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Developing a User Interface for an Ultrasound Device Designed for Midwives and General Health Practitioners Situated in Low Resource Nations and Communities

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Abstract. As part of the United Nations-mandated Millennium Goals, GE Healthcare wanted to create a compact, robust, and easy-to-use ultrasound that would provide better access to healthcare for mothers in low-resource nations. Vscan Access is an ultrasound device designed for midwives and general practitioners to assess early pregnancy risks for mothers who need it most. Chemistry worked with the GE Healthcare team to conduct ethnographic research in Indonesia, facilitate cross-functional creative workshops with multi-stakeholder teams, as well as developed and executed a complete design and testing of the entire front-end user interface. Vscan Access won the President's Design Award in Singapore in 2016, and is now deployed across numerous developing nations in urban and rural communities around the world. This case study outlines the various challenges faced when developing a product intended for deployment in a mission-critical setting, employed by midwives and general health practitioners with varying degrees of expertise.

Keywords: UX · UI · Design Research

1 Introduction

In response to the United Nations-mandated goal to reduce maternal mortality ratio by three quarters, GE Healthcare was motivated to develop an ultrasound medical device that was usable by the midwives in developing communities. Since 1990, the maternal mortality ratio has been cut nearly in half, and most of the reduction occurred since 2000. More than 71 per cent of births were assisted by skilled health personnel globally in 2014, an increase from 59 per cent in 1990. Globally, there were an estimated 289,000 maternal deaths in 2013¹.

¹ <http://www.un.org/millenniumgoals/maternal.shtml>

Chemistry, a Singapore-based service design consultancy, was appointed by GE Healthcare to conduct detailed research in the Indonesian market, particularly focusing on rural healthcare workers and midwives. Along with ethnographic and qualitative research, Chemistry was also appointed to execute iterative user experience and user interface design, informed by the research conducted in Indonesia. Finally, Chemistry also hosted and facilitated co-creation workshops, which brought together all stakeholders for the first time, in order to outline a development plan for Vscan Access.

The motivation for the development of Vscan Access is primarily articulated by its President’s Design Award citation:

*”Vscan Access is an innovative ultrasound device designed to help health-care workers assess pregnancy risks early and expand quality care to mothers who need it most. With Vscan Access, midwives, paramedics, clinical officers and general practitioners can estimate gestational age and delivery date to help better plan and manage deliveries. They can conduct examinations that may result in early detection of potentially lifethreatening pregnancy complications, and guide critical decisions over the course of antenatal visits. The device wirelessly transfers data to patients, referral facilities or remote experts, ensuring accuracy and efficiency... Singapore-based creative design agency Chemistry was appointed by GE Healthcare to help with end-user research and to plan and facilitate creative workshops with multidisciplinary stakeholders. Through rigorous testing with midwives and general practitioners, Chemistry went on to deliver the complete design of the digital touchscreen user-interface. The depth of the initial field research and the rounds of testing helped the team refine the user experience to a level that made it naturally intuitive to the user. Aspects around consistency of icons, colour and placement of functions on the screen mean that a midwife could use the product almost immediately. The power of the touchscreen was leveraged to present contextually relevant information, thus helping to implicitly guide them through the steps they need to take.”*²

In this paper, we describe some of the challenges and learnings experienced, while developing the Vscan Access device.

1.1 Previous Work

Kimberly et al. found in Zambia that by empowering midwives with obstetric scan training, midwives became competent in conducting basic obstetric scans, and retained these skills for up to six months [1]. Specialised training is required for incumbent ultrasound devices, and this can be costly and time-consuming. The need for an easy-to-use, cost-effective and robust ultrasound device is apparent both from a user perspective, as well as a business opportunity due to the gap in the market.

Kimberly et al. go on to discuss how clinical decision-making and pregnancy management improved, when ultrasound was available to midwives in Zambia. The clinical management of 17% of obstetric cases was changed, particularly

² <https://www.designsingapore.org/pda/award-recipients/2016/vscan-access>

patients with malpresentation and multiple gestations, once ultrasound devices were integrated into the healthcare process. This reiterates the need for ultrasound services for ANC in developing communities [1].

Ross et al. discovered that mobilised mothers would seek four or more antenatal care (ANC) visits. In Uganda, ultrasound implemented in a primary care facility led to both a 72% increase in total antenatal care visits, as well as a four-fold increase in women attending four or more ANC visits [2]. The increasing demand by mothers for ANC services is rising, and the need for competent ANC service providers grows with this need, demonstrates a further requirement for cost-effective and simple-to-use ultrasound devices.

Previous portable ultrasound devices have been developed and deployed in developing communities. Spenser tested one such device in Ghana and found that the challenge was incorporating the device into local medical practices [3].

Portable ultrasound devices have also been tested for pre-hospital emergencies. Busch discovered that prehospital ultrasound when applied by a proficient examiner using a goal-directed, time sensitive protocol was feasible, and did not delay patient management, providing diagnostic and therapeutic benefit [4].

2 Case Study

An ethnographic, qualitative research study was designed and administrated by Chemistry in Indonesia. This was conducted in order to better understand midwives and the mothers they serve in low-resource communities.

2.1 Study Design

The study was conducted in two phases with twelve midwives and six general medical practitioners (GPs) located in a suburb of Jakarta. Phase one included ethnographic, qualitative interviews to better understand the needs and challenges of both midwives and GPs when practicing ultrasound scans within their means, resources and capabilities on-site and also in hospitals.

Phase two of the study took the learnings from phase one, synthesised these insights into a seamless user experience journey for both patients and healthcare practitioners, and prototyped novel user interface and industrial design iterations in the form of click-through prototypes and product mockups, to better understand user acceptability from the point of view of both the medical practitioner and patient experience. Twenty GPs and midwives were subjects for phase two of the study.

2.2 Synthesis & Findings

Several key insights were derived from both phases of the study. From an industrial design perspective, the device could not be a handheld device, as both hands are needed for the interaction with the patient - one to hold the probe

and the other to key in values as well as conduct measurements. The environment that the midwives and GPs worked in demanded a sturdy and durable device, with no flimsy or loose parts that could break or be lost, as often the medical practitioner would not have access to medical facilities and would need to conduct ultrasound testing in the field.

From a user interface perspective, the device interface had to be both intuitive and reassuring. Although most participants had been practising pre-natal medicine for years, they mostly were not used to handling ultrasound devices, or even touch screens, as of 2012/2013 most local Indonesians still used feature phones and Blackberry devices, and medical devices at the time did not use touch screens at all. In addition, the flat design trend promoted by the Google/Android interface language, which also debuted around that time, were not suitable for the target user base, and participants expressed that they preferred the three dimensional mockup of the user interface elements. With this in mind, the team used design language tropes such as drop-shadows and colour, in order to differentiate elements in the user interface.

Finally, the device needed to offer more than just simple ultrasound functionalities. To support their work and make the investment of the reduced but still substantial price tag of such a device worthwhile for participants, additional functionalities like patient records storage was very much desired. However the overall device needed to have a 'no fuss but professional' feel. Participants clearly stated a wish for a professional looking device and interface. Any attempts to give the design a more 'consumer product' look and feel, a more decorative look, or localised look via culturally-biased aesthetics, vibrant colour schemes, etc. were clearly rejected. It was important to strike a balance between an approachable yet professional look, for both the industrial design as well as the user interface.

3 Conclusion

To date, GE has shipped nearly 2000 units, with the product being used in Africa, Asia and Europe. Most of the devices have gone to countries like Nigeria, Ghana, and Ethiopia, where GE has Primary and Referral Care programs, which include training of midwives and healthcare workers to conduct basic obstetrics ultrasound testing using Vscan Access. This enabled task shifting and helped provide much needed antenatal care in rural and other local health centres.

In addition, the product is also being used in labour and delivery wards in Europe, where they use it to check for foetal presentation and position. This is particularly interesting as the original intent of the device was for low-resource and developing communities, however the success of the device has transcended this application into developed markets due to its usability and robustness.

Finally, the research and design implementation was recognised as a success beyond its market performance, by winning the President's Design Award in Singapore, in 2016. As the product continues to be used by medical practitioners around the world, incremental improvements are planned based on real-world usage and feedback.

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