

Introduction: Tools of Design

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“[Tools] exist so that we may do more, see better, gather information, transform things, make decisions, investigate new frontiers, interact more fluidly and precisely, achieve higher forms of aesthetic satisfaction—extend our reach.” (McCarty & McQuaid, 2015)

Tools have been with us as long as humanity; ever since we picked up a stone and used it to crack open a nut. Paleoanthropologist Louis Leakey even considered that “the most significant step that ever was taken in human history, the thing that turns animal into man was this step of making tools to a set and regular pattern” (Meredith, 2011). They are among the first examples of human design (McCarty & McQuaid, 2015) and are integral to how we encounter our surroundings and “attain the results of our imaginings” (Decker in Piedmont-Palladino, 2007).

Tools are the material and intellectual extensions that can augment our physical and cognitive abilities (McCullough, 1998), and, as such, play a crucial role in all aspects of the design process and in various forms. They can be the conceptual frameworks that provide “a vocabulary for constructively intervening in processes of meaning making” (Krippendorff, 2005) or the mechanical machines that help us expand the precision, complexity and scale of our work (Cardoso Llach, 2015). Their manifestation can vary from a general methodological representation of knowledge or processes such as a flow chart (Dubberly, 2004) or even games (Habraken & Gross, 1988) to a specific physical instrument in which certain affordances are embedded (Spier, 1970). Their design and use may be abstract and ad hoc to fit into the early stages of the creative process (Mitchell, 1993) or more structured to integrate into discrete digital programs such as CAD (Loukissas, 2012).

Both for research and design, these tools can act as important catalysts to “realize what did not exist before, to introduce desirable changes in the world, to project the technological, social, and cultural consequences of a design” (Krippendorff, 2005). Being so closely intertwined with our design process means these tools can have paradigm-shifting effects on the insights gathered and designs created. As Culkin (1967) succinctly describes: “We shape our tools and, thereafter, our tools shape us.” In the process of designing tools for something, we learn more about that thing, but also make decisions that shape the outcomes that we—and others who use our tools—produce. Especially today, when computation and digital technologies continue to play an increasingly important role in both society and our design process, how can we understand the potential for change these tools have on our designs and the development of the very tools themselves?

The answer to this question is wide ranging; the present additional Tools of Design track cannot attempt to cover the enormous range of topics that could be discussed, but offers a selection of



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papers that discuss issues very pertinent to design and design research today. The papers range from theory-driven explorations of existing tools used in the design process to reports of more applied investigations of custom designed tools. The authors both draw from the history of the development of certain design tools to understand the impact on the designs we have today, as well as consider how these tools can shape the technologies and designs we create in the future.

1 Developing tools for our design research and creative processes

One of the key parts of the design process is idea generation; gathering and translating insights in a design project into new opportunity areas and potential solutions. In ‘Changes in design research: sources and methods of ideas generation in industrial design’, Ying Sun, Sander Münster and Carlo Michael Sommer interviewed 12 experienced designers to investigate which sources, methods and tools were used, when, why and what influence they had on the resulting ideas. While acknowledging that the real design process is more non-linear and iterative than simply presented in their work, the authors collect a useful overview—and good starting point for further investigation—of the methods and tools used by designers in the idea generation process.

Card sets are one type of tool that is often used to aid the idea generation process, as well as provide summaries of design methods or offer solutions for specific problems. In ‘Card-based tools for creative and systematic design’, Robin Roy and Warren James analyse the history of this tool used in the design process and present a new classification for the use and development of them based on an exploration of 72 such card-based tools. Aware that these tools are often mainly used by those who develop them, the authors trial some of the tools, concluding that the card sets that are more likely to lead to more practical design outcomes for both novice and professional designers are those which summarise domain-specific methods that can be applied to real world tasks.

Lulu Yin and Eujin Pei describe a real-world application of a card-based tool as part of a larger toolkit in their paper ‘A co-experience toolkit: investigating the issues of the pavement environment and the relationship with elderly pedestrians’. As part of their pavement design research, the authors developed a toolkit to aide those involved in the study of urban planning in better understanding the needs of elderly users. Despite having a fairly specific application, the paper presents a useful case study on how to iteratively develop a tool throughout a project.

As the above project demonstrates, in design research it is very important to understand the user’s—often emotionally driven—perspective. In ‘Point of View framework: describing the audience’s emotional connection to information design artifacts’, Soojin Jun examines design strategies that can enrich the user’s emotional connection to information design artifacts. Through applying the framework to two information design case studies, the author demonstrates the potential for this tool and a beginning for providing a metalanguage for researchers and designers to more explicitly describe a user’s emotional connection to information design.

Turning this idea of emotional connection to information back on ourselves, Francesca Mattioli, Silvia Deborah Ferraris, Venere Ferraro and Lucia Rosa Elena Rampino consider the mixture of biases that may be present in interdisciplinary and cross-cultural teams and present a tool to help reveal differences in interpretations in their paper ‘My-bias: A web-based tool to overcome Designers’ Biases in Heterogeneous Design Teams’. The research adds a useful tool to not only a designer’s individual reflective practice, but other fields in which teamwork takes place, and contributes to an interesting debate on the range of team dynamics required for creativity.

2 Tools to understand and design new technologies

The explosion of computation in our lives today has prompted many authors to consider how we research our interactions with these digital technologies and develop tools to reflect on and explore their potential. One such paper is ‘Discovery DiDIY: An immersive gamified activity to explore the potentialities of digital technology’ by Marita Canina and Carmen Bruno. Using game-based tools to

guide participants through experiential co-design activities that help them understand the business and social potentialities of digital DIY technologies such as 3D printing, the authors demonstrate that this more playful approach has an important role to play in amplifying the emotional involvement of the team and creating a fertile environment for lateral thinking.

Another tool applied to understand projects related to 3D printing is presented in the paper 'Annotated portfolios as a method to analyse interviews' by Marita Sauerwein, Conny Bakker and Ruud Balkenende. An important tool used in the design research process is the qualitative analysis of interview data, with many software programs existing to help structure the process. Here, the authors present the addition of annotated portfolios as an improved method for creating more immediately visual analyses of interview data; a tool to help summarise, categorise and represent information about the elements of a design at multiple levels of interpretation.

A project that applies many of the types of tools described above to understanding how teams can better develop digitally connected products is described in 'Developing a Design Toolkit for the Internet of Things' by Ilaria Vitali and Venanzio Arquilla. Despite not yet being fully tested, the authors' detailed description of the toolkit's development provides useful information for both novice and expert researchers and designers developing new Internet of Things based-products.

Another, more experiential and collaborative tool that aims to explore attitudes towards and develop design insights for a new digital technology—this time autonomous vehicles—is described by Arun Ulahannan, Rebecca Cain, Gunwant Dhadyalla, Paul Jennings, Stewart Birrell and Mike Waters in their paper 'The Ideas Café: engaging the public in design research'. Here, members of the public and experts are brought together in an informal cafe setting to discuss issues relating to autonomous vehicles, such as trust in the technology. While similar to other design research methods such as focus groups, the Ideas Café's open and contextually-located approach allowed conversations to move from one-on-one with experts to sharing thoughts with the whole group, resulting in consensus building and excitement to continue participation in future research.

Another approach for understanding and designing the interactions with an autonomous vehicle that used metaphors and enactment to support imagining and sharing conceptual visions was presented in the paper 'Horse, butler or elevator? Metaphors and enactment as a catalyst for exploring interaction with autonomous technology' by Helena Strömberg, Ingrid Pettersson and Wendy Ju. While acknowledging some limitations in the technique, the authors demonstrated through several workshops that their tool can enhance a multidisciplinary design team's creation of interaction designs for certain scenarios related to autonomous vehicles.

3 Integrating computation into the tools of design

As has been written about extensively, computation is becoming increasingly integrated into our design tools (Bernal, Haymaker & Eastman, 2015). These last papers consider the effect these new technologies have on both our designs and our role as designers. In 'A Study on the Roles of Designers Co-Evolving with Tools', Jeong-Sub Lim and Eui-Chul Jung analyse the faculties of designers and assess how they have evolved throughout the history of computer-aided design tools. As well as providing a good overview of the development of computational design, the authors present an interesting approach for considering how our interactions with these tools will change in the future.

Focusing on one area of computational design tools—specifically, graphic design software—Nolwenn Maudet continues this historical analysis of the changing interactions of designers with these technologies in the paper 'Reinventing Graphic Design Software by bridging the gap between Graphical User Interfaces and Programming'. Identifying a gap between the GUI-based softwares that just mimic the skills of the designer and the programming techniques that require coding skills, the author describes how elements called graphical substrates—customisable interactive visual tools—can improve the creativity and user-friendliness of these computational design tools.

The theme of customisation is continued by Viktor Malakuczi, Loredana Di Lucchio, Alex Coppola and Ainee Alamo Avila in 'Post-Series Design: a tool for catalysing the diffusion of personalisable design'. Discussing how the growth of digital fabrication tools enables the creation of one-off and customisable designs, the authors present a tool to support designers in identifying meaningful opportunities and developing conceptual and computational designs for personalisable products.

Inspiration in a designer's creative process is also often a very personal—and increasingly digital—process. In 'Surfing for Inspiration: Digital Inspirational Material in Design Practice' by Janin Koch, Magda László, Andrés Lucero and Antti Oulasvirta, the authors present the results from a survey that asked designers about their practices for finding inspiration material online. While the proliferation of such sources enables designers to collect a large repertoire of potential design solutions, further developing these tools to include additional information related to the initial designer's experience and process could help users to better trust the material and relate it to their own work.

Apart from the online tools mentioned in the above paper, collecting inspiration and synthesising it into new ideas are currently not supported well by computational design tools. In my own paper, 'An Ontology of Computational Tools for Design Activities', my co-author V. Michael Bove and I present a review of computational technologies that could play a role in these tasks. Using a framework that aims to help designers and researchers more easily understand the potential of these new technologies by deconstructing design activities into more discrete underlying tasks, neural networks and stochastic algorithms were found to provide features that could potentially allow for discovering and linking new information together in unexpected ways.

The ocean of information and possibilities opened up to us as designers and researchers by digital tools such as the internet reflect the same vastness that the Tools of Design theme can have. The papers presented here show only a small part of this wide range of research, many of which focus on the new digital technologies that are becoming increasingly integrated into our lives and creative processes. The almost infinite nature of designing tools to help us design better technologies, which are themselves tools, suggests that designers and researchers have tool-making in our DNA. This is the beginning of a conversation that will hopefully grow and evolve, as will our tools of design.

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