Design process improvement

A review of current practice

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Edited by
John Clarkson and Claudia Eckert

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Foreword

Industry and Academia have worked together for many years on research topics for their mutual benefit at varying levels of engagement on a wide variety of topics, a large proportion of which have been in the pursuit of technology to improve products or manufacturing methods. There is a growing awareness within industry that improvements in people and processes are just as vital for the health of the business.

Good design is fundamental to product success. Consequently there is a great incentive to improve. An understanding of the good practices that are being employed in some quarters and recognition of the opportunities that exist is a good starting point for improvements. There is a view that Industry is not involved in formulating or incorporating the outcomes of design research and Academia is not addressing the needs of Industry.

This book addresses the issues. It provides a wide-ranging review of current academic design research that has been carried out in close cooperation with Industry. It reveals current practices that would be of benefit to those concerned with design in its widest context. It also highlights areas where further research would be beneficial.

This is a timely contribution in the drive to understand and improve the design process, which is so vital to business success.

G E Kirk, RDI
Chief Design Engineer,
Engineering Fellow,
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Preface

The process is important! I learned this lesson the hard way during my previous existence working as a design engineer with PA Consulting Group's Cambridge Technology Centre. One of my earliest assignments involved the development of a piece of laboratory automation equipment for a major European pharmaceutical manufacturer. Two things stick in my mind from those early days – first, that the equipment was always to be ready for delivery in three weeks and, second, that being able to write well structured Pascal was not sufficient to deliver reliable software performance. Delivery was ultimately six months late, the project ran some sixty percent over budget and I gained my first promotion to Senior Engineer.

At the time it puzzled me that I had been unable to predict the real effort required to complete the automation project – I had genuinely believed that the project would be finished in three weeks. It was some years later that I discovered Kenneth Cooper's papers describing the Rework Cycle and realised that I had been the victim of “undiscovered rework”. I quickly learned that project plans were not just inaccurate, as most project managers would attest, but often grossly misleading, bearing little resemblance to actual development practice.

I was proud of my well-structured subroutines founded on a well-structured programme architecture. So why did the equipment that had worked perfectly in the laboratory behave so badly when installed on the customer's site? I had fixed numerous ‘bugs’ prior to delivery in response to a barrage of performance tests and observed the customer using the equipment without fault. However, I now know that it is generally accepted that as many bugs that you find prior to delivery you are likely to leave in the code.

A few years later I was asked to lead a team to develop an automatic control system for a prototype firefighter training simulator to be delivered to the Royal Navy. This was a hugely complex undertaking with many seemingly conflicting requirements, the need to use unproven technology to create the simulated environment, and a typically robust fixed-price contract. Despite these challenges we delivered a system with over five hundred inputs and outputs on time, to budget and with only four minor software errors reported in over ten years of use.

John Clarkson
Reader in Engineering Design,
Director, Cambridge Engineering
Design Centre

I have often reflected on the differences between these two projects in order to understand the reasons behind their widely differing outcomes. The ‘products’ were evidently different. Whilst the simulator development was undoubtedly more complex than the earlier automation project, it was commercially and technically far more successful. The key, it appeared, was the design process.

At the start of the simulator project I realised that I would personally have to demonstrate the integrity of the control system – a complex mix of hardware and software to control propane gas burners, smoke generators and fans in an enclosed, dark space – before it could be adopted by the Navy instructors. The simulator was to be designed to provide a safe, controllable, realistic and environmentally friendly training environment for the trainees and their instructors. Given the failure of my earlier programming attempts, these requirements focused my attention on acquiring the necessary skills to complete such a project.

I undertook training in structured software analysis and development (SSAD) techniques and applied this to the task at hand with liberal doses of risk identification, analysis and control, driven by a rigorous Ministry of Defence quality master plan. Half of the project was spent understanding the requirements, ten percent on coding the software, and the remaining forty percent testing the resulting system.

I learned many things from this experience. First, that active risk management is critical to the successful development of a complex product. However, on its own it is insufficient. There is a need to identify and characterise critical components or systems within a product and to actively manage the interfaces between them. This provides a reference point for communication of the product architecture and its associated functionality, and a basis for continuous risk management. Second, that risk management and interface management have also to be integral to the management of the design process. The risk of not achieving project goals can be as important as the risk of not achieving technical goals. There is equally a need to identify and characterise critical activities within a design process and to manage the interfaces between them.

My fascination for the design process has grown from these early experiences and inspired much of the recent research in the

Engineering Design Centre at the University of Cambridge. There is always room for improvement in design. Maybe there is a need for a better product, or for a better, more effective and economic, design process – the late delivery of new products has been shown to be the single largest contributor to the loss of company profits in the UK. Our own experience of working with automotive, aerospace and healthcare companies has shown that effective communication, management of change and process planning are all essential ingredients for an effective product development process.

This book aims to develop an understanding of these issues as a means to facilitate design process improvement. Part I contains a series of review articles written by a team of international experts on models of design, perspectives on design, design practice and design management. Part II provides an introduction to the wealth of academic research on these topics by presenting the activities of research centres from around the world.

This book is for:

- design managers and business leaders who want to improve their company design procedures
- designers who want to know how to design more efficiently
- researchers who want to explore the field of design process improvement.

It is intended to be used as a reference resource to provide an introduction to the key issues currently facing design practitioners and researchers – further reading is suggested through the many references to other resources. In addition, I hope that the descriptions of the research centres will encourage design practitioners to explore the benefits of collaboration with the research community. Together there is much potential for understanding and improving the design process as a means to ensuring continued customer satisfaction and commercial success – the process is important!

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