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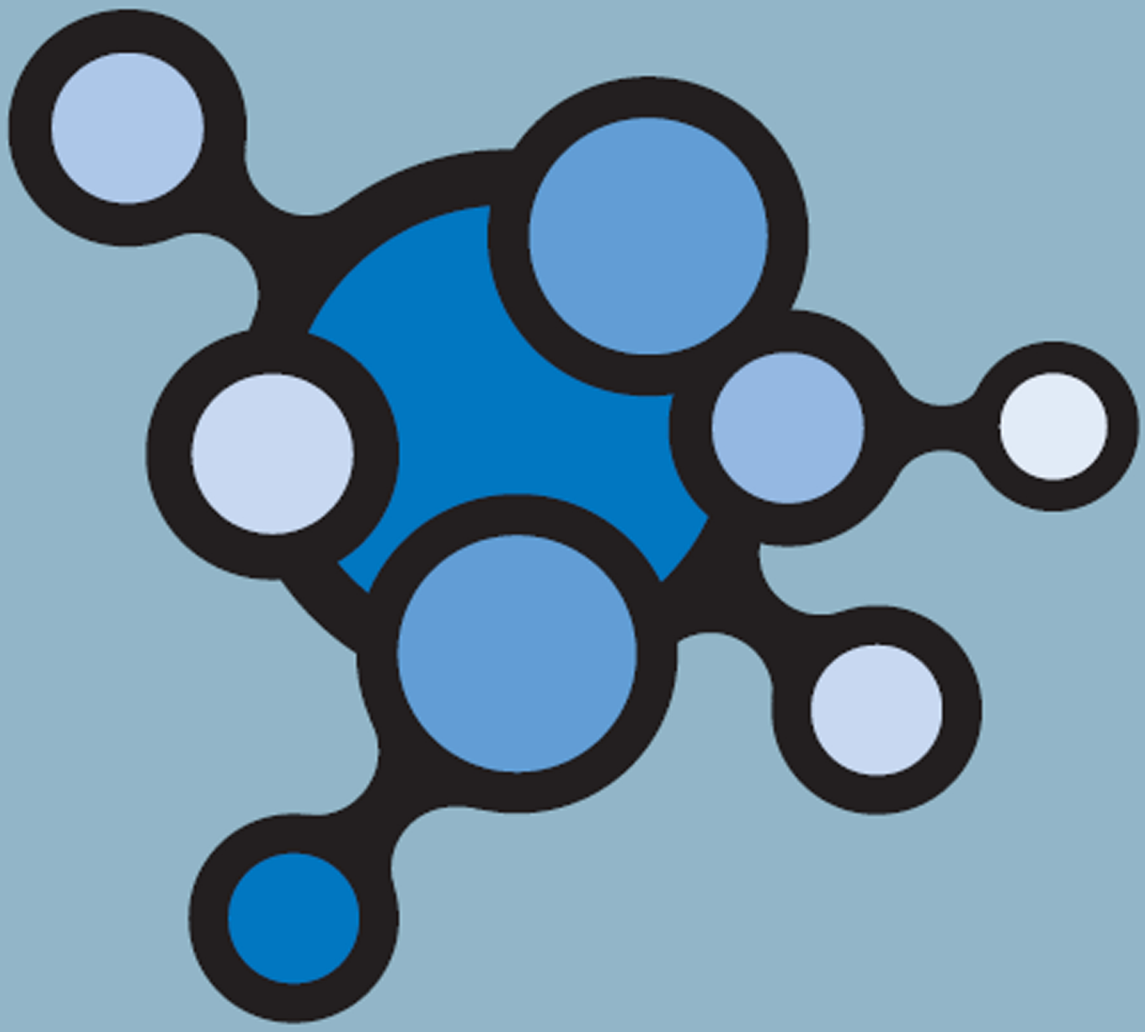
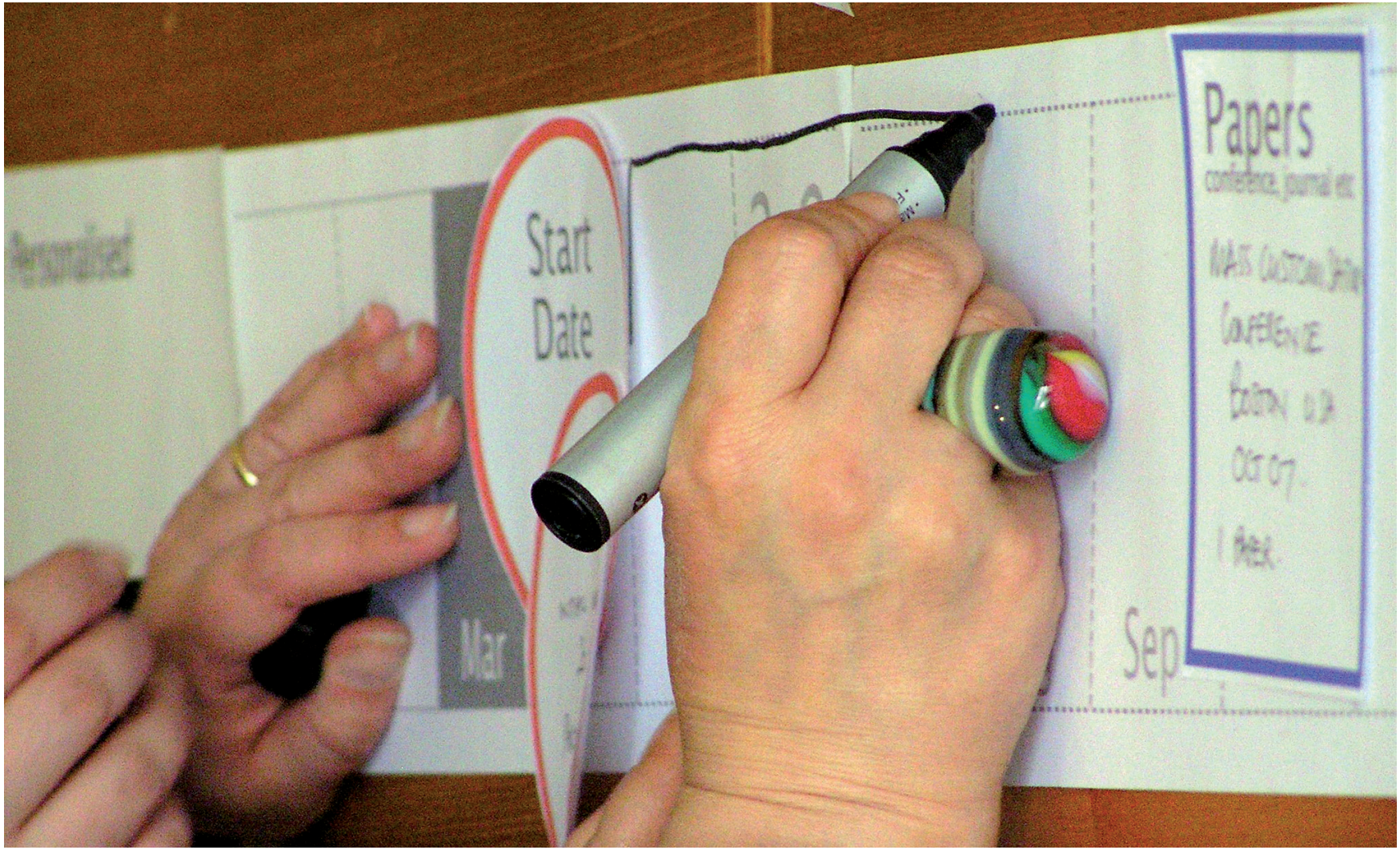
Designing for the 21st Century

Interdisciplinary Methods and Findings

Edited by Tom Inns



Designing for the 21st Century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Dedication

This book is dedicated to Archie, Fergus and Ruby Inns and Isobel Wylie – four explorers born into the 21st century.

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Acknowledgements

We have a database which lists over a thousand people who have engaged with the Designing for the 21st Century Initiative, as project participants, as part of the process of commissioning and managing projects and as enthusiastic supporters of the ideas and concepts developed through the research. Each should be individually acknowledged; we have space below to name a few.

The Arts and Humanities Research Council (AHRC) and Engineering and Physical Research Council (EPSRC) must be thanked for their commitment to the Initiative. Over the last five years as Initiative Director I have learnt a great deal about the complex role that the UK Research Councils play in lobbying, co-ordinating, facilitating and nurturing research on behalf of the UK academic community. These tasks are undertaken by a surprisingly small team of dedicated individuals: the Designing for the 21st Century Initiative has received tireless support from Philip Esler, Shearer West, Anne Sofield, Simon Glasser, Gail Lambourne, Paul Lansdown, Jake Gilmore from the AHRC and Paula Duxberry, Stan Fowler, Prabhat Sakya, Andrew Clark and Derek Gillespie from the EPSRC. Ably assisting the Research Councils have been all those from both academia and industry who have contributed to the peer review of project proposals, commissioning panels and evaluation of outcomes.

The Initiative has benefited from the input of an inspired Advisory Group (Stuart Walker, Bill Gaver, Alan Short, Stuart MacDonald, Stephen Scrivener, Fiona Lettice, David Humphries, Andrea Siodmok and Geoff Kirk) enthusiastically chaired by Rachel Cooper. Rachel has been a delight to work with; she has the rare gift of helping initiate ideas, giving others headspace to develop them whilst always being accessible for wise counsel.

David Kester, Lesley Morris, Mel Taylor, Ruth Flood and Ursula Davies from the Design Council have played a key role in supporting Initiative events and helping locate a future position for design research within the UK.

The 20 teams that used Phase 2 Research Project funding to explore different facets of designing in the 21st century must also be thanked. Hopefully you will find their work an inspiration. For this book they have taken the time to reflect on their projects, often in a very candid open way, to help maximise the insights that might be drawn from their work.

I would also like to thank all of those at my own institution, the University of Dundee, who have supported my contribution to the Initiative, particularly Cathy Brown, Caroline Peters, Steve Brogan, Georgina Follett, Mike Press, Seaton Baxter and graphic designers Dave Herbert and Gary Gowans.

Producing this book has been made easier with a great editorial team at Gower Publishing. Many thanks to Fiona Martin, Gillian Steadman and Jonathan Norman.

Finally, it is Initiative Co-ordinator, Vicky Hale, who must be acknowledged as the driving force behind the production of this text. She will always remember the summer of 2009 as being the one when she stared at pages and pages of text, living in the world of jpegs, dpi, attachments, deadlines and edits.

Both Vicky and I thank our loved ones for their support during this 21st century journey. Big hugs for Justine, Archie, Fergus and Ruby from me and for Gavin and Isobel from Vicky.

Prof. Tom Inns
Initiative Director
Designing for the 21st Century

Preface

'Once you enter its world Design becomes a passion.' I said this in the Preface to the first volume produced as a result of the AHRC and the EPSRC research funding Initiative 'Designing for the 21st Century'. Here we have the second volume, the results. This clearly illustrates the comprehensive nature of 'design', the richness, and the depth and breadth of design research.

Having campaigned for 25 years for academia, industry and research funders to recognise the contribution that design, designers and design researchers make to improved global wellbeing. I am so pleased to have been able to promote and support this programme and to follow the work of the Initiative Director Prof. Tom Inns and the research teams, guided by the wisdom of an eminent advisory group.

The chapters in this book are testament to the dynamic change that is occurring in design research. Design has never recognised discipline silos, and designers and design researchers have always crossed boundaries, stepped into other disciplinary realms to create solutions to problems, to challenge orthodoxies and to innovate. Previously this has been undervalued by government, industry and academia, but this Initiative has provided a formal funded opportunity to enable this to happen and to prove its value.

The research orchestrated by, through, and around design has included researchers from the arts, sciences, social sciences and humanities, addressing most of the issues and problems facing contemporary society – notably sustainability, the environment, inclusivity, accessibility and all aspects of socially responsible design, as well as the pervasive technology that is dominating our now digital world. The research undertaken moves from measuring the value of design internationally, and visions of the

future for the design industry, through service design, design and complexity, metadesign, considerate design and fashion, to democratising technology, branding places, making better workplaces and learning spaces, into the digital and virtual worlds and our interaction with them.

However, there are two predominant themes in the book, the first being 'people and teams' – almost all the research has involved large multi-disciplinary teams. It has also involved workshops. . . and more workshops – workshops with other disciplines, with users, industry and policy makers. The second is 'doing design', through making prototypes, testing prototypes, visualising tools and systems. This is not surprising; the reason why we are passionate about design and design research is because it is essentially, I believe, about working with people to improve our world.

It has now been recognised that individuals or single disciplines cannot address the challenges that face us in the 21st century. We must change our notions of research especially in academia; many research teams now need to be interdisciplinary or indeed what some people call 'post-disciplinary'. This can be a challenge to some, not to design; the research reported here illustrates the value of design research in providing cohesion, orchestration, systemisation, visualisation and innovation and in leading our approach to solving problems and creating the future.

I congratulate the research teams and especially Tom, and Vicky Hale the Initiative Co-ordinator, who have inspired and encouraged the teams towards their individual goal, while understanding and promoting the overarching Design for the 21st Century landscape. This book is a testament to that work. We all now need to ensure that it continues.

Prof. Rachel Cooper
Chair
Designing for the 21st Century Advisory Group

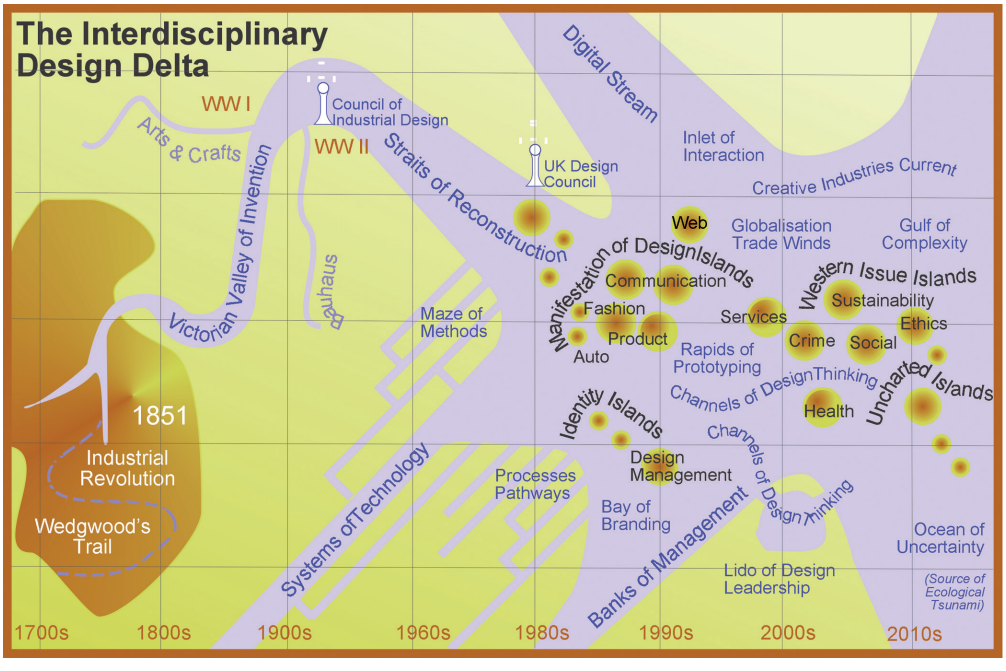

Figure 1: Finding relationships between the 41 research projects supported by the Designing for the 21st Century Initiative is complex. To make sense of this broad portfolio I often think of each project as being a research ship within The Interdisciplinary Design Delta shown above.

The delta construct is based on my personal educational and professional design experiences. For me, this river starts in the Victorian era, its source being the foothills of the Great Exhibition of 1851 (of course, design could start much earlier). The river of design runs through the Valley of 19th Century Invention and into the 20th century, continually fed by design movements and philosophies. More recently, fed by developments in digital technology, production and greater understanding of business, we see the design river expand into an interdisciplinary design delta. Within the delta, design finds a home in the Manifestation of Design Islands, being applied to products, textiles, communication materials and to new areas such as services. We also see the emergence of the Currents of Design Thinking; by this I mean the application of a design approach (design skills and design process) to the way business and society makes decisions, creates value and generally innovates. In this form, design potentially has applications in many new areas and so within my map we see the Channels of Design Thinking flow around the Western Issue Islands, potentially creating solutions for issues associated with health, terrorism, crime, education and an ageing population. Ultimately, the Interdisciplinary Design Delta then heads for the future and tips into the Gulf of Complexity and the Ocean of Uncertainty.

Each of the projects described in this book can be thought of as a research ship making a journey through this Delta. Different journeys have used different charts; many have crossed paths; on occasions ship's crew have been shared. Some expeditions have helped chart the waters around a particular island; others have speculated on how the currents of design thinking might impact on an issue or what might lie upstream.

Prof. Tom Inns, August 2009

Introduction

Prof. Tom Inns, (Duncan of Jordanstone College of Art and Design, University of Dundee)

Welcome to the second book describing projects that have been undertaken as part of the Designing for the 21st Century Research Initiative. The first book was published in December 2007 and tracked the work of 21 research cluster projects that were supported by Phase 1 of the Initiative funding.[1] This second volume describes the work of the 20 project teams that were supported through Phase 2 of the Initiative's research funding.

[1] INNS, T. (ed.), 2007. *Designing for the 21st Century: Interdisciplinary Questions and Insights*. Aldershot: Gower Publishing.

This introductory chapter provides a guide to the material within the book. This starts with a brief overview of the Designing for the 21st Century Research Initiative: its history, aims and structure. The generic format of all the chapters is then described, followed by a summary of each contribution and a brief rationale of the chapter sequencing. The introduction concludes by suggesting key lessons that might be learnt from the Initiative as whole. This is achieved by reflecting on progress made against all three of the Initiative's key aims and describing future strategies that might fast-track the realisation of future opportunities.

Overview of the Designing for the 21st Century Research Initiative

Academic research in the UK is supported by seven of the research councils, each covering their own portfolio of disciplines and subject interests. The councils provide the university sector with research funding through a mixture of research grants and studentships. Historically, much of this funding has been made available through responsive mode support (individuals make a direct application to the research council that funds research in their discipline). Increasingly, however, funding is also directed into strategic programmes. These are themed (usually around issues of government and sector priority) and are often interdisciplinary, being

supported by more than one research council.[2] The Designing for the 21st Century Research Initiative is an example of a strategic programme. The programme was conceived in 2002, as a response to growing policy interest in the creative industries[3] and out of recognition that many of the design challenges facing society in the 21st century require investigation through interdisciplinary research.

[2] RCUK, 2009. *RCUK Annual Delivery Plan Report*, 2008–09 Swindon: Research Councils UK.

[3] DCMS, 2001. *Creative Industries Mapping Document 2001*. London: Department for Culture Media and Sport.

The AHRC and EPSRC each committed £3.25 million to fund the Initiative activities between January 2005 and December 2009. The total budget of £6.5 million was split between two phase of research. £1 million was used to fund the Phase 1 research cluster projects; £5.5 million was used to support the Phase 2 research projects. The Phase 1 research cluster projects were reported in the first Designing for the 21st Century book mentioned earlier. This book reports on work completed as part of Phase 2 of the Initiative. Across both phases of activity the Initiative had the following aims:

- To help build a new diverse research community with a common interest in 21st century design.
- To help stimulate new ways of design thinking to meet the challenges of designing for 21st century society.
- To help support leading edge design research that is reflective, socially aware, economically enterprising and internationally significant.

Phase 2 research projects

The Phase 2 research call documentation was drafted during the second half of 2005, this was informed by the community of researchers engaged with Phase 1 research cluster projects. In November 2005 a two-day workshop with 75 members of this community helped define the profile of the Phase 2 research call and the criteria that might be used for project assessment (one of the first times that a research council programme has actually been designed through a participatory design process).

The Phase 2 call was announced in January 2006. The aim of this funding was to support substantive interdisciplinary research projects of 12–24 month duration. Funding of up to £400,000 was available for each project. In April 2006, 65 proposals for Phase 2 research funding were submitted. Following a detailed process of peer review over the summer of 2006, a commissioning panel met in September 2006 to consider project applications. Table 1 provides a very brief overview of each of the 20 Phase 2 research projects, more detailed information is available at www.design21.dundee.ac.uk or by accessing the relevant URL in column 4 of the table.

Project title	PI	Institution	URL
Considerate Design for Personalised Fashion Products	Prof. Sandy Black	University of the Arts	www.consideratedesign.org.uk
Branded Meeting Places	Prof. Richard Coyne	University of Edinburgh	http://ace.caad.ed.ac.uk/branded
Practical Design for Social Action	Dr Andrew Dearden	Sheffield Hallam University	www.technologyandsocialaction.org
DEPtH: Designing for Physicality	Prof. Alan Dix	Lancaster University	www.physicality.org
Embracing Complexity in Design	Prof. Jeffrey Johnson	The Open University	www.complexityanddesign.net
Inclusive New Media Design	Dr Helen Kennedy	University of Leeds	www.inclusivenewmedia.org
Designing Services in Science and Technology-based Enterprises	Lucy Kimbell	University of Oxford	http://designingforservices.typepad.co.uk
Stress Computation, Visualisation, and Measurement	Dr Wanda Lewis	University of Warwick	http://go.warwick.ac.uk/design21
Design Synthesis and Shape Generation	Dr Alison McKay	University of Leeds	www.engineering.leeds.ac.uk/dssg
Design Scoreboard	Dr James Moultrie	University of Cambridge	www.designscoreboard.org.uk
The Welcoming Workplace	Prof. Jeremy Myerson	Royal College of Art	www.welcomingworkplace.com
People-centred Computational Environments	Prof. Ian Parmee	University of the West of England	www.ip-cc.org.uk
Designing for Affective Communication, Personalisation and Social Experience	Prof. Chris Rust	Sheffield Hallam University	
Bike Off 2 – Catalysing Anti Theft Bike, Bike Parking and Information Design	Adam Thorpe	University of the Arts	www.bikeoff.org
Emergent Objects	Prof. Mick Wallis	University of Leeds	www.emergentobjects.co.uk
Democratising Technology	Lois Weaver	Queen Mary, University of London	www.demtech.qmul.ac.uk
2020 Vision – The UK Design Industry in 2020	Prof. Alex Williams	University of Salford	www.ukdesign2020.org/about2020.php
Sustainability for Metadesign	Prof. John Wood	Goldsmiths College, University of London	http://attainable-utopias.org
Multimodal Representation of Urban Space	Gordon Mair	University of Strathclyde	http://web.mac.com/raymond.p.lucas/iweb/Multimodlity/Home.html
Realising Participatory Design with Children and Young People	Dr Andree Woodcock	Coventry University	www.coventry.ac.uk/researchnet/d/418/a/2906

Table 1, Summary of Phase 2 research projects

How This Book is Structured

The Phase 2 projects started in late 2006/early 2007 and were completed by the beginning of 2009. Each of the project teams has followed their own individual dissemination strategy, producing conference contributions, journal papers, exhibitions and books for special-interest groups and stakeholders. In addition each team has also contributed a chapter to this book. The aim, in doing this, has been to create a central repository that captures activity across the Initiative's project portfolio, helping signpost the reader to more specialist publications and outputs. The book also aims to provide a reference for readers interested in design research methods and their applicability to different types of design research problem.

Each of the chapters describes the background to the project in question, who the researchers were, how they became involved in the project and what their motivations might have been. The aim has been to try to capture the reality of how interdisciplinary research teams are formed and how they go about the process of negotiating research project activity.

The chapters then describe the approach taken by each team, providing details of the research methods that have been used within each project, where these methods find their origins, how methods have been blended to support an interdisciplinary approach, and, where appropriate, the iterative nature of the research journey – as you read the chapters you will see how methods have often evolved during the course of the research.

Each chapter then concludes with a review of the new knowledge and understanding generated through the project work, locating these insights into contemporary understanding of the topic.

Each one of the research teams has addressed a very different facet of 21st century design. Outlined below is a brief summary of each team's work and a rationale for the sequencing of the chapters.

The book begins with two contributions that look at the current position of design. James Moultrie's and Finbarr Livesey's chapter explores the challenges associated with comparing design capabilities in different countries; in doing this the authors make some interesting observations about the position of design in different parts of the world. The global theme is then taken up in the following chapter in which Alex Williams

et al. explore where the UK design industry might be in ten years' time and how it might respond to potential global challenges and opportunities. Again, this chapter makes a useful contribution to both our understanding of design and the methods that can be used to research the sector.

Lucy Kimbell then examines the role of the service designer, an increasingly significant form of design practice. This chapter profiles many approaches for capturing key aspects of designer/stakeholder interaction for analysis from an interdisciplinary perspective. Sandy Black *et al*. focus on the role of the fashion designer, another under-researched discipline within design's canon, focusing in particular on how fashion might respond to technological change and its environmental responsibilities.

These four descriptions of change and emergence provide a useful preparation for Katerina Alexiou's *et al*. contribution on embracing complexity in design. This presents a framework for unpacking the relationships between design and complexity science – relationships that if pursued bring valuable insights for both disciplines.

The next six chapters all examine how different tools and methods might bring greater clarity to the process of design. Each is located within a particular context, but the lessons have the potential for wide application. John Wood describes metadesign, an approach that allows design to deal with complexity and, particularly, the challenges of sustainability by pursuing principles of synergy between design team members. Joslin McKinney *et al*. then examine the contribution the performing arts can make in catalysing innovation within design. Approaches for encouraging participation are then explored further by Ann Light. She describes how methods from collaborative art practice might allow more democratic discussion of technological change with the groups often most marginalised by it. Richard Coyne *et al*. maintain the focus on technology and people describing interventions that shed light on the interaction between ubiquitous digital technologies and notions of place. The challenges of designing meaningful encounters between individual and content are then analysed by Chris Rust and his team in their project My Exhibition. This chapter provides insights into interdisciplinary collaboration and the issues associated with understanding tacit knowledge and user's value sets. Alan Dix *et al*. develop the theme of human interaction, but in their chapter the focus shifts to understanding the role of physicality within the design process and how it affects the

nature of designed outcomes. Raymond Lucas *et al*. then investigate how multiple sensory modalities can be captured to inform the design process; their research explores the use of tools to support the capture of sensory information in the urban environment, but the approach clearly has potential for export to other areas of design.

The subsequent set of five chapters investigate the role of design in a series of key 21st century social issues. Many research approaches have been used, and all of the work culminates in guidelines and principles for use by future design teams. The first of these chapters describes the work of Jeremy Myerson and Jo-Anne Bichard, whose research is based on evaluation of carefully planned design interventions; this time the aim is to build greater understanding of the workplace needs of older knowledge workers. Their chapter provides a rich description of the many strategies and techniques (from the design stable) that can be used to investigate a key issue confronting 21st century society. Andrée Woodcock *et al*. explore practices used in the design and refurbishment of schools. This work investigates the use of participatory design approaches within this key area of 21st century public expenditure, again with clear reporting of research methods and best practice. Adam Thorpe *et al*. report on how design can be framed as an 'open innovation approach' for dealing with the challenges of bike crime, and once more the description culminates in clear guidelines for others who want to address the this issue within their design work. The next chapter profiles the work of Helen Kennedy *et al*. who explore the use of guidelines in the work of web designers; the research focused on social inclusion particularly, for those with intellectual difficulties, but also tells us a great deal about how designers use guidelines in their practice. Finally, Andy Dearden *et al*. report on the work of a large team who investigated how the capability of social-action organisations might be extended by appropriating and adapting information communication technologies through a design approach.

The final three chapters of the book explore how different forms of computer modelling might enhance the act of designing. Ian Parmee *et al*. describe how a team of researchers drawn from many design disciplines have systematically developed a framework describing the challenges of undertaking conceptual design in a digital environment. The framework provides a powerful platform for framing future research. Alison McKay *et al*. stay with the issue of computer-supported conceptual design, but focus on the challenges and opportunities associated with building better shape recognition and manipulation systems for designers. As with Parmee's work, the approach is novel in the way it takes an interdisciplinary approach to a problem confronting all design disciplines.

The final chapter by Wanda Lewis and John Brew explore the challenges of digitally modelling complex fabric structures, which have widespread application in architecture. She demonstrates how this knowledge base can be readily transferred to support innovation in other areas such as fine art conservation.

Key Lessons

It is useful to reflect on this broad portfolio of work and consider the progress that has been made against all three of the Designing for the 21st Century Initiative's key aims: i.e., research community building, exploration of design thinking and development of leading-edge research.

Research community building

Realistically, the Initiative was never going to deliver one overarching community for design research. Instead, the work has helped groups of individual researchers build new highly productive communities of research interest (often across traditional discipline boundaries). In parallel, new relationships with practitioners have been formed with new approaches to knowledge exchange. From this a great deal can be learnt about the strategies that both individuals and interested organisations might adopt to facilitate community building in the future. To maintain this momentum the following ideas might be usefully pursued.

Locating communities through a topography of design research

It would be extremely useful to capture the topography of design research communities operating both in the UK and beyond. Such a landscape is obviously highly emergent, but there are many established research societies, communities of research interest and networks of publication all with steadily evolving aims and objectives. Initiatives such as Designing for the 21st Century augment these with new communities of interest, often short-lived, convened to address a specific topic of interest. Banking the high-level knowledge generated in these interactions and providing intelligent signposting for interested parties could make a significant impact on development of the design research landscape. Considerable investment is currently being made in building each entity, but less attention is currently paid to locating networks relative to each other. Both activities probably add the same value, yet we are currently blind in our understanding of the whole.

Finding new research partnerships by applying dual thinking to research portfolios

The Designing for the 21st Century Initiative was originally conceived as a platform for nurturing relationships between technological perspectives on design with those from the arts and humanities paradigm; hence the sponsorship from both the EPSRC and AHRC. Many of the projects have negotiated new interactions in this space and offer insights into how different perspectives can be integrated to the mutual benefit of each participant:

- Ian Parmee's work on People-Centred Computational Environments, has, for example, supported '*collaboration of seemingly disparate cognitive disciplines that require a common core expertise*'. The work, which brings together perspectives from engineering, drug design, software engineering, biosensors and graphical design has built a common framework of terminology, issues and research questions for computational environments.
- The team led, by Alison McKay, has worked on Design Synthesis and Shape Generation, taking a generic problem faced by design disciplines from across the spectrum of engineering and design. By applying interdisciplinary thinking, a new visual perspective on the problem of shape recognition and manipulation has emerged.
- The work of Sandy Black involved three fashion design projects reviewed through two modelling techniques taken from the world of engineering. In their conclusions the authors suggest that '*learning generated from the fast-moving fashion industry can be quickly applied to the engineering sector, for which product cycles are longer*'. In parallel, they also describe the benefits a systematic approach from the world of engineering brings to fashion design.

Now we have insight into how these interactions are built and managed it would be beneficial to systematically explore how dual thinking could energise research right across the portfolio of both communities. What common problems confront design in both its technological paradigm and design discipline setting? How could dual-thinking help build new insights for stakeholders from both communities?

Building communities interested in design as a knowledge transfer process

Design has also proved its potential as an integrating theme for researchers from disciplines beyond Technology and the Arts and Humanities. The Designing for the 21st Century Research Initiative has operated at a time of growing interest in knowledge transfer (driven by government policy, which in turn is influenced by the urgency with which many issues confront business and society in the 21st century). Researchers from many disciplines now have an interest in design as a process for translating research needs into research projects and out into relevant applications of knowledge. An understanding of this design approach could be embedded much more widely within the entire research community. Many interesting models for achieving this have been created by Designing for the 21st Century project teams. Adam Thorpe *et al*. describe their approach to catalysing anti-theft design based on an open innovation model. They suggest that '*visualisation of research knowledge (by applying design) helps interdisciplinary synthesis happen. It aids communication and knowledge transfer between disciplines and stakeholders*'.

Building communities that engage practice in design research

Of key importance within much of the Initiative's research activity has been the need to link research with design practice in a meaningful way. In order to improve how design is practised, it often needs to be studied in a real-life context; developments then need to be suggested and evaluated. To capitalise on this research, worthwhile developments then need to be integrated back into practice. Many of the Initiative's researchers report on the difficulties in doing this. In the Design and Physicality project Alan Dix describes how '*Access is always a problem in ethnographies as the idea of being observed can be disturbing*'. In Helen Kennedy's work exploring inclusive new media, the team describe how direct observation of designers was not that revealing and getting direct access was difficult to choreograph.

Within the portfolio of Phase 2 projects many useful strategies have been adopted for overcoming these problems and ensuring that research engages with the work of practitioners:

- Both Dix's and Kennedy's teams overcame problems of access '*by taking practising designers out of the workplace*' through specifically designed workshops.
- In the work of Lucy Kimbell, which examined the role of service designers when working with science and technology-based firms, the research team '*asked* [service design] *consultancies and enterprises to work together for six days over five months, with the designers paid a flat fee for their participation*'.
- Alex Williams worked in partnership with the UK design industry body, British Design Innovation (BDI) when building a 2020 Vision for the design industry. He comments '*Working with the BDI, a design membership organisation, was key in promoting the project to the sector and ensuring significant levels of participation from designers*'.
- Jeremy Myerson's and Jo-Anne Bichard's exploration of the Welcoming Workplace was steered by an '*expert group comprising academics and industrial partners*'. Working with key stakeholders from the project outset allowed outputs such as design guidelines to be endorsed by leading industry bodies – all strategies that integrated the work of the team with that of design professionals.

Central to all these projects is a sense of co-creation, with the research team working with the practice base in an integrated way. The examples suggest that building a research community that can co-create in this way requires:

- A considerable investment in time. All of the project teams working in an integrated way with practitioners had long-standing relationships with their partners. There needs to be investment in building relationships between the research base and those engaged in practising design professionally (as a precursor to research project partnerships).
- Finding appropriate ways to use research funding to support co-creation. There is a long tradition of academic researchers working in partnerships with large corporations. Working with the creative industries is, however, problematic as most businesses are small. The models suggested above are founded on a true exchange of value between researchers and practitioners.

- Shifting the dissemination culture associated with design research. The academic base is driven by the requirement to publish in peer reviewed formats such as journals, books and exhibitions. This is important as this verifies research quality and codifies research knowledge. New emphasis is needed, however, on disseminating findings in a form that practice can readily absorb (for example, by creating guidelines and workshops). In turn, this can only be achieved by understanding how that practice works and how new knowledge might be most readily exchanged. This is a zone that is ripe for new innovations.

Exploration of design thinking

During the period of the Designing for the 21st Century Research Initiative there has been an explosion of interest in design thinking. In the US, authors, such as IDEO's Tim Brown,[4] regularly discuss the role of design thinking in business. The Initiative's projects have shed light on our understanding of design thinking in two distinct ways: firstly, by reflecting in detail on what some of the core skills and knowledge sets associated with design thinking might be; secondly by providing examples of how design thinking might add value when used as an approach in academic interdisciplinary research.

Unpacking design thinking for the 21st century

The projects have contributed to our understanding of design thinking on many fronts. The Embracing Complexity in Design project has systematically explored design's relationship with complexity science. Many authors have written about this relationship,[5] and the team has provided a bank of outputs explaining these connections. The team led by Alan Dix has explored the whole issue of physicality, the role of prototypes being much discussed in design-thinking literature. A large number of the projects feature descriptions of participatory design – again, central concepts in a design-thinking approach. In this book many examples of practical tools and techniques are clearly described.

[4] BROWN, T., 2008. Design thinking. *Harvard Business Review*, June.

[5] THACKARA, J., 2005. *In the Bubble: Designing in a Complex World*. Cambridge MA: MIT Press.

Interdisciplinary academic discovery through a design-thinking approach

The Initiative has also explored the contribution a design-thinking approach can make to interdisciplinary research in an academic environment. Adam Thorpe *et al*. systematically review this contribution and describe the ways in which design research can, observe, visualise, create briefs, critique, realise, test and evaluate. Having a design-trained research team (or team member) has allowed design-thinking approaches to be used to build bridges between interdisciplinary research perspectives, speculate on future positions and embody research outcomes. This contribution is not surprising, as the role of designers in interdisciplinary situations has been discussed for over twenty years in interdisciplinary business activities, such as new product development, that classically involve engineering, marketing, finance, human factors and production).[6] In the Designing for the 21st Century project portfolio, researchers have demonstrated this contribution in research teams involving a variety of disciplinary partners. Within this zone there is considerable potential for design thinking. UK research funding is increasingly focusing on issues that are of strategic interest to the economy and society – for example, obesity, an ageing population, connected communities, global warming etc. All of these issues require an interdisciplinary research approach that can be facilitated through a design-thinking contribution.

[6] JONES, C., PERKS, H. and COOPER, R., 2005. Characterising the role of design in a new product development an empirically derived taxonomy. *Journal of Product Innovation Management*, 22(2), pp. 111–127.

To capitalise on this opportunity, further articulation of design's potential contribution is needed to both research funders and interdisciplinary research teams. In parallel, design researchers have to build confidence in their skill-set to take on these new roles within the interdisciplinary landscape. Above all, innovative new research relationships need to brokered between discipline specialists and design research facilitators.

The international significance of the Initiative

The final aim of the Designing for the 21st Century Research Initiative was to support research activity that was internationally significant. International interest in the work can be clearly demonstrated at two levels.

Firstly, each of the Phase 1 and Phase 2 research projects has located its activity and findings in an international context through conference presentations and other research outputs (as evidenced by the outputs listed in this book). Some of the research teams have been proactively working with international partners who recognise the significance of the expertise that has been built through the support of the Initiative.

Secondly, there is a growing recognition internationally in the need to invest in design research. The Designing for the 21st Century Initiative provides a useful model of how a programme of design research can be structured at a national or regional level, initially with research cluster projects and then through a process of co-creation (supported by intensive workshop activity) into a phase of substantive research projects. The model is not perfect, and the reflective lessons described in this chapter suggest actions that would enhance the quality, timeliness and impact of a future initiative of this sort. The activity has, however, highlighted the huge potential that further design research investment might bring in addressing many issues confronting society in the 21st century. It will be very interesting to track the impact of this legacy over the coming years.

Design Scoreboard: Development of an Approach to Comparing International Design Capabilities

Dr James Moultrie and Finbarr Livesey, (University of Cambridge)

Background

Design is increasingly becoming recognised as important to national competitiveness. Whilst there are a plethora of mechanisms to measure national performance in innovation and research and development (R&D), no such schemes exist for design. Indeed, design is often subsumed into these schemes, treated narrowly as a component of innovation of a small part of R&D. In practice, however, design can be treated independently and has a wider span, both within firms and for the nation as a whole. This project sought to address this gap, to develop an approach to comparing national design capabilities. The project team brought together a range of perspectives, including accounting, product design, manufacturing, management, fashion and construction to ensure that the outputs encompassed a wide view of design.

Context

The value of design

Since the 1980s there have been a number of landmark studies that have attempted to determine the benefits of investing in design. Most of these studies have taken the firm's perspective. In 1987, Black and Baker[1] examined 'design orientation' in around 60 small engineering firms, using 'company growth rate' as a measure of success. They discovered that 95 per cent of the companies with a negative growth rate made no use of professional design skills. Walsh *et al*.[2] identified a generally positive relationship between design consciousness and success in firms. In 2001 Hertenstein *et al*.[3] also set out to establish the 'value of design' in a five-year study of 51 companies across four sectors. The results indicated

[1] BLACK, C. D. and BAKER, M. J., 1987. Success through design. *Design Studies*, 8(4), pp. 207–216.

[2] WALSH, V. R. R., BRUCE, M. and POTTER, S., 1992. *Winning by Design: Technology, Product Design and International Competitiveness*. Oxford: Blackwell Business.

[3] HERTENSTEIN, J. H., PLATT, M. B. and BROWN, D. R., 2001. Valuing design: enhancing corporate performance through design effectiveness. *Design Management Journal*, 12(3). pp. 10–19.

that the 'design-led' firms outperformed their competitors at a statistically significant level for 12 measures of financial performance (including growth rate, return on sales, return on assets etc).

There have been comparatively few studies taking a regional or national perspective on the value of design. Sentence and Clark[4] surveyed 800 British manufacturing companies to establish the relationship between design activity and economic performance; specifically the impact on profitability, growth and exports.[4] The study concluded that design-intensive firms had a higher proportion of sales in overseas markets and grew more rapidly. However, the model used to capture design expenditure was simplistic and poorly defined. The Danish Design Centre[5] conducted an empirical analysis of the macro-economic effects of design (i.e., firms employing professional designers) and established a clear correlation between '*employment of design and the economic success businesses achieve. . . this is especially marked for companies that adopt a comprehensive approach to design. . . The correlation is so marked that it cannot be disregarded or questioned*.' However, they also noted that design is not the sole contributor to success. Firms using design also tended to adopt a more professional approach to all aspects of their business.

In 2003 the New Zealand Institute for Economic Research (NZIER)[6] compared the competitiveness ranking of nations (from the World Economic Forum 2002) against a 'design-index' derived from the Global Competitiveness Report (GCR). This design-index drew on existing measures within the GCR, including: extent of branding, capacity for innovation, uniqueness of product designs, production process sophistication and extent of marketing. In their study, they identified an almost linear relationship between this compound design-index and national competitiveness – the top 25 competitive nations scored highest on the design-index. However, this approach has methodological weaknesses, both in the selection of criteria for the design-index and also in the potential circularity introduced by the inclusion of the same measures along both axes.

To date, the only reliable national comparison of design is a study of the design sector in Sweden, Denmark, Iceland, Finland and Norway.[7] This one-year research project addressed the Nordic design industry, with individual country reports and an aggregated national comparison. Evidence on the design sector, export success, education and awareness was compared, with recommendations for how the design industry could be more commercially competitive.

[4] SENTENCE, A. and CLARK, J., 1987. *The Contribution of Design to the UK Economy*. London: London Business School.

[5] DANISH DESIGN CENTRE, 2003. *Economic Effects of Design*. Copenhagen: National Agency for Enterprise and Housing.

[6] WALTON, M. D. I., 2003. *Building a Case for Added Value through Design*. Wellington: New Zealand Institute of Economic Research.

[7] POWER, D. and JANSSON, J., 2006. *Nordic Design for a Global Market: Policies for Developing the Design Industry in the Nordic Region*. Oslo: Nordic Council of Ministers.

Existing approaches to measuring national capabilities

There is a strong tradition of measuring and comparing aspects of national competitiveness and economic performance. These comparisons enable changes in the strengths and capabilities of different nations to be assessed. Measurement of R&D and innovation performance in particular has been instrumental in establishing policies and setting national targets for improvement. Some of the better-known scoreboards include:

- **European Innovation Scoreboard:**[8] a comparison of measures of innovation in firms throughout the EU based on survey data. Enables comparison of strengths and weaknesses across EU states on several innovation-related indicators. These indicators draw on data from national statistics and the *Community Innovation Survey*.
- **Value Added Scoreboard:**[9] Value added is a measure of the wealth created by a company and is typically defined as 'revenue from sales less costs of bought in goods and services'. This scoreboard provides a comparison of the top 800 UK firms and 750 EU firms by value added. Values are aggregated to indicate national performance.
- **R&D Scoreboard:**[10] Based on reported spend on R&D from firms and compiled nationally and for comparison across the EU and other nations. The R&D Scoreboard has specifically enabled the development of clearly articulated targets for public and private investment in R&D.

Design ≠ innovation ≠ R&D

These existing scoreboards fail to take sufficient account of the role of design. Design is not the same as innovation or research and development. Nevertheless, design is often viewed narrowly as a subset of innovation and specifically as the 'aesthetic' element of new product development. The *Community Innovation Survey*[11] treats design in a very narrow way, asking firms if they are engaged in 'All forms of design', where design is 'for the development or implementation of new or improved goods, services and processes'.

Similarly, guidelines on accounting for R&D are based on definitions in the *Frascati Manual*,[12] where design is treated as '*an essential part of the innovation process that covers plans and drawings; technical specifications; and operational features necessary for the conception, development, manufacturing and marketing of new products and processes.*' Thus, within the accounting standards, design is essentially viewed as producing drawings within new product development.

[8] TRENDCHARDT, 2009. Available at: <http://www.trendchart.org/tc_policy_infointro.cfm>. [Accessed February 2009].

[9] DEPARTMENT OF INNOVATION, UNIVERSITIES AND SKILLS, 2008a. *The Value Added Scoreboard*. London: Department for Business Enterprise and Regulatory Reform.

[10] DEPARTMENT OF INNOVATION, UNIVERSITIES AND SKILLS, 2008b. *The R&D Scoreboard*. London: Department for Business Enterprise and Regulatory Reform.

[11] NATIONAL STATISTICS, 1996. *Community Innovation Survey*. London: Department of Trade and Industry.

[12] ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, 2002. *Frascati Manual 2002: Proposed Standard Practice for Surveys on Research and Experimental Developments*. Paris: OECD.

It is increasingly apparent that strength in technology development and exploitation is not sufficient.[13] While innovation and R&D are important, many products and services rely for their profitability and value added not only on their physical or functional aspects, but also on the experience they deliver.[7] Design has a wider role in delivering experiences, services, brands, communications and in helping to understand and satisfy customer needs. In addition, design is fundamental in supporting the exploitation of ideas, but it is also important to firms which are not engaged in R&D or which are not viewed as traditionally innovative. This might include sectors such as furniture and clothing[14] or retail, hotels and leisure. The emphasis on exploitation and development of technology is also less relevant to many service-based firms, where creating new brands and experiences is the driver of success. Thus, design is different from both R&D and innovation and would benefit from being treated independently for analysis and international comparison.

Thus, this project set out to address this gap, and sought to develop a 'National Design Scoreboard'.

Approach

Difficulties in measuring design nationally

A common difficulty with studies exploring the impact or effects of design is in defining design. Some studies defined design narrowly, as a subset of innovation or an aspect of product development.[1,5] Other studies provide ambiguous definitions,[2] whereas others still avoid any specific definitions, leaving survey participants to rely on their own view of design.[15] In 2004 Von Stamm noted this ambiguity in studies of design, commenting that, despite much debate over the last two decades, there is still confusion about the boundaries between design, design management and new product development.[16]

A further level of complexity is introduced when investigating national design performance, as responsibility for design often falls between governmental departments. In some nations, design is viewed as supporting technical innovation. In others, it is a part of the creative industries. In the UK for example, the Design Council reports to the Department of Innovation, Universities and Skills (DIUS). However, much of the available evidence for design is collated and provided by the Department of Culture, Media and Sport. Within the DIUS, design is considered as contributing to technical innovation. However, the creative industries in the UK are defined as 'those industries which have their

[13] STRATEGIC DIRECTION, 2005. Continuing concerns over European R&D: ongoing decline in R&D could seriously affect Europe's manufacturing future. *Strategic Direction,* 21(4), pp. 33–35.

[14] DTI, 2005. *DTI Economics Paper Number 15: Creativity, Design and Business Performance*. London: Department of Trade and Industry.

[15] DESIGN COUNCIL, 2006. *Design in Britain 2005–2006*. London: Design Council.

[16] VON STAMM, B., 2004. Innovation: what's design got to do with it? *Design Management Review*, 15(1), pp. 10–19.

origin in individual creativity, skill and talent and which have a potential for wealth and job creation through the generation and exploitation of intellectual property'.[17] These industries include advertising, architecture, the art and antiques market, crafts, design, designer fashion, film and video, interactive leisure software, music, the performing arts, publishing, software and computer services, and television and radio. In other nations, the creative industries are sometimes referred to as the experience industries (for example, Sweden); cultural industries (for example, France, USA, Japan); copyright industries (for example, Canada, USA, Australia); or media and entertainment industries (for example, Hong Kong).

[17] DCMS, 2001. *Creative Industries Mapping Document 2001*. London: Department for Culture Media and Sport.

These ambiguities in defining and positioning design reflects the integrative nature of design as the interface between art and science, the interface between technology and experience, and the interface between a firm and its customers. However, it also results in genuine difficulties in establishing comparable data at a national level.

Framework development and workshop

To measure national design capabilities, it is recognised that there is no single indicator that can provide a comprehensive picture of performance. Thus, it is necessary to explore a wide range of potential indicators.

Following an initial literature review exploring alternative approaches to measuring national capabilities, a framework was developed, based on the concept of a 'national design system', to use as a basis for considering potential measures. This categorises indicators as part of the enabling conditions, inputs, outputs or outcomes [Figure 1].

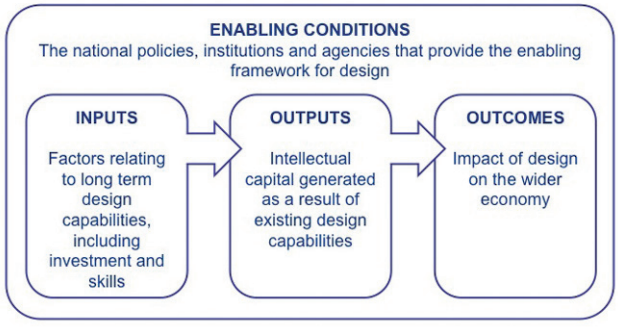

Figure 1, Simplified national design system approach

- Enabling conditions: including national policies, strategies, institutions and endowments. Many national governments are actively involved in design promotion through programmes that promote design to both business (particularly SMEs) and the general public.
- Inputs: the development of human capital relating to design, including design graduates, designers in the workforce and those working in the design sector.
- Outputs: intellectual capital generated as a result of design activity, including design registrations, trademarks and receipt of design awards. Although there is a lot of available data on design registrations and trademarks, it is often difficult to compare, due to complexities in national, regional and global registrations. For this study, values have been collated for registrations through the World Intellectual Property Organization (WIPO), through the EU and also in the USA. International intellectual property registration is complex, and to reflect this complexity, it is necessary to consider registrations from all regions. However, due to space limitations in this paper, data taken from WIPO alone will be discussed.
- Outcomes: reflects the results of the outputs. This is difficult to collate at a firm level, but possible to analyse for the design sector, including design exports and the turnover of the design services sector.

Using this systemic approach, it is possible to identify gaps and trends in the overall performance of the design system, to explore national differences in individual indicators and to comment on the level of transfer from inputs to outputs, and outputs to outcomes.

With this underlying model as a template, potential measures were explored in a workshop with 20 participants from government, the design services sector, academia and industry. Participants were invited as experts in their sector and also as potential stakeholders for the design scoreboard. They were asked to identify measures which would be of use in a national design scoreboard and which would potentially enable international comparison.

As a result of the workshop, around 45 potential indicators were identified, although many were focused at the company level. The extended project team reviewed these indicators and rationalised the list to a set of seven key indicators, which were viewed as important and for which data was also likely to be currently available. These seven are listed, with definitions, in Table 1.

Absolute measure	**Relative** measure	**Comments/issue**
Total public investment in design promotion and support	Public investment in design promotion and support as a percentage of GDP	• Government investment and not investment from the private sector • Difficulties arise in capturing all investment when it is spent on diverse initiatives and also in the different regions of a nation • Thus, this value includes only investment in recognised national or regional bodies
Total number of design graduates	Number of design graduates per million population	• Subjects include: graphic/communication design, interior design, industrial/product design, digital/web/media design, fashion design
Total number of WIPO design registrations	WIPO design registrations per million population	• Although WIPO is only one route for design registration, it indicates an intention to trade internationally and is thus a valid source of comparison
Total number of WIPO trademark registrations	WIPO trademark registrations per million population	• Although WIPO is only one route for trademark registration, it is indicative of an intention to trade internationally and is thus a valid source of comparison
Total number of design firms	Number of design firms per million population	• Design subjects include: graphic/communication design, interior design, industrial/product design, digital/web/media design, fashion design • Employment should include all employees, not just those engaged in design
Total turnover of the design services sector	Turnover of the design services sector as a percentage of GDP	
Total employment in the design services	Employment in the design services sector per million population	

Table 1, Definitions of indicators used in this study