University of Technology, Sydney

A cooperative design approach to the design of interactive devices for small, specialized user groups.

by

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Declaration of Authorship

I, Stefan Lie, declare that this thesis titled, "A cooperative design approach to the design of interactive devices for small, specialised user groups", and the work presented in it is my own. I confirm that:

- This work was done wholly while in candidature for a research degree at this University.
- No part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution.
- When I have consulted the work of others, this is always clearly attributed.
- Where I have quoted from the work of others the source is always given. With the exception of such quotations, this thesis is entirely my own work.
- I have acknowledged all main sources of help.
- Where the thesis is based on work done myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.

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Abstract

This research considers a cooperative design approach to the design, development and implementation of interactive devices catering to small, specialised user groups. Conventional methods of mass production used in the manufacture of interactive devices demand medium to large volume production runs of 10,000 to 100,000 + units for products to remain cost effective. This drives the need for products to appeal to large user groups, which means product implementation catering to small user groups is limited. However there is a need for interactive devices catering to small user groups in industries that require specialised devices to do specific tasks. Such industries include mining, health care and aged care to name a few. Recent advancements in Additive Manufacturing technology combined with the availability of Open Source Hardware + Software offer the possibility to develop and implement interactive devices for low-volume production starting as low as one unit produced. Conventional User Centred Design approaches used in Industrial Design are tailored towards high-volume production, however for small-volume production a cooperative design (co-design) approach may be more relevant.

To investigate this a study was conducted by devising a co-design approach and applying it to the design, development and implementation of an Operator Control Unit (OCU). This OCU was designed to control a semi-autonomous robotic Grit-blasting Assistive Device (GAD) that was deployed on the Sydney Harbour Bridge (SHB). The purpose of the SHB GAD is to remove old paint and rust from the Harbour Bridge steel structure by blasting it with grit. The development of the SHB GAD, including its OCU, is a joint project between Roads and Maritime Services (RMS[1]) and the University of Technology Sydney's Centre for Autonomous Systems. The project was chosen for the study because the SHB GAD is a tool developed specifically for the Sydney Harbour Bridge and is to be used by a small user group of ten users. The study was conducted by designing and developing the OCU cooperatively with five users, who are employees of RMS.

[1] In November 2011 the RTA (Roads and Traffic Authority) of New South Wales, Australia, was renamed RMS (Roads and Maritime Services).

Upon implementation of the OCU resulting from the study, a review of the co-design approach was conducted, by interviewing the five users and asking them to reflect on the process. The results revealed that this research is able to make contributions that will assist in furthering knowledge in this area. Furthermore the results led to a set of conclusions, of which one is that a co-design approach adds value to a project at a personal, team and company level. The resulting OCU was also compared to two commercially available OCUs. This comparison demonstrated, that the resulting OCU could be identified as a robotic OCU even though the users involved in the co-design approach had no previous design or robotics experience. The contributions and conclusions may provide new ways of structuring Industrial Design and Human Robot Interaction approaches to the design of interactive devices for small, specialised user groups.

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Abbreviations

ABS	Acrylonitrile Butadiene Styrene
CAD	Computer Aided Design
Co-design	Cooperative Design
EOD	Explosive Ordnance Disposal
E-Stop	Emergency Stop (button)
GAD	Grit-blasting Assistive Device
HCI	Human Computer Interaction
HRI	Human Robot Interaction
IDE	Integrated Development Environment
IP Code	Ingress Protection rating Code
OCU	Operator Control Unit
PDA	Personal Digital Assistant
PPE	Personal Protection Equipment
RMS	Roads + Maritime Services
RTA	Road Traffic Authority
SHB	Sydney Harbour Bridge
SLS	Selective Laser Sintering
SWAT	Special Weapons And Tactics
UCD	User Centred Design
USAR	Urban Search And Rescue
UTS	University of Technology Sydney
3D	3 Dimensional

Glossary of Terms

Pot-master	Person controlling the supply of grit and compressed air to blast guns (the grit is supplied via large pots, hence the name).
Resistive	Resistive touch screen, reads input signals if pressure is applied.
Capacitive	Capacitive touch screen, reads input signals if an electric conductor such as bare human skin touches the screens surface.
Real-life	Life as it is lived in reality, involving unwelcome as well as welcome experiences, as distinct from a fictional world. In the context of this research the setting of the study is in real-life in that it is a real project and not an academically controlled study.
Dead Man Switch	A safety device that it used by grit-blasting Professionals to safeguard themselves against accidentally being hit by the blast stream of their blast gun.

Technologies utilized to conduct this research

Concepts Unlimited	CAD software used to create virtual 3D models of the OCU housing.
FDM	Fused Deposition Modelling was the Additive manufacturing technology used to manufacture OCU housing prototypes 1 and 2.
SLS	Selective Laser Sintering was the Additive Manufacturing technology used to manufacture the real OCU housing.
Qt Creator	Open Source IDE (Integrated Development Environment) software used to design and code the OCU GUI.
Nvivo 10	Qualitative data analysis software used to analyse interview data.
EndNote X3	Bibliography software used to manage the bibliography, citations and references.