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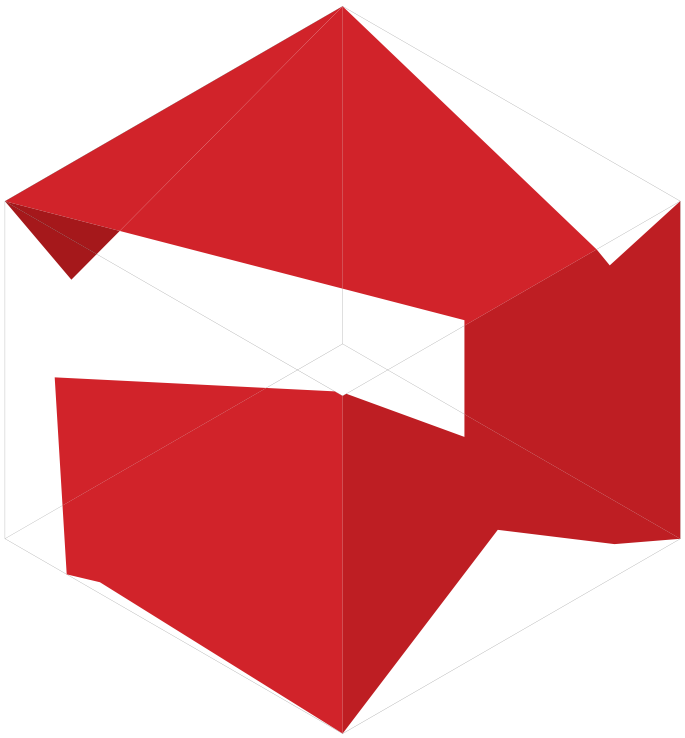

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Aura:
Wearable Devices for Non-verbal Communication between Expectant Parents

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Abstract: Aura is a set of wearable devices to enable non-verbal communication between expectant parents. The project investigates possible aesthetic experiences as alternative applications to biometric monitoring. It aims to overcome the current situation in which the pregnant woman is seen as mainly, and merely, as either a patient or a "blessed body". Medical staff and potential users were interviewed as part of the initial analysis. Based on the outcome of that phase of research, we designed a service embodied in two devices: a garment for the expectant mother and a bracelet for her partner. Fetal movements are translated into a 'light message' for the mother-to-be and into a 'haptic message' for her partner. The simultaneous connection of both partners enhances the emotional messages transmitted by the devices. The relationship is participatory, and the actions of both partners shape the conversation.

Keywords: Fetal movements, design as research, pregnancy, evocative communication, wearable computing, biometric monitoring

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Aura: Wearable Devices for Non-verbal Communication between Expectant Parents

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Introduction

Prenatal technologies, such as ultrasound, may assist in the forecast of possible fetal disorders. Though clearly helpful, such technologies underline the medical aspects of pregnancy, framing its context in hospitals and similar institutions. The pregnant woman tends to be reduced to being a patient: "the Western medical model has viewed women's reproductive activity as pathological" (Nash, 2007). Moreover, the "medical gaze" [5] objectifies a power relationship that can shape the behaviours of a mother-to-be. Finally, "the use of, and dependency on technology, can make the woman feel further diminished. Because a machine is looking inside her uterus, her ""personhood" is by-passed" (Côté-Arsenault et al, 2009). This project tried to establish a more balanced relationship between the pregnant woman and the other active participants who took part in these monitoring trials to explore alternative applications of biometric monitoring. The emotional side of communication is a key factor between parents-to-be. Though inspired by the "critical design" approach (Dunne, 2006), the project does not occupy its most provocative side. It focuses on potential users' needs and desires, leaving room for imagination. Ambiguity was chosen as an opportunity to provide aesthetic experiences that could be "intriguing, mysterious, and delightful" (Gaver et al, 2003).

Scope and motivations

From the beginning of the project, the main focus has been on how bodies can provide data that can become the basis for improving emotionally meaningful experiences for the users. Moreover, the project was driven by the desire to design devices defined by physical interactions rather than on screen. Within this context, new opportunities for biometrical monitoring were explored, moving beyond current applications - mainly for medicine and sport.

A focus on the emotional side of communication shaped the design process. As a result, blurred, and slightly ambiguous designs, especially in terms of interactions, were the most appropriate for this project. In this way, it is possible for the users to explore several nuances of emotions, being emotionally and physically involved in the creation of meaning for their communications.

Theoretical background

In terms of design theory, this project is inspired by the Critical Design approach and attempts to provide new perspectives on peripheral needs and desires. In particular, this project explores and addresses complex emotions: the challenge was to give room for imagination, going beyond the rationale of logic and efficiency. In this sense the project tries to reach an aesthetic experience in order to provide a "material tale" (Dunne, 2006), as an alternative to the assumption that "rationality and reality have become synonyms in an industrial society" (Dunne, 2006). *Aura* explores evocative communications and interactions between reality and imagination. Driven by a poetic attitude, the project uses ambiguity as a design tool. In this sense, the characteristics of the relationships involved in this project offered a fertile ground for experimentations.

Physiology

Even if the main aim of the project has never been related to mere medical issues, collaborating with medical staff was particularly helpful in two ways. On the one hand, it helped us realise the types of products and services currently available on the market and which kinds of needs they are designed for. On the other, it made it easier to explore which psychological and emotional aspects of the pregnancy experience are not commonly addressed in medical

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facilities. For this information, we thank Dr. Sante Tosetto, Chief of the Obstetrics and Gynecology Department, Castelfranco Veneto Hospital, near Venice.

User research

In order to unveil possible latent demands, we dedicated part of the project to user research. The methods we used integrated field research with desk research of the sociology of pregnancy. The first part of the user research was developed ethnographically in order to disclose stories and desires from expectant couples. The research included participatory interviews with six people: one raised in Spain, three in Italy and two in the UK. During the field research, it was possible to distinguish patterns of behaviour for three main types of relationship: one-to-one, one-to-few and one-to-many. The most relevant for this project was the one-to-one relationship with the partner, followed by a one-to-few relationship, in which close friends and relatives acted as an "audience".

Three findings emerged from the interviews. Firstly, pregnancy is highly affected by medical schedules: just one manifestation of the power of the medical field over pregnant women and their partners. Secondly, a pregnant body, irrespective of the woman's level of comfort, becomes a "biological spectacle" for "nonpregnant" people (Balsamo, 1995). Thirdly, the conceptual distance between the couple changes significantly when pregnancy begins: in terms of time and place (couples tend to avoid staying separated for too long) and, in terms of emotional perception (only one is carrying the baby). The desk research involved comparative ethnographic methods, as well as a framework of liminality and surveillance. Specifically, the concept of the pregnant woman as an "important body" (Tsipy, 2009) was seen as a cross-cultural paradigm. In this sense, the expectant mother is seen as either: potentially in danger, or as a person in need. The framework in which this trend takes place was recognised in the liminality of the pregnant body: the woman is not usually perceived as an holistic entity with her baby, but as a sort of temporary container for a potential new life. Finally, it was possible to recognise, as is dominant in western countries, the perception of medicine as a normative agent that disciplines the timing and behaviours of pregnant women. The aim of the project was to reframe the context in which pregnancy is perceived and to explore alternative values attached to it. The main references for the desk research were Balsamo (1995), Tsipy (2009), Côté-Arsenault et al (2009) and the Foucauldian perspective of Nash (2007).

The dress design

Figure 1 (left) / Figure 2 (right)

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The project is designed for expectant mothers and their partners from the 25th week of pregnancy. Beyond the spatial distance between the two people, it unveiled a gap in the emotional and perceptual sides. *Aura* aims to let people explore that gap in order to discover different modes of communication and connection.

The concept that led the design process was to enhance explorative and evocative communications between the couple, set in an everyday experience. Given the theoretical foundations and the findings in the field, it was decided to design a service, embodied in a dress and a bracelet, which focused on evocative communications between parents-to-be.

The idea of a dress was to provide a comfortable and engaging experience during pregnancy. The design includes two stretchable elements: the first around the breasts, welcoming the growing morphology of the pregnant woman; the second on the lower abdomen in order to provide comfort and support to the belly (Figure 1). The display evokes a subtle form of communication caused by the diffusion of light on silk. It is sewn at the top and bottom, while the sides are left open: in this way the mother can have a more intimate, seamless and warm perception of her body. The concept of the dress was embodied in an actual prototype, which takes also the role of an archetype for other possible versions which were conceived in order to fit different contexts of use.

At a glance, the idea of visually representing fetal movements on a dress might seem to contradict the premise of breaking the frame of the mother as the carrier of a newborn. However, with this dress, the mother-to-be is re-empowered by the possibility of choice. From the status of an object of surveillance by medical equipment, she becomes an active subject that can decide for herself whether or not to display what is happening within her body, and to whom. Futhermore, within the idea of liminality, the dress acts as a tool to enhance the power of social relationships against medical technology. Both the one-to-one relationship with the partner and the one-to-few relationship with the “audience” are meant to foster a human bonding that counterbalances the authority of technology. This project takes advantage of fashion mechanisms in order to turn the role of the mother-to-be upside down. Thanks to the pride of wearing the dress in front of a small number of people (with the control to gain their attention) the expectant mother becomes active in the performance of her pregnancy. Finally, the feedback encountered during the final tests confirmed that the objectives of the design were achieved.

The bracelet design

In order to achieve the most suitable interactions and feelings, according to the concept of the project, the design of the bracelet involved an iterative process. As a result, the bracelet includes two small vibrating motors embedded in white silicon rubber (Figure 2). The shape of the bracelet provides a clear indication of the motor placements. Additionally, the object is includes a temperature sensor that activates the bracelet when it is worn, and a force sensor senses the responsive touch of the partner. Much effort was spent in developing a texture for the bracelet which enabled a soft touch sensation. The final result is a compelling combination of texture and vibrations giving a blurred, almost tickling sensation.

Interactions 1: The fetal movement

Fetal movements trigger the motor that initiates interactions between the expectant parents. There are four main reasons: it is a sign of good fetal health; it is a discrete signal providing a definite timing to the event and fluency (Löwgren, 2005) to the service; it is quite easily detected (Borges et al, 2010), providing a bonding effect for both parents-to-be; and, as shown in Figure 2, the final bracelet prototype caressing the abdomen when the baby moves, is a familiar gesture. Even though medical issues were not the core focus of this project it is worth discussing some unexpected outcomes. Fetal movements can be fully recognised from the 25th week of pregnancy (Valle, 2004). Statistically, the risk of a miscarriage from the 12th week is extremely low (Tong et al, 2008). This means that the possibility of needing to deal with such a loss while using the dress is relatively rare.

Nevertheless, if this happened, there is very little room for intervention from the. Moreover, measuring fetal movement is highly recommended (Valle, 2004) by physiologists to pregnant women, and this design promotes such a behaviour.

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Finally, from a psychological perspective, the focus of the project was not in dealing with the first mutation of the pregnant body, but more specifically with the second phase of the pregnancy - with issues such as body acceptance, self-image, public-image and bonding.

Interactions 2: The conversation

The user research highlighted two interesting points: the current lack of possibilities for physical communication between partners, especially relating to the modification of the female body; and, ways in which the pregnant body communicates through its mere presence. The "spectacle" of the pregnant body might embarrass pregnant women when the types of communication involved cross the border of private and public.

The design choice was then to provide a means to re-empower the pregnant woman through an enhanced role in this "spectacle", and at the same time to cast a public sign in a private code.

In this project, if the mother-to-be caresses her abdomen when the baby moves, a series of LEDs light up on her dress depending on her hand's position. This message is translated and sent wirelessly to her partner's bracelet causing a slight vibration. If the partner decides to take part in the "conversation" by grasping the bracelet, a pulsing vibration - whose intensity is proportional to the fetal movement - is echoed in a pattern of lights on the mother-to-be's dress. This light constellation follows the hand's movements. When one of the partners decides to conclude this shared moment, both devices fade out gently.

Interactions 3: The relationship dynamics

The relationship dynamics shaped by the interactions of this project rely on three keystones: the relationship between the partners can be recognised as being "do ut des" (give to receive). The expectant mother both shares her experience with her partner, and enables the partner to show involvement in the relationship, increasing the level of bonding and receiving attention usually restrained by temporary absences.

Secondly, the nature of the conversation is momentary. Depending on their own situation, each partner can decide whether to continue the emotional conversation - just as, in a more familiar situation, we must decide whether to take a phone call which interrupts a face-to-face conversation. This evaluation, of course, is not necessarily conscious. Nevertheless, the behaviours suggested by the design are more subtle than a phone conversation, and would let the couple maintain their own communication channel.

Finally, both the visibility of the dress and the peculiar shape of the bracelet work as means for validating "parents-to-be status" to one another and on a social level.

The prototype

Two devices were prototyped in order to test and refine the interactions. Since non-hospitalised fetal movement detection is still a developing field, we decided to make use of the piezoelectric sensor technology developed by Luis Borges and his team at Universidade da Beira Interior, Portugal (Borges et al, 2010). The display element was the main focus of our prototype. The dress prototype uses 16 LEDs fixed inside a "fabric sandwich", organically arranged. To lend elegance to the garment and to achieve a compelling visual effect of diffuse lights, the external skin is made of silk. The sandwich is sewn into the dress, allowing room for its wearer to caress her abdomen without touching the LEDs. Caressing prompts contact with 16 force sensors. In this prototype they are handmade: two layers of metallic tape are glued on fabric and separated by a layer of carbon-impregnated black polyethylene film. This allows the system to set a threshold and detect whether or not the mother-to-be is caressing her womb. The bracelet is made of non-allergenic, atoxic white silicone, with a one-button, shaftless, vibromotor and a force sensor.

User test

In this phase the garment and the bracelet are working prototypes and their archetype role is indicated by their simplified shapes and the use of black and white. Possible scenarios were filmed and shown to potential users to test the project concepts with expectant parents. In fact, the intrinsic characteristics of the dress - the size of the dress in particular - were a strong impediment to testing the actual outfit with several different users. Creating more than one working prototype was not a viable option due to time, scope and budget.

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Nevertheless, thanks to the short movie, the interviewees were able to project themselves into a scenario where the project is already mass-produced. Their reactions suggested that women would be proud to "show off" their pregnant status, especially if they could decide when it would be appropriate. In this sense, the purpose of using vehicle of fashion in order to persuade them into a proactive and somewhat provocative role of the pregnant woman was achieved. The woman took an active role in the "biological spectacle", deciding whether or not to highlight the peculiarity of her body and her relationships when she's the focal point of social interactions.

Another interesting result was that both partners seemed fascinated by the idea of being able to get closer to their future child through the interactions proposed by this project. In this sense, there was unanimous feedback from expectant parents that the kind of communication proposed couldn't be compared with a seemingly cold medium such as a phone call. Interviewees expected the product would be either bought by themselves or given as a present by friends and close family members.

The aspect which the expectant parents interviewees seemed most sceptical about was the potential negative side-effects of fetal exposure to Wi-Fi. Both expectant mothers and partners stated that this would be a major concern of the project, which would compromise its success. However, interviewees also stated that they perceived electromagnetic fields generated by other devices (e.g. mobile phones and home wireless connections) as potentially more harmful, and therefore they reassessed the potential harmfulness of the project as being mild.

Conclusions

The initial hypothesis of this project was that it might be possible to use digital and communication technologies - traditionally oriented towards efficiency and precision - to design a system to enrich the emotional experience of expecting a baby, particularly for the father-to-be. It was not clear at the outset what kind of system would be appropriate and where it should lie on the spectrum between highly discreet to exhibitionistic. Interviews with medical personnel as well as with expectant parents shaped the initial concept of a system to allow others (father, friends, and family) to sense the movement of the baby and to keep communication between the parents-to-be when they needed to be apart. The first design challenge was to design garments that were light in weight, comfortable for both the man and the woman. As it would most likely be worn all day, the garment required an everyday, non-technological aesthetic. The second challenge was to design a natural way to interact and communicate through a non-verbal language.

Feedback from potential users suggests that the proposed system offers new possibilities in communication, especially by interactions which are highly emotional and evocative. The line taken in the project - informed by the work of Dunne, Gaver and Raby and cultural studies analysis of pregnancy - resulted in a system that satisfied the desires of parents-to-be – a very particular state of heightened emotion which can be difficult for non-parents to imagine. To provide an enriched experience, future developments of the project should involve a more sophisticated prototype, designing the technology as a platform so that it could be applied to different styles of garment. In this first phase the electronics are not entirely integrated into the fabric, for instance, but fabric could be integrated with stretchable circuit boards (SCBs) and sensors. These improvements would amplify the users' physical involvement and stimulate their emotional reactions more deeply.

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Marco Righetto (b. 1985) gained his undergraduate degree cum laude in Media and Communication at Padua University, and published his pre-thesis essay (with Nicola Negrin and Francesco Rossetto) with the Lombardy Institute of Journalists. An enthusiastic video-maker, he has attended workshops with Mike Mills and PES, and shot a mini-documentary shown at the 11th Venice Biennale of Architecture 2008, for CheckIn Architecture. In 2009 he spent six months as an Erasmus student at EINA, Barcelona's art and design school, and was a semi-finalist of the Adobe Design Achievement Award (ADAA) in the mobile design category with *Piscator*. In 2010 he was selected as semi-finalist of ADAA in the mobile category with his project *Madeleine* and spent six months as an interaction designer intern in Fjord Madrid. He graduated in April 2011 in the Masters program in Visual and Multimedia Design, Faculty of Design and Arts, Iuav University of Venice, specialising in Interaction Design. Thanks to his thesis project, *Aura* - a set of wearable devices for non-verbal communication for expectant parents - he was selected as finalist at the ADAA 2011, was a keynote speaker at the Fall Fjord Kitchen event in Berlin (October 2011) and was a selected speaker at Ambience11 in Borås, Sweeden (November 2011). He has been working as an interaction designer in Fjord Madrid since May 2011.

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Gillian Crampton Smith began her interaction design career in 1981, designing and programming a magazine layout application. This prompted her passion for bringing graphic design knowledge to digital design. She taught interaction design at St Martin's, later becoming Professor and Head of Department at the Royal College of Art. In 2000, invited to Italy by Telecom Italia and Olivetti, she set up the research and teaching institution Interaction Design Institute Ivrea, and in 2006, with Philip Tabor, founded and now coordinates the Interaction Design programme in the Visual and Multimedia Communication masters course, Iuav University of Venice. Her collaborations have included Apple Computer, Interval Research, H-Farm and IDEO; she is now a Research Affiliate at MIT. Her career has concentrated on encouraging design students to think innovatively about the potential of digital technologies and persuading companies that design can transcend just problem-solving; she believes that business and academia, in collaboration, have much to learn from each other.

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Philip Tabor studied architecture at Cambridge, where his PhD concerned CAD (computer aided design), and was for many years a partner in Edward Cullinan Architects. He co-founded the Land Use and Built Form Studies research centre (now Cambridge University's Martin Centre) and Applied Research of Cambridge, a company specialising in developing CAD software (later sold to aircraft manufacturers McDonnell-Douglas). He was awarded a Personal Chair in Architectural Theory and Criticism at University College London, where he was the Director of the Bartlett School of Architecture. He taught at Interaction Design Institute Ivrea and, with Gillian Crampton Smith, founded and now coordinates the Interaction Design programme in the Visual and Multimedia Communication masters course of the Faculty of Design and Arts, Iuav University of Venice. He believes that interaction design can and should equal architecture's historic role: to develop and transmit social values and cultural meanings subtly, wittily and movingly.

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