ID, 2) facilitating theory for ID, 3) communication theory for ID, 4) providing theory for ID, 5) information theory for ID, and 6) language theory for ID. There is no specific theoretical order between the base disciplines or between the external information design theories.

Infology Theory

The *infology theory* is based on research within information design (Pettersson, 2014). It includes, but is not limited to, the following four fields of knowledge: 1) combined disciplines, 2) infology, 3) infography, and 4) infodidactics.

Combined Disciplines

Traditionally *science* is seen as a systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about the universe (Wilson, 1998).

In *applied science* people apply basic existing scientific knowledge to develop practical applications. An example of this is engineering and developing of technology. We may view an applied science, as a “combined discipline,” as a “practical theory,” or as a “theoretical practice.”

Information design is complementary to information technology in the same way as architecture is complementary to “building technology” and engineering is complementary to technology. Also dance, design, economics, education, fine arts, journalism, medicine, music and theatre, are examples of areas and disciplines that have a practical as well as a theoretical part.

Combined disciplines are complex areas to research and study. It is obvious that information design as an academic discipline needs to incorporate theoretical contributions from other disciplines. Adding a theoretical view to the practice of design is to reflect on the aims, methods and the results of this practice.

In order to make qualified reflections regarding practice and theory we need concepts both to structure our thoughts, and to describe them verbally (Nordegren, 2004, p. 23-24). When studying a *combined discipline* it is important for the students involved to work with realistic and true problems, and problem-oriented learning methods.

Yin and yang, or yin-yang, is a concept used in old Chinese philosophy to describe how some seemingly opposite forces are interconnected and interdependent, and how they give rise to each other. We think of many natural dualities, such as life–death and light–dark, as physical manifestations of these concepts. Yin and yang can also be seen as complementary forces interacting to form a *dynamic system* in which *the whole is greater than the parts*. In my view the combination *theory–practice* is such an example in information design.

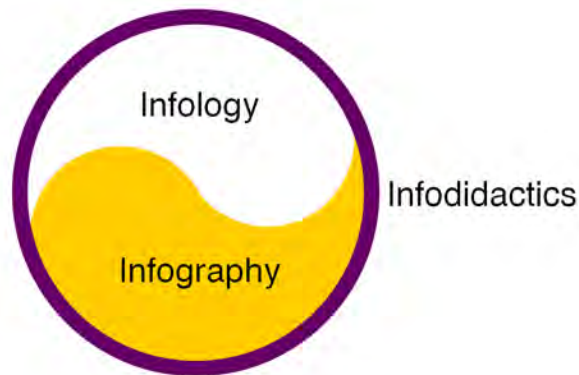
Infology

As an academic discipline, information design rests on a *foundation*, which can be expressed by the following four basic statements: 1) ID is inter-disciplinary and multi-disciplinary. 2) ID is multi-dimensional. 3) Theory and practice co-operate in ID. 4) There are no firm rules in ID. In my opinion these four basic statements are more than postulates and theories. These statements represent facts that are already established and recognised by people who are working within information design all around the world.

The theoretical part of information design, as well as message design, is called infology (figure 3). It has been defined as the “science of verbal and visual presentation and interpretation of messages” (Pettersson, 1989, p. x). On the basis of man’s prerequisites, infology encompasses studies of the way a combined verbal and visual representation should be designed in order to achieve optimum

communication between a sender and a group of intended receivers. Infology contain both theoretical (descriptive) elements, as well as normative (prescriptive) elements.

Figure 3. This model shows how infodidactics (teaching), embraces infology (theory), and infography (practice). View this as a cross section through a sphere.



Complicated language, in both texts and pictures, will impair the understanding of the message. Thus producers of information and learning materials can facilitate communication, and the learning processes of the intended receivers. Tonfoni (1998, p. 16) concluded: “The way information design is designed today will in fact deeply affect people’s learning processes and their ability to access knowledge in a very wide sense.”

Information sets providing the wrong information may actually give a *negative result*, and the receiver may end up less competent than before (Pettersson, 2002, p. 53). Shedroff (1999, p. 269) pointed out that *understanding* is a continuum that leads from data, through information to knowledge, and ultimately to wisdom.

Any graphic message should be legible, readable, and well worth reading for the intended audience and any audio message should be audible, distinct, and well worth listening to. Every information designer needs to have theoretical knowledge as well as practical skills related to the discipline.

Infography

The practical part of information design is called infography (Pettersson, 1989, p. 206) (figure 3). It includes all the intellectual and practical work and skills needed for design of messages. The *information designer* is a person with competence to transform data into high-quality information. The information designer has to identify the communication and information problems and create plans, with schemes and specifications, to solve the problems.

An information designer often works as a project manager. The task is often to coordinate production of words, visuals and graphic design, but sometimes also the use of light, sound, space and time, for the presentation of messages in different media. The task of designing complete information materials may often be far too overwhelming for one single individual. For that reason a team of people, with skills in different areas, are often working close together. According to Schriver (2011) professional information designers possess *tacit knowledge* about genres, processes, stakeholders, symbols, and tools.

Waller (1995) discussed the mutual incomprehension among designers and psychologists (p. 6):

“Designers are frequently appalled by the poor standard of stimulus material used by psychologists, while psychologists are frustrated by designers’ lack of a theoretical framework, their lack of evidence, and their apparent unwillingness or inability to articulate their processes.”

Later Waller concluded (p. 9):

“What underlies this apparent incompatibility of psychology and design is a fundamental difference in the kind of knowledge they employ. Scientists are committed to building explicit knowledge that is public and accountable. Designers are committed to building tacit knowledge that is private and unarticulated. Explicit knowledge is taught by explaining. Tacit knowledge is taught by showing, and learned by doing.”

The creative processes are influenced and supported by *message design principles*, and are performed with *message design tools* suitable for the type of representation that has been selected to solve a specific problem. Message design principles can be seen as a set of guidelines for design and development of a verbal/visual message. Main creative processes for a verbal/visual message include the following four activities: 1) analysis and synopsis, 2) production of draft, 3) production of script, and 4) production of original and master (Pettersson, 2002, p. 32). Each activity includes a review process. When the production is finished the final product may be evaluated.

Information ethics is one of the *administrative principles* in information design. According to this principle the information designer *must respect copyright* as well as other laws and regulations that are related to design, production, storage, distribution, and use of information materials. This concerns the use of artwork, illustrations, logos, lyrics, music, photographs, specific sounds, symbols, text, and trademarks. It is also very important to respect different ethical rules, media-specific ethical guidelines, and honour all business agreements.

The ethical rules for the press, radio and TV clearly take exception to any falsification and manipulation of picture contents through digital modifications and montages, or through misleading captions. *Image manipulation* implies the improper control of people's perception of a given reality through the use of visuals.

Normally we are allowed to crop an original picture, as well as enlarge and reduce its size. Obviously the information designer can use modern computers and graphics processing programs to create, and edit her or his own drawings, photographs as well as moving pictures on film and video.

In order to convey high-quality information to the user the information designer sometimes will have to suggest modifications, and ask the original authors, draftsmen, and photographers for permission to make changes in their original works. In many cases the information designer may also be a stakeholder as far as copyright is concerned. The information designer should never engage in any falsification, un-ethical, or illegal manipulation of contents.

Infodidactics

The special methods that are used for education and for teaching the various aspects of information design are called *infodidactics* (Pettersson, 1998, p. 7) (figure 3). The huge spread among the different disciplines makes information design an interesting, but also a complex area of research, study and teaching. Understanding is the goal of all scientific enterprise. When we understand a subject matter we are able to explain phenomena and predict new phenomena.

Although information design theories frequently refer to descriptive theory and propositions, their main function is to guide the information designers in how to actually design, present and produce information sets. Information design students have to learn how to actually design, present and produce information sets that work for the intended audiences. Students need realistic experience with true problems, regular information providers, actual information sets, real information interpreters, and experience with budgets and time limits. Information design students also need to work with theoretical assignments.

In an international project, coordinated by the International Institute for Information Design, information design faculty defined essential competencies for an information designer. According to this group professional information designers need to know methods and theories, which govern the

design and interpretation of information, and all relevant facts and tools for qualified professional activities in the discipline (idX, 2007, p. 6). These “core competencies” include properties, that constitute effective information, facts, tools and the skills needed for the structuring, rendering and applying of information, capabilities of information and communication technologies, related insights gained through research done in cognitive and social sciences, existing conventions and applicable legislation and standards, implications of business management, and the social demands underlying successful professional practice.

Aesthetics Theory for ID

The group “*art and aesthetic disciplines*” includes fields such as aesthetics, architecture, art history, computer graphics, film, fine art, iconography, iconology, illustration, music, painting, photography, and sculpture. Aesthetic theories that are based on perception favour sensation over intellect, favour seeing over reading, favour universality over cultural differences, and favour physical immediacy over social mediation (Lupton & Miller, 1999, p. 62).

At present the *aesthetics theory* for ID includes, but is not limited to, the following two fields of knowledge: 1) beauty theories, 2) colour theories.

Beauty Theories

Aestheticians discuss the *philosophy of art* from various perspectives, such as: definitions of art, experiences of art, interpretations of art, metaphysics of art, and production of art. Philosophers have made many unsuccessful attempts to define beauty. Three art theories concerning the nature of beauty are: 1) the formal theory, 2) the emotional theory, and 3) the relational theory.

Aestheticians value art for its originality and expressiveness. Its focus is on individual artefacts crafted through the manual and aesthetic virtuosity of the artist. Design, in contrast, is valued for its fitness to a particular user and to a particular task (Mullet & Sano, 1995, p. 8). While a painter or a sculptor can choose any imaginable shape, a designer is limited by the function of the thing being designed. Of course many designers want to provide aesthetic experiences where possible, but the design aesthetic is always related to the intended function of the information products intended for widespread distribution and use.

Colour Theories

Historical colour theories have included principles used to create harmonious colour combinations in architecture and painting. Every historical *colour wheel* is a visual representation of a specific colour theory (Anderson Feisner, 2006). Colour can be described in aesthetical, physical, physiological, psychological, and technical terms. For the receiver it must always be absolutely clear if colour is used for decoration, or if it has some kind of cognitive importance.

Facilitating Theory for ID

The group “*cognitive disciplines*” includes fields such as cognitive science, didactics, pedagogy, psychology, sociology and their subareas. At present the *facilitating theory for ID* includes, but is not limited to, the following four fields of knowledge: 1) attention theories, 2) perception theories, 3) processing theories, and 4) practical application theories.

Attention Theories

Among the thousands of stimuli in the external context we only feel, hear, see, smell, taste, or “pay attention to” one stimulus at a time. Attention is sudden, direct, and distinct. The sequential flow of

attention to the parts of a message is determined by the sequence in which information is presented to us. In information materials graphic form, pictures, sound, and words compete for our attention. Information materials must get attention, and maintain attention.

Certain simple shapes or colours “pop out” from their surroundings (Ware, 2000). This is called “pre-attentive processing.” Ware wrote (p. 163): “In essence, pre-attentive processing determines what visual objects are offered up to our attention.” The features that are pre-attentively processed can be organised into categories based on form, colour, motion, and spatial position.

Perception Theories

Perception entails fast, holistic, parallel, and simultaneous processing. It may take only 2-3 seconds to recognize the content in an image, but 20-30 seconds to read a verbal description of the same image, and 60-90 seconds to read it aloud. We look for, recognize patterns, and combine them into something meaningful. The *main goal* in information design and instruction design should always be *clarity of communication* (Pettersson, 2002).

We select some elements in a picture as the figure, the object of interest. The remaining parts constitute the *ground* on which the figure rests. Our visual system has a strong preference to ascribe the contour to just one of its border regions and to perceive the other side as part of a surface extending behind it (Palmer, 1999).

The essential thesis in *Gestalt psychology* is that in perception the whole is *different from the sum of its parts* (Palmer, 1999). There are many Gestalt principles, and the following nine provide most opportunities for designers: 1) closure principle, 2) common fate principle, 3) continuity principle, 4) contrast principle, 5) good form principle, 6) grouping principle, 7) objective set principle, 8) proximity principle, and 9) similarity principle.

Processing Theories

Day and Lloyd (2007) argued that concepts derived from *affordance theories* are highly useful in understanding the role of online technologies in learning. Waller (2011) discussed affordance qualities in documents and graphic design. In a document we tend to see significance in the way things are aligned, and in their relative prominence.

Schema theory describes how knowledge is acquired, processed and organized. The focus is on how we assign meaning to things through social experience (Davis, 2012, p. 80). We use schemata to organize current knowledge and provide a framework for future understanding. We are more likely to notice things that fit into our already existing schemata.

Action theory is a theory of personal change that is oriented towards professional education, especially related to leadership in organizations. Here the focus is on solving problems that are complex and badly structured. Then it is necessary to change underlying values and assumptions.

The *dual-code memory model*, or the *dual coding theory*, proposes that rather than just one sensory memory, one short-term memory, and a long-term memory, as might be implied in information processing theory, there are actually separate memory systems for different types of information. We have a verbal system for processing and storing linguistic information and a separate *non-verbal system* for spatial information and mental imagery.

Practical Application Theories

Our memory for pictures is superior to our memory for words. This is called the *pictorial superiority effect*. Careful integration of words and pictures engage people more effectively than words or pictures alone (Sadoski & Paivio, 2001). In the generative theory of *textbook design* learning is viewed as a constructive process (Mayer et al. 1995).

Based on the *dual coding theory*, the *cognitive load theory*, and the *constructivist learning theory* Mayer (1997) proposed a *cognitive theory of multimedia learning*. Generally multimedia researchers

define multimedia as the combination of text and pictures (Mayer, 2005). The words can be spoken or written. The pictures can be animations, illustrations, photos, or video.

Multimedia learning occurs when we build mental representations from these words and pictures. Multimedia instructional design attempts to use cognitive research to combine words and pictures in ways that maximize learning effectiveness. According to this theory multimedia explanations allow students to work easily with verbal and non-verbal representations of complex systems.

Communication Theory for ID

The group “communication disciplines” includes fields such as advertising, communication theory, cultural studies, educational technology, gender studies, human computer interaction, instructional technology, journalism, media, persuasion design, planned communication, television, and video production. At present the *communication theory for ID* includes, but is not limited to, the following four fields of knowledge: 1) audience reception theories, 2) culture theories, 3) interaction theories, and 4) media literacy theories.

Audience Reception Theories

There are a large number of communication theories, attempts to explain *how* and *why* humans communicate with each other. Several theories may be labelled *audience reception theories*. Examples are the encoding/decoding model, the reader-response theory, structuralism and post-structuralism, and uses and gratifications theory.

Culture Theories

Culture theories include cultural studies, cultivation, and gender studies. Contents in basic textbooks show traditional gender roles and gender stereotyping regardless of the major changes that have appeared in public opinion (Hunter and Chick, 2005; Odén, 2005). Incorrect and unfair gender representation and gender stereotyping will impair the credibility of information sets. Whether we are aware of it or not, visual culture is found in every arena of public and private life (Lefler, 2014).

Interaction Theories

Human *computer interaction theories* comprise research on the design of computer systems that support people so they can carry out their activities and tasks productively and safely.

All graphical user interfaces (GUI's) are communication systems (Mullet & Sano, 1995). A GUI is the form of communication between users and computers that facilitates interaction (Mok, 1997). An interface is the visible piece of a system that a user sees or hears or touches (Head, 2000).

Media Literacy Theories

Media literacy resides within numerous disciplines (Fox, 2005). This field of knowledge includes studies of medium and message, media literacy outcomes, and the agenda-setting theory. A medium is an aid used in the transfer of a message from a sender to a receiver. Each medium has unique aesthetics, codes and conventions. According to Martens (2010) evaluating and explaining the effectiveness of media literacy education is one of the most overwhelming challenges for current media research.

Providing Theory for ID

At present the *providing theory for ID* includes, but is not limited to, the following four fields of knowledge: 1) design concepts, 2) design processes, 3) design by reduction, and 4) modern graphic design.

Design Processes

Design processes include cognitive as well as practical aspects and activities, and include the development from a concept or an idea to a final product. A good *design process* will guarantee required results. It is important to define the problem during an introductory analysis and planning phase. To be effective a message must have good legibility and good readability. A small mistake early in the design process may prove very costly.

Design by Reduction

The most fundamental design technique is *reduction* (Mullet & Sano, 1995, p. 38). Wherever possible the designer should remove insignificant elements in layout, pictures, and texts in order for significant design elements to be clearly noticed. A message has good *legibility* if it is easy to read, and if the reader can easily see and distinguish all different parts of the message. A message has good *readability* when it is easy to understand.

Modern Graphic Design

The history of graphic design reveals that the manipulation of visual structure has always been fundamental to our thinking about how communication works (Davis, 2012, p. 22). During several decades graphic design was gradually consolidated into a design profession. Armstrong (2009, p. 97) noted that digital technology fundamentally transformed graphic design “as one millennium ended and another began.”

Information Theory for ID

The group “*information disciplines*” includes fields such as information architecture, information ethics, information literacy, information retrieval, information science, information systems, information technology, and information theory. At present the *information theory for ID* includes, but is not limited to, the following four fields of knowledge: 1) information architecture, 2) information literacy, 3) information science, and 4) information quality.

Information Architecture

To some degree information architecture originates in library science. Information architecture involves the structural design of systems for organization of data to help people to find, navigate, and manage information in complex systems. This emerging discipline is focused on combining principles of architecture and design in order to support usability. Information architecture is the intersection of the information content, the context of use, and the intended users (Morville & Rosenfeld, 2006; Wodtke, 2009).

Information Literacy

Information literacy is the ability to obtain information from the media and to judge its accuracy (Malmelin, 2010, p. 133). Information literacy is central to all successful learning and by extension to all successful living. It is important to review the information material with respect to credibility, graphic design, structure, style, and terminology before the technical production. When transferred from seller to buyer information remains available to both.

Information Science

Information science (IS), or *library and information science* (LIS), is a broad and interdisciplinary area of research (Ma, 1999). According to Fidel (2012, p. 56) numerous researchers have borrowed their

theories from other fields in order to build theories in library and information science, and studies of information behaviour.

Information Quality

High-quality information is correct, credible, relevant to the situation, and easy for the intended audience to access, interpret and understand. Securing *information quality* is one of the *administrative principles* in information design (Pettersson, 2010). According to this principle the *content of the message* is more important than its context, execution, and format.

Language Theory for ID

The group “*language disciplines*” includes fields such as drama, lexicology, lexicography, linguistics, literacy, rhetoric, semiotics, terminology, visual literacy, and writing. At present the *language theory for ID* includes, but is not limited to, the following six fields of knowledge: 1) plain language, 2) terminology theory, 3) rhetorical theory, 4) semiotic studies, 5) pattern languages, and 6) visual languages.

Plain Language

According to Garner (2009) plain language strives to be easy to read, understand, and use. In plain language the message has a high degree of *readability*. In many countries, laws mandate that public agencies use plain language to increase access to programs and services. A number of organisations have published criteria for evaluating the *clarity of documents* (Evans, 2011). There are many writing techniques that can achieve plain language.

Terminology Theory

The increasing complexity of modern society, as well as the interlinking and overlapping of subject fields make great demands on the accuracy of communication. According to *terminology theory* a concept is an idea of something, a referent. A term is a linguistic representation of the concept. A definition is a linguistic description of the concept. A concept is not bound to any particular language.

Rhetorical Theory

Classical *rhetorical theory* was the first of all communication theories. Rhetorical theory is not only used for text, but also for images and pictures. The interplay between text, visuals, and graphic form needs to be studied and tested thoroughly before optimal combinations can be found. Illustrations in textbooks must be relevant to the prose contents. Text, visuals, and graphic form should always work together to fulfil information design objectives.

Images can convey strong arguments and make us make decisions. In the news media photojournalism may arouse emotions, control our perceptions, engage, and make us take sides in conflicts and crises (Mral & Olinder, 2011).

Semiotic Studies

The development of *semiotics*, at the start of the twentieth century, was consistent with avant-garde art and design efforts to challenge prevailing ideas about the structural relationships between form and meaning (Davis, 2012, p. 131).

Based on Peirce's triadic model Amare and Manning (2013) discussed a “unified theory of information design.” The three corners in their triangular model of this theory represent the primary categories of visual-communication goals: 1) to evoke *feeling* (decoratives), 2) to provoke *action* (indicatives), and 3) to promote *understanding* (informatives).

All kinds of visual artefacts and purposes of communication, including printed/written text, fit in this model. However, in my view this approach is far too narrow to constitute a “unified theory of information design.” We need to consider many more aspects than semiotic concepts.

Pattern Languages

People have used general appearance and *pattern recognition* since ancient times. Nonverbal signs can produce many symbols with different meanings. In any culture people have to agree on the meaning of signs. Colour coding is a good way to show that something is connected, or especially important. Visual messages are superior to verbal messages when content is emotional, holistic, immediate, spatial and visual.

Visual Languages

As in the case of verbal language, visual grammar, syntax and vocabulary have been ascribed to visual language, while their particular functions have by and large been identified. Interpretation and creation in *visual literacy* can be said to parallel reading and writing in print literacy (Avgerinou & Pettersson, 2011). Usually receivers are capable of interpreting far more content in a given picture than the designer had in mind. Pictures can have a positive, a neutral, and also a negative effect on learning.

4 Future Work

So far established disciplines and professions have contributed to information design with more than one hundred facts, hypotheses, postulates, and also theories. I see this work as a start, and I hope that others will contribute with more hypotheses, and with more theories. I hope that it will be possible to formulate new principles and then new guidelines that will be useful in our practical work designing effective and efficient messages, information sets and learning materials.

References

- AMARE, N. & MANNING, A. D. 2013. *A Unified Theory of Information Design: Visuals, Text & Ethics*. Amityville, NY: Baywood Publishing Company, Inc.
- ANDERSON FEISNER, E. 2006. *Color Studies. How to use color in art and design*. London, UK: Laurence King Publishing Ltd.
- ARMSTRONG, H. 2009. *Graphic design theory Readings from the field*. New York: Princeton Architectural Press.
- AVGERINO, M., D. and PETTERSSON, R. 2011. Toward a Cohesive Theory of Visual Literacy. *Journal of Visual Literacy*, 30(2), 1-19.
- DAVIS, M. 2012. *Graphic design theory*. London, UK: Thames & Hudson.
- DAY, D. & LLOYD, M. M. 2007 Affordances of online technologies: More than the properties of the technology. *Australian Educational Computing*, 22 (2), 17-21.
- EVANS, M. 2011. *Criteria for clear documents: A survey*. University of Reading, UK: Simplification Centre. Technical paper 8.
- FIDEL, R. 2012. *Human information interaction: An ecological approach to information behavior*. Cambridge, MA: MIT Press.
- FOX, R. F. 2005. Researching media literacy: Pitfalls and possibilities. In G. Schwartz & P. U. Brown (Eds.), *Media literacy: Transforming curriculum and teaching* (pp. 251-259). Malden, MA: Blackwell.
- GARNER, B. A. 2009. *Garner on Language and Writing: Selected Essays and Speeches of Bryan A. Garner*. Chicago, IL: American Bar Association.

- HEAD, A. J. 2000. *Design Wise. A guide for evaluating the interface design of information resources*. Medford, New Jersey: Cyber Age Books.
- HUNTER, M. W., & Chick, K. A. 2005. Treatment of gender in basal readers. *Reading Research and Instruction*, 44 (3), 65-72.
- IDA, *The Information Design Association*. 1997. The origins of the IDA.
- idX. 2007. *Information design: Core competencies. What information designers know and can do*. Wien: IIID. Retrieved from www.iiid.net/PDFs/idxPublication.pdf
- JACOBSON, R. 1999. *Information Design*. The MIT Press, Cambridge, Massachusetts; London, England.
- LEFLER, B. 2014. Visual Culture and Advertising. *VASA Journal on Images and Culture (VJIC)*, Nr. 6. January. Retrieved from <http://vjic.org/>
- LUPTON, E. 2009. Why theory? In H. Armstrong (Ed.), *Graphic design theory: Readings from the field*. New York: Princeton Architectural Press.
- LUPTON, E. & Miller, A. 1999. *Design Writing Research*. London, UK: Phaidon Press limited.
- MA, Y. 1999. Visual Information Science: Its Need and Place in the Curriculum of Library and Information Science Education. In R. E. Griffin, W. J. Gibbs, & B. Wiegman (Eds.), *Visual Literacy In An Information Age*. Loretto, PA: International Visual Literacy Association.
- MALMELIN, N. 2010. What is Advertising Literacy? Exploring the Dimensions of Advertising Literacy. *Journal of Visual Literacy*, 29 (2), 129-142.
- MARTENS, H. 2010. Evaluating media literacy education: Concepts, theories and future directions. *Journal of Media Literacy Education*, 2, 1-22.
- MAYER, R. E. 1997. Multimedia learning: Are we asking the right questions? *Educational Psychologist*, 32, 1-19.
- MAYER, R. E. 2005. Introduction to multimedia learning. In R.E. Mayer (Ed.), *The Cambridge Handbook of Multimedia Learning*. New York: Cambridge University Press.
- MAYER, R. E., Steinhoff, K., Bower, G., & Mars, R. 1995. A Generative Theory of Textbook Design: Using Annotated Illustrations to Foster Meaningful Learning of Science Text. *ETR&D*, 43 (1), 31-43.
- MOK, C. 1997. *Designing business: Multiple media, multiple disciplines*. San Jose, CA: Adobe Press.
- MORVILLE, P. & Rosenfeld, L. 2006. *Information Architecture for the World Wide Web: Designing Large-scale Web Sites*. Sebastopol, CA: O'Reilly Media
- MRAL, B. & Olinder, H. 2011. *Bildens retorik i journalistiken*. Stockholm: Norstedt.
- MULLET, K., & Sano, D. 1995. *Designing visual interfaces communication oriented techniques*. Mountain View, CA: SunSoft Press A Prentice Hall Title.
- NELSON, H. G. & Stolterman, E. 2003. *The Design Way. Intentional Change in an Unpredictable World. Foundations and Fundamentals of Design Competence*. Englewood Cliffs, New Jersey: Educational Technology Publications.
- NORDEGREN, A. 2004. *Design som teori och empiri. Ett designteoretiskt forskningsprojekt med en prototyputveckling av ett symbolsystem för vinsmaker*. Stockholm, Sweden: KTH Arkitekturskolan, Doktorsavhandling.
- ODÉN, P. 2005. *Gender in English Teaching Books*. Luleå, Sweden: Luleå University of Technology, Department of Languages and Culture.
- PALMER, S. E. 1999. *Vision Science. Photons to Phenomenology*. Cambridge, MA: MIT Press.
- PETTERSSON, R. 1989. *Visuals for information, research and practice*. Englewood Cliffs, NJ: Educational Technology Publications.
- PETTERSSON, R. 1998. *Information design and learning*. Presentation at Vision Plus 5. Learning meets Information Design, Information Design meets Learning. International Institute for Information Design, Fachhochschul-Studiengänge-Vorarlberg, Austrian Federal Ministry of Science and Transportation, Ministry of Education and Art, UNESCO. Schwarzenberg, Vorarlberg, Austria, July 2-4.

- PETTERSSON, R. 2002. *Information design—An introduction*. Amsterdam: John Benjamins Publishing Company.
- PETTERSSON, R. 2010. *Information Design—Principles and Guidelines*. *Journal of Visual Literacy*, 29 (2), 167-182.
- PETTERSSON, R. 2014. Information Design Theories. *Journal of Visual Literacy*, 2014, 33, (1), 1–94.
- SADOSKI, M. & Paivio, A. 2001. *Imagery and text: A dual coding theory of reading and writing*. Mahwah, NJ: Erlbaum.
- SHEDROFF, N. 1999. Information interaction design: A unified field theory of design. In R. Jacobson (Ed.), *Information design*. Cambridge, MA: The MIT Press.
- SCHRIEVER, K. A. 2011. What we know about expertise in professional communication. In V. W. Berninger (Ed.), *Past, present, and future contributions of cognitive writing research to cognitive psychology*. London, England: Psychology Press/Taylor Francis Group.
- SIMLINGER, P. 2007. *idX development of international core competencies and student and faculty exchange in information design within the EU/ US cooperation program in higher education and vocational education and training*. Wien: International Institute for Information Design.
- TONFONI, G. 1998. *Information design: the knowledge architect's toolkit*. Lanham, Md.: Scarecrow Press Inc., and Exeter: intellect.
- WALLER, R. 1995. *Information design: How the disciplines work together*. Reprinted 2011 as technical paper 14. Reading, UK: Simplification Centre at University of Reading.
- WALLER, R. 2011. *What makes a good document? The criteria we use*. Technical paper 2. Reading, UK: Simplification Centre, University of Reading.
- WARE, C. 2000. *Information Visualization. Perception for Design*. San Francisco: Morgan Kaufmann Publishers.
- WILSON, E. O. 1998. *Consilience: The unity of knowledge*. New York, NY: Vintage Books.
- WODTKE, C. 2009. *Information Architecture—Blueprints for the Web*. New Riders.

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Chapter 12

Using new media art and multisensory design for information and data representation

Patricia Search

keywords: Multisensory design, data representation, cross-modal perception

New media design can expand our awareness of data relationships in complex information spaces. Traditional Western design organizes information in structured hierarchies that restrict the way we interpret relationships. In today's information society, we need to represent information in fluid, holistic formats that challenge us to uncover new relationships using diverse spatial and temporal perspectives. We need to understand the semiotics of different media and the new semantic structures and metasyntax that result from cross-modal perception. This paper includes examples, created with an interactive art medium called HyperGlyphs, that illustrate how new media design and multisensory information can create engaging experiences that expand our perception of multimedia and spatiotemporal relationships. The art installation encourages participants to explore dynamic information relationships from diverse perspectives that are outside the framework of Western logic. Graphics, sound, text, action, and reflective abstraction create a discursive environment that defines layers of sequential and simultaneous associations, as well as kinesthetic relationships that integrate the cognitive and sensory feedback from the interactive experience. During this interaction, multiple participants interact with the media, resulting in a dynamic social discourse that also adds new layers of meaning to the interpretation of the information.

1 Introduction

Information design requires innovative approaches to media design that support creative problem solving and new perspectives for information retrieval and analysis. Most interface designs reflect Western logic and design methodologies that emphasize hierarchical organizational structures and navigation. For complex information environments, including data analysis, it is important to explore new semiotic structures for interaction design that create flexible information spaces that help users synthesize information and develop a holistic approach to creative problem solving and information representation.

With interactive multimedia design, it is possible to use different sensory modalities to explore ideas from diverse perspectives. To take full advantage of this potential, the interface design and organization of the information should provide different ways of navigating and accessing information so users can compare variables in different contexts and simplify complex relationships. These environments can take advantage of the power of electronic media to provide new perspectives with elements that are 'in a perpetual state of reorganization' (Bolter, 1991: 9).

Interactive art and new media design provide opportunities to explore alternative perspectives and new dimensions in information and data design. Weinbren (2007: 69) noted that ‘Works of new media make the next step, by allowing multiple pathways through the database and permitting viewer input into, and control over, how individual paths are formed, accessed, and compounded.’ With experimental art projects, it is possible to explore new directions in multisensory design that help us understand the complex spatiotemporal relationships and semiotic processes that shape our perception and understanding of information in interactive multimedia environments.

This paper presents some multisensory design elements that augment traditional approaches to information design. Graphics, sound, text, and movement create interactive semantic structures that we can leverage to produce intuitive designs that expand the potential for discovering new relationships in complex information spaces and data sets. The paper includes visual designs from an interactive art project that uses HyperGlyphs, a medium for creating interactive, audiovisual computer programs. The project explores the syntax of individual media and the metasyntax that emerges in these interactive environments. The examples highlight the perceptual and cognitive associations and spatiotemporal relationships that are integral to multimedia design.

2 Multisensory Perception

Using different media and senses in information design increases the number of variables we can represent and process in complex data relationships. Research has shown that cross-modal perception can enhance our ability to process information from individual sensory modalities. Freides (1974) conducted an extensive literature review on the relationship between cross-modal functions and information processing. He concluded that perception that involves one sensory modality is less accurate than complex counterparts that involve more than one sense, especially if the cross-modal perception involves the integration of visual or audio information with somatosensory information (haptic and kinesthetic stimuli). He also concluded that with complex information, such as spatial or temporal pattern recognition, contextual and parametric variables are less important than the sensory modality itself. With complex spatiotemporal patterns, the sensory modality is a critical variable because each modality processes information in a different way, and we will use the modality best suited to process spatial, temporal, tactile, or kinesthetic stimuli.

Extensive research has also demonstrated that cross-modal stimuli alter the perception of visual information when sound is added to the visuals (Vroomen & de Gelder, 2000). These changes in perception occur with the processing of synchronous audio and visual information, as well as with the processing of information in different spatial domains such as audio and visual sources that come from different locations (Bertelson & Radeau, 1981; Vroomen, Bertelson & de Gelder, 1998; Vroomen, 1999; Vroomen, Bertelson & de Gelder, 2001). Sound can enhance the detection of specific individual visual elements as well as motion (Vroomen & de Gelder, 2000; Beer & Watanabe, 2009). The addition of repetitive sounds to visuals can alleviate ‘repetition blindness’ which occurs when viewers do not perceive visuals that repeat in rapid succession (Chen & Yeh, 2009). Research has also shown that the multisensory integration of audio and visual stimuli is a physiological process that takes place within the neurons in the brain (Paulesu, Harrison, Baron-Cohen et al., 1995; Sams & Imada, 1997; Driver & Noesselt, 2008; Stein & Stanford 2008; Beer & Watanabe, 2009).

The field of multisensory data design is an emerging area of information design that will benefit from this ongoing research in cross-modal perception. Spence, Senkowski, and Röder (2009) pointed out that current research in this area seems to be shifting from a focus on spatial information processing to the impact of sensory modalities on the temporal processing of information. This new emphasis on the temporal dynamics of information processing will play a significant role in defining new directions for multisensory data design where animations and sonification map changes in data variables over time.

3 New Semantic Structures

In addition to the perceptual integration of different sensory stimuli, multisensory design creates a new communication syntax that is derived from dynamic perceptual, cognitive, spatial, and temporal relationships. Our understanding of data relationships of all types, ranging from general information to detailed, numerical data, is shaped by this syntax.

HyperGlyphs is an art medium that provides opportunities to explore new perspectives in interactive information and data representation. With this software, it is possible to create multimedia installations that highlight the interaction of different 'worlds' using dynamic audiovisual and kinesthetic relationships. This research is inspired by indigenous consciousness and how indigenous peoples view relationships in physical and spiritual worlds. The work also reflects the Japanese concept of MA which defines space and time as an integrated whole that is perceived through an individual's experience.

The HyperGlyphs installations defy the 'either/or' perspective that traditionally prevails in Western diachronic logic. They enable participants to explore a fluid space in which text, graphics, sound, motion, and interaction create a dynamic syntax and matrix of cognitive, perceptual, and semiotic relationships. Audiovisual transformations and interaction with the elements signify the integration of past (what was), present (what is), and future (what will happen). The space between events is as important as the space where events actually happen. Space defines moments in the continual process of change, demonstrating that 'space and time serve as the contexts in which all communication entities exist and unfold' (Monge & Kalman, 1996: 74).

Polysemiotic Structures

In HyperGlyphs installations, polysemiotic structures are defined with contrasting audiovisual elements and interaction. Visual depth and spatial dimensions, created with multiple layers of form, color, space and transparency, suggest diverse perspectives, new possibilities, and the synthesis of elements and connections between ideas. Design elements create integrated layers of spatial and temporal relationships that symbolize the multiple connections in complex information networks (Figure 1).

Figure 1. Transparent layers symbolize the synthesis of information. Copyright 2014 Patricia Search. All rights reserved.



Visual elements also transform into ‘ghosted’ images or shadows that suggest the integration of the actual with the possible. Space folds into itself, uniting objects with the surrounding space. Events, as well as the space between the events, take on significance. Space and time are flexible entities that describe relationships between events. The process of interaction creates patterns and rhythms that encode space and time into tangible representations of dynamic relationships and the transformation of ideas (Search, 2006).

Sound in the installations also expands our awareness of spatial and temporal relationships. Sound penetrates space and creates additional layers of depth. Different types of sound, such as angular, linear, steady beats and changes in timbre, volume, or tempo, expand the syntax of the design. Sound, integrated with the display of graphics, creates an interactive dialogue that suggests multiple layers of associations and diverse perspectives.

In HyperGlyphs, the polysemiotic semantic structure that emerges defines a discursive communication experience. Images, text, sound, and movement create an enactive, iconic, and symbolic space in which semiotic structures overlap and define a metasyntax that integrates the syntax of the different media (Search, 2011). The metasyntax creates a fluid semiosis by defining sensory and cognitive models that transcend the meaning of individual media or actions (Search, 2011). Parallel, synchronous formats co-exist with linear, sequential progressions. Causation is all-inclusive, not exclusive, leading to the holistic integration of diverse levels of detail, abstraction, and spatiotemporal relationships.

These interactive environments lead to cognitive and perceptual interpretations that are characterized by inversion, translation, and reflection. Turkle and Papert (1993) referred to this type of cognitive mapping of diverse perceptual responses as ‘bricolage.’ The combination of non-linear access to sensory information also results in what psychologists call reflective abstraction—a process that leads to generalizations through the synthesis of multiple perspectives (Piaget, 1977). Campbell (2001: 12) pointed out that reflective abstraction leads to ‘constructive generalizations, to genuinely new knowledge, to knowledge at higher levels of development, and to knowledge about knowledge.’ Memory also contributes to the abstraction and synthesis of information because viewers create mental landmarks. Memory creates a new type of experiential space that is based on sensory input and perception (Search, 2009). Referring to Patricia Hampl’s essay titled ‘Memory and Imagination,’ McConkey (1996: 201) noted that memory connects answers ‘to the abstract issues that underlie life itself.’

Audiovisual Rhythm

Rhythm is an important element in these polysemiotic environments. There is the rhythm of the visuals, sound, movement of the graphics, and the movement of the viewer as s/he interacts with the programs using gestures, body movements, and physical interaction with the interactive hardware. Rhythm also occurs when audio and visual symbols that represent closure and continuity (e.g., circles, squares) contrast with shapes or sounds that suggest infinite time and space (e.g., straight lines, sustained sounds). The rhythm of the sound can vary from fluid, lyrical refrains to strong, steady beats. In information design, these unique rhythms can be used to represent different types of data and information relationships.

Sound and rhythm also communicate time. Seaman (2007: 130-131) pointed out that sensed time causes time to appear to move at different speeds:

When a work is being explored as a flowing movement through virtual space, time may appear to move at different speeds. Fragmentation can promote a feeling of the elongation of time—as one observes the different media-elements and processes displayed in the menu system . . . Alternatively, the exploration of ambient audio loops prompts the feeling of a meditative ‘suspension’ of time.

These perceptions of time also impact the perception of space. Sounds or rhythms that appear to fragment time also appear to divide space. Ambient sounds create the perception of a continuous, expansive space, while repetitive loops carve out areas of space in a specific location. These temporal dimensions of space can exist simultaneously as overlapping layers, as well as define sequential representations of space.

Research has shown that cross-modal perception takes place very quickly when sound is synchronized with the visual information (Giard & Peronnet, 1999). Sounds that match the visual and rhythmic qualities of the graphics, animations, or transitions underscore the cognitive and/or emotional connections communicated by the visuals. O’Leary and Rhodes (1984) also indicated that segmenting sensory information in one modality can result in segmentation in another modality. For example, visual elements seen as two separate elements or movements result in the perception of two separate audio tones with the introduction of concurrent sounds. Similarly, the perception of sensory information as a continuous visual element results in the perception of continuous sounds. Vroomen and de Gelder (2000) discovered that when a tone separates from an auditory stream, it causes visual elements to appear to separate from synchronized visual stimuli. Sound can also highlight intensity, dissonance, and contrast in visual relationships. Researchers have demonstrated that the intensity of sound can enhance the perceived visual contrast and intensity of a stimulus (Stein, London, Wilkinson & Price, 1996; Vroomen & de Gelder, 2000).

Interaction

This cross-modal dialog is further enhanced in interactive multimedia design by the physical interaction of the participants who must move in specific ways to display, select, and animate information on the screen. The lines, space, and rhythms associated with these movements enable participants to engage in the interactive spatial representation of the data. Participants may, for example, make curved, fluid movements or linear, angular movements with the interactive hardware or their bodies. These actions create a rhythmic contrast to the movement of visuals and the audio, further emphasizing the potential for using cross-modal perception to define relationships in information design. The rhythm of these actions also emphasizes the ‘space’ between the links and connections between ideas. Action defines the simultaneous existence of multiple spaces, times, and relationships. Action is more related to a state of existence than a particular event, object, time, or space.

This type of interaction design, called kinesthetic design, helps the viewer understand the visual and cognitive relationships in the spatial representation of information (Search, 2003). Berkeley (1922) demonstrated that kinesthetic and tactile experiences shape our perception of space. Klemmer, Hartmann, and Takayma (2006: 140) noted that that ‘our bodies play a central role in shaping human experience in the world, understanding of the world, and interactions in the world.’ When we physically interact with models or other tactile representations of data, we use reflective practice to work through ideas rather than just think about them (Klemmer, Hartmann & Takayma, 2006). Researchers have also documented the significance of ‘drawing’ relationships in physical space with hand and arm movement to clarify conceptual relationships and enhance memory and recall (Fish & Scrivener, 1990; Fish, 1993).

4 HyperGlyphs Installation

This section takes a closer look at a specific HyperGlyphs installation and shows how the interconnection of polysemiotic semantic structures, cross-modal perception, kinesthetic design, and reflective abstraction define dynamic multisensory networks.

In the installation, two participants interact with the graphics and sound in two different computer programs (Figure 2). The images and audio from the programs are projected in layers on top of each other, creating an immersive experience for the viewer. Free-form shapes are juxtaposed with geometric shapes to suggest different types of information and relationships (Figure 3). The viewer can rotate the individual forms in various ways to explore the relationships between shapes, lines, space, and time. As the elements move, they reveal new connections between the forms and sounds. Lines, text, numbers, filled shapes, and layers of transparency and sound provide alternative perspectives and ways of interpreting these relationships. When the participants interact with the programs, social discourse adds another layer of interpretation to the information. The participants explore new relationships based on the actions of other participants, and they discuss their different perspectives as they navigate through the programs.

Figure 2. Two participants use interactive hardware to interact with two different computer programs. The images from each program are projected on top of each other on a white wall. Copyright 2014 Patricia Search. All rights reserved.

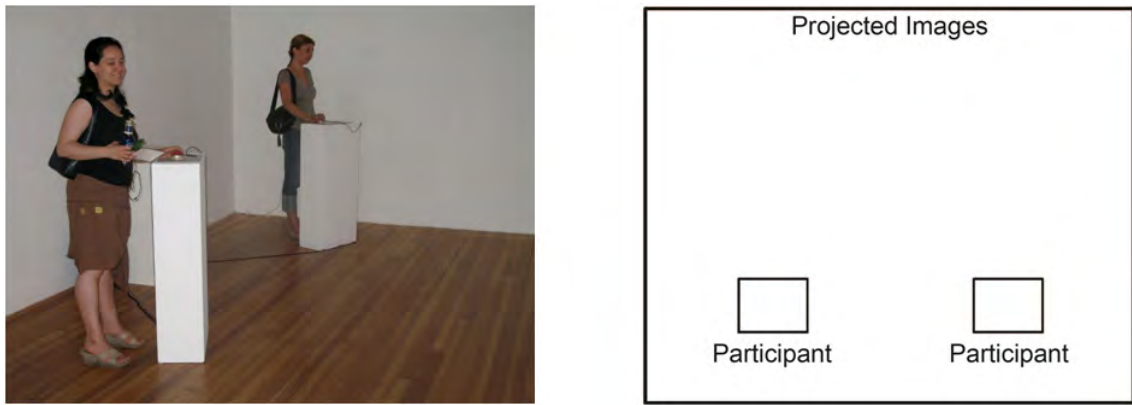
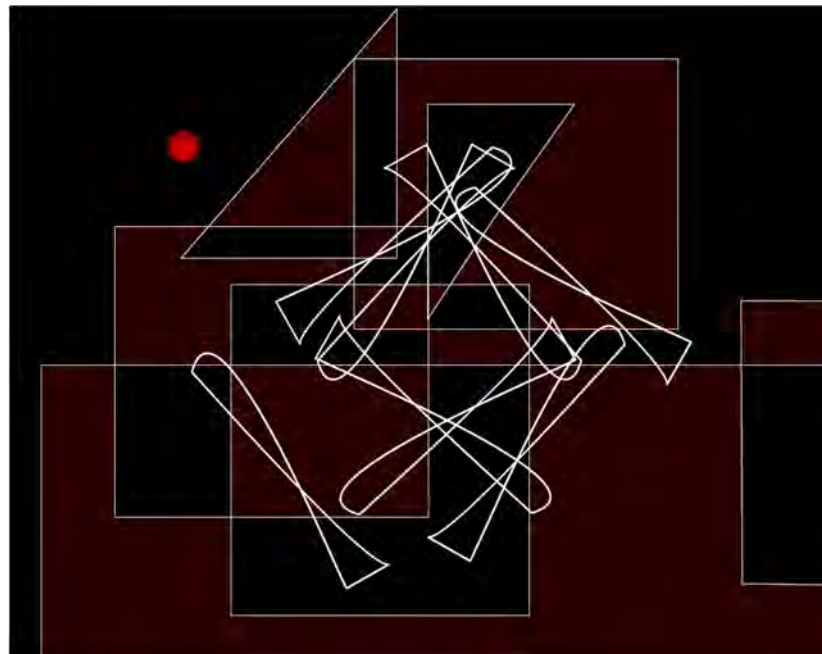
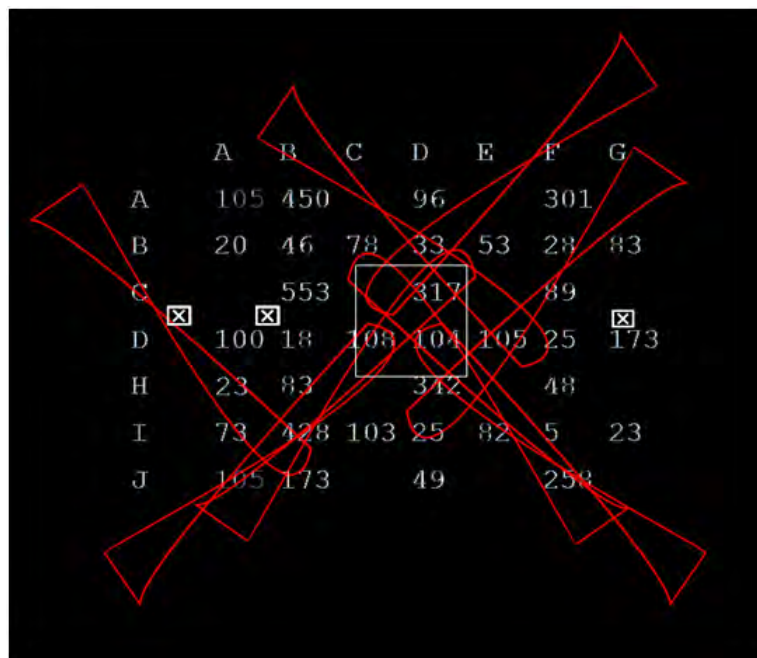


Figure 3. Geometric shapes and free-form elements symbolize different relationships. Copyright 2014 Patricia Search. All rights reserved.



The installation highlights the significance of space. Space becomes an active element rather than a void. Silence between audio elements, blank spaces between graphics, and outlined shapes represent the potential for new relationships and interpretations. As participants interact with the programs, these spaces take on added significance as the voids fill with new graphics, text, and sounds. For example, in the screen shown in Figure 4, a grid of numbers and the box containing an “x” are symbolic representations of specific data. On the left side of the screen, there is a space between the two boxes with the ‘x.’ It is a dynamic space that reveals another layer of text when the participant moves the cursor over the blank space. This action suggests the integration of different types of information, some of which may be unknown initially and then revealed over time with exploration. Other design elements also underscore the potential for combining information in different ways. For example, the Gestalt law of similarity prompts the viewer to group these boxes even though they appear on opposite sides of the screen. Participants can also move the large square, shown in the center, around the screen and frame different numbers and graphics.

Figure 4. Different types of graphics symbolize the potential for transforming discrete data into dynamic relationships. Copyright 2014 Patricia Search. All rights reserved.



The juxtaposition of visuals that represent structure (e.g., a grid of numbers, geometric shapes) with free-form elements reminds us that logic, order, and uncertainty are integral dimensions of information analysis. These visual symbols signify the potential for taking linear, structured ideas and combining them into dynamic, flexible relationships. They remind us that structure can be fluid and multidimensional, and interactive designs that support this type of fluid information can lead to new perspectives and innovative ways of exploring complex relationships.

In this art installation, language also references spatial and temporal relationships and the potential for combining information in different ways. Words such as now, then, and listen move apart, come together, overlap, and slide past each other, suggesting new ways to use space and time to define dynamic relationships. Terms like ‘between two worlds’ include multiple layers of symbolism that signify different types of multisensory experiences and dichotomous relationships—virtual and tangible, sensory and mathematical, cognitive and perceptual.

The HyperGlyph designs enable participants to view information from outside the framework of narrative and causality by providing multidimensional ways of framing virtual information within the context of the user's tangible, physical environment. While there is a level of determinism in the programming logic in the computer programs, that control is offset by the abstract, recursive nature of the curvilinear graphics, reflective text, and lyrical sounds that represent the open possibilities for defining new relationships through creative exploration of information and data sets.

5 Hyperplanes

In these interactive environments, layers of multisensory information intersect to form hyperplanes that create a counterpoint of audio, visual, and rhythmic patterns that define different types of spatial and temporal relationships.

With multimedia design, it is possible to perceive sounds and visuals simultaneously as well as sequentially, resulting in different cognitive interpretations of changes over time. The sounds form hyperplanes that intersect the environment from various angles as the sounds penetrate the surrounding space. Because we can hear sounds while we look at visuals, we are able to explore multidimensional spatial and temporal connections simultaneously.

Kinesthetic design also adds layers of patterns and spatiotemporal connections to the hyperplanes and the audiovisual syntax. Figure 5 shows an image projected onto the wall and the type of patterns the participants might make with the interactive hardware as they move it to navigate through the programs. The patterns created by this physical interaction occur at right angles to the visuals that are projected onto the wall, creating a geometric grid of intersecting spatiotemporal planes that are continually redefined by dynamic visual patterns.

In some of the art installations, draped fabric and physical objects are included in the projection space and add new dimensions to the hyperplanes. The projected images create transparent layers of shape and colors that cascade onto the folds of the fabric and wrap around the objects. The virtual images acquire three-dimensional highlights and shadows as they morph into the shapes of the physical objects. The images are integrated into the physical environment and transformed into information sculptures that intersect the hyperplanes—reminding us that all information is multidimensional ‘real’ data that impacts our lives.

6 New Media Design and Data Exploration

The following multisensory design elements, highlighted in the HyperGlyphs installations, can be incorporated into interactive applications to represent patterns and relationships in information and data analysis:

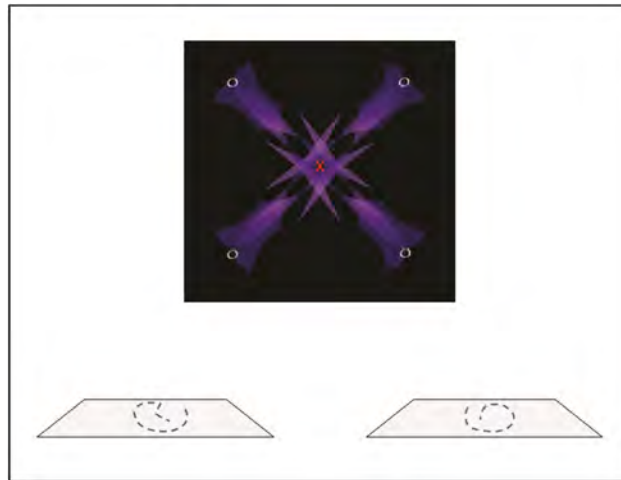
- layers of transparent forms, lines, colors, and sounds that highlight data connections;
- animations and visual transformations that show variable changes over space and time;
- audio elements that represent data variables and sequential and/or simultaneous relationships;
- rhythm in visuals, sound, and spatial movement that highlight patterns, outliers, and anomalies;
- cross-modal perception that highlights spatiotemporal changes in data;
- active space for creating new links and networks of associations;
- interactive tools that make it possible to compare different groups of variables, reveal select elements, and study the intersection of patterns as elements move and transition over space and time; and

- interaction designs that limit the use of a priori linguistic categories and support flexible navigation to encourage the development of diverse perspectives.

These approaches to representing relationships encourage exploration which is an important dimension in data analysis. The process of data analysis often starts with specific questions and expectations. The semantic-syntactic network of images, text, and sound, as well as the viewer's knowledge and experience, also directs actions and interpretations. However, it is important for the viewer to work in an interactive environment that facilitates data exploration and shapes new perspectives.

With multisensory data representation, the ensuing dialog between logic and perception should lead to an ongoing quest for new insights and interpretations. It is important to be open to the element of 'surprise' which can energize our senses and force us to reevaluate our conclusions and procedures in data analysis. We must be willing to continually review models of 'reality' that are defined by abstract, numerical descriptions of tentative truths. Minsky (1986: 277) pointed out that we need to understand the interaction of different types of complementary knowledge, and while we search for 'islands of consistency' within which ordinary reasoning seems safe, we must also find 'the unsafe boundaries of those domains.' In information and data design, we must be able to explore those 'unsafe' boundaries and the limitations of perception and logic, and transform those boundaries into new knowledge and insights about the complex world around us.

Figure 5. Participant interaction creates additional patterns in space and time that form hyperplanes which are perpendicular to the images projected onto the wall. Copyright 2014 Patricia Search. All rights reserved.



7 Conclusion

Multisensory design provides opportunities to create interactive designs that channel our intuitive abilities to use different sensory modalities to synthesize information. This process enables us to develop new perspectives and identify patterns, trends, and relationships in data sets. Layers of information can be combined into polysemiotic semantic structures that highlight both the simultaneous and sequential dynamics of complex information networks. Seaman (2007: 136) referred to this type of interaction with media and processes as field theory in which 'the participant, the environment, the interface system, audio processes and the media-elements explored through interaction determine meaning.' This approach to information design creates a fluid environment that reminds us that data is not static. It is a matrix of changing relationships that are defined by context and the viewer's experience.

These interactive designs should also be supported by a database that is organized in a flexible format rather than a fixed, hierarchical structure (which has been the norm in information architecture and database design). With flexible, ontologically flat databases, users are free to explore and define relationships between objects. Srinivasan and Huang (2005: 12) introduced the concept of ‘metaviews’ which evolve when users rearrange the database elements to define different perspectives and ‘multiple, evolving ontologies.’ Paul (2007) also noted that meta-narratives emerge from the dynamic reorganization and exploration of the characteristics, organization, and cultural specifics of individual database elements.

Multimedia metadata is another design element that expands the potential for creating flexible databases that encourage exploration and diverse perspectives. Traditionally, metadata has been text-based, but multimedia metadata provides opportunities to use different media, not just text, to define and organize database information. The media can take advantage of the iconic properties of visual and linguistic symbols and suggest different associations between database elements. The different media create multiple levels of perceptual encoding, spatial and temporal relationships, and cognitive associations (Search, 2015). Seaman (2007: 137) quoted Harris and Wolf’s (1998: 1-2) description of integrational linguistics which notes that linguistic and non-linguistic signs are not mutually exclusive: ‘Human beings do not inhabit a communication space which is compartmentalized into language and non-language, but an integrated space where all signs are connected.’ Multimedia metadata can expand the potential for creating meaningful connections and associations between elements in databases.

These new technologies and applications that use multiple forms of sensory representation provide a window on the next generation of information and data design. Multisensory designs in user interfaces, database organization, and metadata enable us to use sensory modalities and multiple perspectives to augment our perception and cognitive understanding of dynamic data relationships. New media art and design projects are unique resources that provide new insights for using multisensory design and cross-modal semiotics to create intuitive information and data representations.

It is important to remember that data can weave a matrix of dynamic relationships that tell stories by highlighting connections between people, events, objects, and ideas. We need to be attentive to the narratives embedded in the data. With multisensory design, we can use our intuitive powers of perception to enhance our ability to identify and interpret those stories. By engaging the senses, we create affective domains and holistic approaches to data analysis that enable us to see beyond the statistics, so we can understand the human, social, and cultural significance of the information (Search, 2015).

References

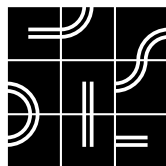
- BEER, A. & Watanabe, T. 2009. Specificity of auditory-guided visual perceptual learning suggests crossmodal plasticity in early visual cortex. *Experimental Brain Research*, v.198, n.2: 353-361.
- BERKELEY, G. 1922. *A new theory of vision and other writings*. New York: E. P. Dutton.
- BERTELSON, P. & RADEAU, M. 1981. Cross-modal bias and perceptual fusion with auditory-visual spatial discordance. *Perception & Psychophysics*, v.29, n.6: 578-584.
- BOLTER, J. 1991. *Writing space: The computer, hypertext, and the history of writing*. Hillsdale, NJ: Erlbaum.
- CAMPBELL, R. 2001. *Studies in reflecting abstraction*. Philadelphia: Psychology Press.
- CHEN, Y. & YEH, S. 2009. Catch the moment: multisensory enhancement of rapid visual events by sound. *Experimental Brain Research*, v.198, n.2: 209-219.
- DRIVER, J. & NOESSELT, T. 2008. Multisensory interplay reveals crossmodal influences on ‘sensory-specific’ brain regions, neural responses, and judgments. *Neuron*, v.57, n.1: 11-23.

- FISH, J. 1993. *The cognitive functions of the sketch*. Cheltenham, UK: Cheltenham & Gloucester College of Higher Education, CAD Centre internal Report (May).
- GIARD, M. H. & PERONNET, F. 1999. Auditory-visual integration during multi-modal object recognition in humans: A behavioral and electrophysiological study. *Journal of Cognitive Neuroscience*, v.11, n.5: 473-490.
- HARRIS, R. & Wolf, G. (Ed.) 1998. *Integrational linguistics: A first reader*. New Orleans: Louisiana State University.
- KLEMMER, S. R.; HARTMANN, B. & TAKAYAMA, L. 2006. How bodies matter: Five themes for interaction design. *Proceedings of Designing Interactive Systems: DIS 2006*, 140-148.
- McCONKEY, J. (Ed.) 1996. *The anatomy of memory*. Oxford: Oxford University Press.
- MINSKY, M. 1986. *The society of mind*. New York: Simon and Schuster.
- MONGE, P. & KALMAN, M. 1996. Sequentiality, simultaneity, and synchronicity in human communication. In: Watt, J. & VanLear, C. A. (Ed.) *Dynamic patterns in communication processes*: 71-91. Thousand Oaks, CA: Sage Publications.
- O'LEARY, A. & Rhodes, G. 1984. Cross-modal effects on visual and auditory object perception. *Perception & Psychophysics*, v.35, n.6: 565-569.
- PAUL, C. 2007. The database as system and cultural form: Anatomies of cultural narratives. In: Vesna, V. (Ed.) *Database aesthetics: Art in the age of information overflow*: 95-109. Minneapolis: University of Minnesota Press.
- PAULESU, E.; HARRISON, J.; BARON-COHEN, S.; WATSON, J. D. G.; GOLDSTEIN, L.; HEATHER, J.; FRACKOWIAK, R. S. J. & FRITH, C. D. 1995. The physiology of coloured hearing. A PET activation study of colour-word synaesthesia. *Brain*, v.118, n.3: 661-676.
- PIAGET, J. 1977. *Recherches sur l'abstraction réfléchissante*, Vol. I & II. Paris: Presses Universitaires de France.
- SAMS, M. & IMADA, T. 1997. Integration of auditory and visual information in the human brain: Neuromagnetic evidence. *Society for Neuroscience Abstracts*, v.23: 1305.
- SEAMAN, B. 2007. Recombinant poetics and related database aesthetics. In: Vesna, V. (Ed.) *Database aesthetics: Art in the age of information overflow*: 121-140. Minneapolis: University of Minnesota Press.
- SEARCH, P. 2003. The metastructural dynamics of interactive electronic design. *Visible language: Cultural dimensions of visual communications*, v.37, n.2: 146-165.
- SEARCH, P. 2006. The spatial grammar of interaction design: Weaving a tapestry of space and time in multimedia computing. In: Griffin, R.; Cowden, B. & Avgerinou, M. (Ed.) *Animating the mind's eye*: 184-190. Loretto, PA: International Visual Literacy Association.
- SEARCH, P. 2009. A new visual literacy discourse for interactive electronic communication. In: Avgerinou, A.; Griffin, R.; Giesen, J. & Search, P. (Ed.) *Engaging creativity & critical thinking*: 181-188. Loretto, PA: International Visual Literacy Association.
- SEARCH, P. 2011. Defining a sense of place in interactive multimedia design. In: Avgerinou, M.; Search, P. & Chandler, S. (Ed.) *Visual literacy in the 21st century: Trends, demands, and capacities*: 143-148. Chicago: International Visual Literacy Association.
- SEARCH, P. 2015. Interactive multisensory data presentation. In: Marcus, A. (Ed.) *Proceedings of HCI International 2015: Design, user experience, and usability* (Part II): 363-373. Cham, Switzerland: Springer International Publishing.
- SPENCE, C.; SENKOWSKI, D. & RÖDER, B. 2009. Crossmodal processing. *Experimental Brain Research*, v.198, n.2: 107-111.
- SRINIVASAN, R. & HUANG, J. 2005. Fluid ontologies for digital museums. *International Journal on Digital Libraries*, v.5, n.3: 193-204.
- STEIN, B. E.; LONDON, N.; WILKINSON, L. K. & Price, D. P. 1996. Enhancement of perceived visual intensity by auditory stimuli: A psychophysical analysis. *Journal of Cognitive Neuroscience*, v.8, n.6: 497-506.

- STEIN, B. E. & STANFORD, T. R. 2008. Multisensory integration: Current issues from the perspective of the single neuron. *National Review of Neuroscience*, v. 9, n.4: 255–266.
- TURKLE, S. & PAPERT, S. 1993. Epistemological pluralism and the evaluations of the concrete. In: Harel, I. & Papert, S. (Ed.) *Constructivism*: 161-192. Norwood, NJ: Ablex Publishing Company.
- VROOMEN, J. 1999. Ventriloquism and the nature of the unity assumption. In: Aschersleben, G.; Bachmann, T. & Müsseler, J. (Ed.) *Cognitive contributions to the perception of spatial and temporal events*: 388-394. New York: Elsevier Science.
- VROOMEN, J.; BERTELSON, P. & de GELDER, B. 1998. A visual influence in the discrimination of auditory location. *Proceedings of the International Conference on Auditory—Visual Speech Processing (AVSP'98)*: 131-135. Sydney, Australia: Causal Productions.
- VROOMEN, J.; BERTELSON, P. & de GELDER, B. 2001. The ventriloquist effect does not depend on the direction of deliberate visual attention. *Perception & Psychophysics*, v.63, n.4: 651-659.
- VROOMEN, J. & de GELDER, B. 2000. Sound enhances visual perception: Cross-modal effects of auditory organization on vision. *Human Perception and Performance*, v.26, n.5: 1583-1590.
- WEINBREN, G. 2007. Ocean, database, recut. In: Vesna, V. (Ed.) *Database aesthetics: Art in the age of information overflow*: 61-85. Minneapolis: University of Minnesota Press.

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