PREFACE
"On Making"

Introduction

Ask people about the great breakthroughs in human life and you will hear answers such as "when man made fire" or "the invention of the wheel" or "electricity". All moments where humankind gained more control over their world through something "man-made".

Man is a maker. But even though the act of making in itself seems to be a stable, integral part of our being, *how* we make is far from stable. Moreover, with every new innovation new forms of making have opened up. We base this on the notion that 'making' and 'thinking' are thoroughly intertwined: our tools for making also shape our thoughts about making; we think through our tools and material.

When looking at the tools that have developed over the past few decades it is safe to say that with the advent of and increased access to machines such as the laser cutter and 3D printer, in conjunction with the growth of online and offline maker spaces and platforms, making has changed significantly. These developments have had a huge impact not only on what we make, but also ~~on~~ the entire socio-economic structure of making; notions such as intellectual property, ownership, manufacturing and many more seem to be in need of reinvention. A 'maker culture' is emerging and a focus on making and skills is retaking a presence in society at its broadest. For example, we see a re-appreciation for the skills in education where there is a growing interest in learning by doing and craft schools re-entering higher academic levels.

The new 'maker culture', promoted by Fab Labs, DIY, maker and hacker spaces, is an utilitarian hybrid of software and hardware 'tinkering' that stands far apart from the quality that skilled craftsman of before would bring. Being motivated by self-fulfilment and desire to do good work for its own sake, the makers privilege assembling technologies into physical objects and fabricate new devices. Attention to formal and interactive qualities of the designed objects is not at the forefront of their creations.

The maker philosophy has attracted the interest of professionals, educators, practitioners and the academic community for the informal, open, networked, peer-led and shared learning, for its potential to create new pathways into technology development and for experimenting with a new economic model for growth and innovation that is not based on mass production and long production chains.

This special issue is the result of our on-going interest in the role making within design.

Within design, we see making as a powerful tool for confronting abstract assumptions with the hard reality of our concrete world. Through the interplay between abstract and concrete, analysis and synthesis inform each other, making that the abstract and the concrete develop not in parallel, but thoroughly intertwined. Making informs thinking, and vice versa. This is especially powerful in design, as this

is an activity characterized by the need to make decisions while lacking sufficient information to do so in a fully informed way.

In this we connect to Donald Schön, who has made the argument that 'making' engages the designer in a reflective dialog with the material [1] and thus opens the solution domain to a given design challenge through the hands. Some aspects of design do not make sense to make abstract, for example, those aspects pertaining to the bodily experience of a design: the feel of a button does not came across from the abstraction of a 2D CAD drawing, but needs to be felt [2].

Connecting to this it should be pointed out that 'the perfect feel of a button' is not absolute; it depends on contextual factors, as well as a number of apparently subjective ones. This makes that a designer needs to train his 'sensitivity in buttons' through reflective practice. Richard Sennett [3] discusses this point in his book 'The Craftsman', where he puts forward that any craftsman (not to be confused with artisan) has an inherent drive to become better at his work for the sake of getting better; craftsmen have the drive to deal with ambiguity and resistance in order to improve their sense of nuance and quality, extending part of their knowledge to their hands. To bring together Schön and Sennett, the hand knows what the head doesn't but needs to be shown. Making thus acts as a catalyst of thought.

However, making is of course not restricted to a reflective dialogue between craftsman and object; there can be multiple craftsmen and objects at play. Moreover, the craftsmen involved can be laymen. As such we distinguish three scales of making: (1) the individual maker; making for and by yourself, (2) making in and for each other, and (3) making at a community or societal level.

Below we elaborate on these by giving three examples.

Making by and for yourself - Case Cardboard Modelling

In our first example, we want to illustrate how making by and for yourself has an important role to play in the arena of product design. We do this by means of a foray into a course on cardboard modelling at Eindhoven University of Technology by Joep Frens. First we describe the course and what is taught in it, then we move towards the lessons from the course for students and the reason that we are interested in the activity of cardboard modelling.

The cardboard modelling (CBM) course finds its theoretical basis in the work of Schön [1]. Throughout the assignments in the course Frens encourages his students to engage in a dialog with the material. The CBM course consists of two parts: first, skills in cardboard modelling are taught, after which the course teaches students how to use those skills in the design process. The course starts with strictly prescribed assignments, but over the course this changes towards assignments that require the students to come up with their own modelling solutions.

As said, the first part of the course is focused on skills: first modelling skills, and then exploration skills. By going through a series of 'fixed' models the students get the opportunity to train themselves in the actual basic modelling techniques. In chronological order the students are tasked to make: a cube, a cylinder, a truncated cone and a cube/cylinder combination as well as two small mechanisms. After these

exercises they should make a block with four mechanisms followed by a model featuring an alternative technique that does not require glue. Next is a more open assignment where the techniques are practiced within a first, small design exercise: they make one part of a modular marble run out of cardboard. Thus the foundations in skilled cardboard modelling are laid (Figure 1).

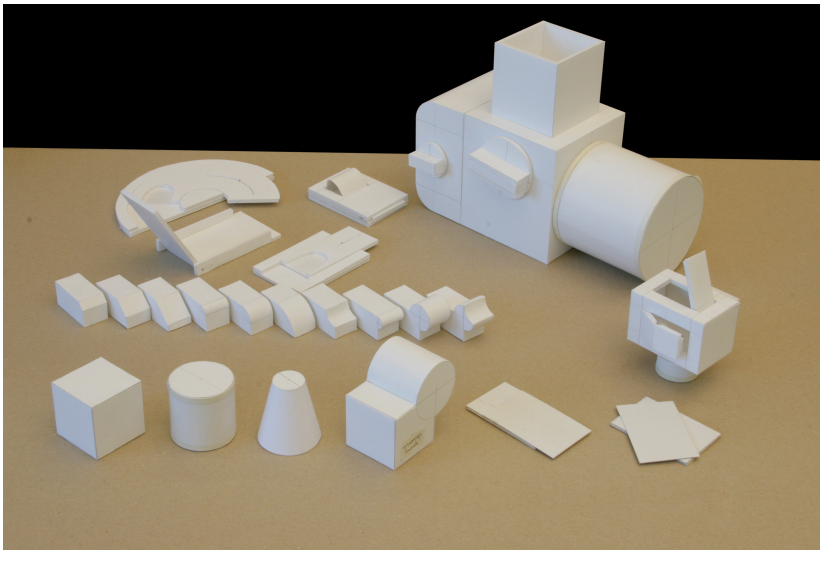

Fig. 1: Result of the skills part of the course (work of Matthijs Kwak)

In the second part of the course the students are asked to explore expressive geometry, in two iterations. They need to create at least three exploratory models in each iteration and they have to do it under time-pressure. After the first iteration the students are asked to present their exploratory models. Using their own models two emergent patterns in their work are discussed: (1) the necessity of scaling down the fidelity of the cardboard models while exploring and (2) the existence of different strategies in exploring (deep and broad explorations [4]). After this they practice these phenomena in a second iteration. In the final exercise the students are asked to design an interactive product and are told to exclusively use the cardboard material for their designerly explorations. In this last exercise they practice the whole range of skills once more; what is more, they go through a range of fidelity levels in their work, i.e., lo-fi models in their explorations that lead to a hi-fi presentation model (Figure 2).

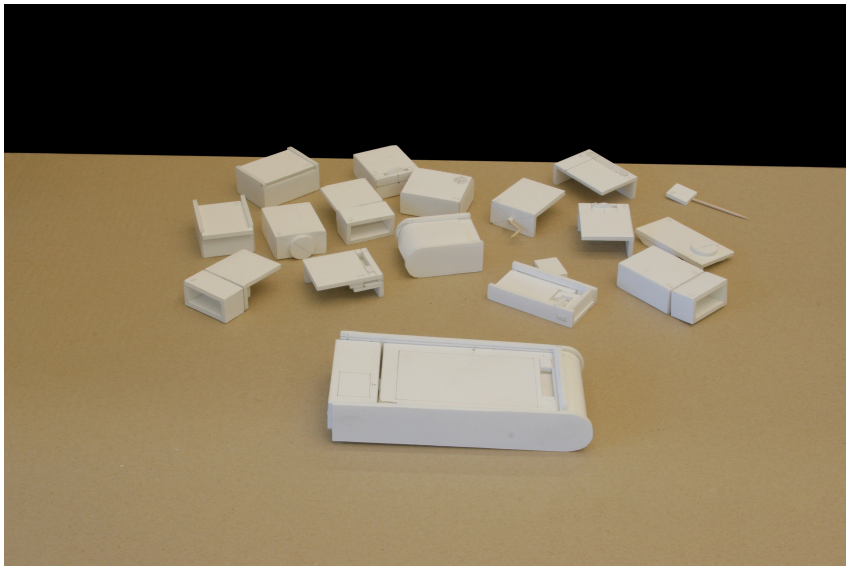

Fig.2: Result of the design part of the course (work of Koen de Greef)

In the cardboard modelling course the students are confronted with a new medium for designerly expression. They are given an alternative for sketching with pen and paper. The reason for this is that Frens believes that explorations in different media are broadening a designers' vocabulary of solutions. Different media give different constraints and thus tickle a designers' creativity in different ways. In order for this to happen a designer needs to master the material. Only when a designer can 'think' with the material is it providing a channel for expressivity.

The cardboard modelling course aims to make students comfortable with a new medium of expression and hence to give them a broader repertoire of skills. As such it shows how the act of making can be a powerful agent in designerly exploration. Cardboard modelling offers the possibility to engage the challenge of designing for interaction in a manner that is more immediate than more conventional sketching techniques on paper that are essentially representing interaction.

Making for and with communities

Our second example concerns making for and with communities. We do this by describing a workshop on everyday rituals.

In 2014, a workshop on the topic of everyday rituals took place at the Eindhoven University of Technology. The aim of this workshop was to address the qualities embodied in rituals from an interaction design perspective, and to explore the relation between the designed artefacts and the rituals they are involved in. This exploration aimed at creating an insight in the reciprocal nature of the influences between the

artefacts and the ritual (and by extension the experiential meanings and the expressed values).

This exploration was made through iterations of making, testing and discussing all details of the rituals, to ensure the perception of values embodied in the ritual, as well as the coherency between artefacts, actions, and meanings [5].

The starting point was the experience of a Japanese tea ceremony, one of the pillars of the craftsmanship in Japanese culture, followed by an extensive discussion with two Tea masters on the topic of the values of the Way of Tea. This provided a ground for the workshop inquiry based on a highly elaborated value system.

The following first series of iterations aimed at creating a complete set to "welcome one's own friends at one's own place". That means the students participation to the workshop aimed at shifting the ritual towards their own everyday mundane world, with their own cultural values and with the intention of welcoming their own friend in their own place. The first deliverable was a low-resolution tea set that could be experienced by the workshop instructor, one of the two tea masters, and a tea connoisseur. The 'low' quality of the resolution connotes the quality of the prototype as well as the ritual. The resolution of the prototype can be characterised by the choice of materials, and structural construction of the set, and the finishing. The resolution of the ritual can be characterised by the refinement of the sequences of actions, the value associated and experienced through the ritual, and most importantly how the artefacts, the actions are contextually consistent and coherent.

Fig. 3: Low resolution exploration on cookies

The second series of iterations aimed at reaching a high resolution of the ritual. All details, artificial ones as well as ritualistic ones, were designed and made. The final ritual was experienced by the same members as in the low resolution one.

Fig. 4: Tidy high-resolution prototype (left), and in use (right)

Each set of iterations were followed by an extensive discussion aiming at pointing out the challenges of designing a ritual, notably the reciprocal influences between the artefacts and the ritual and the implication on the interaction design process. The challenge of this workshop was twofold.

First, experiencing through design that the artefacts, the activities, and the values embodied in the ritual are highly interdependent. Any design decision taken on one of these elements may considerably impact the other elements, which recursively may impact the original design decision. That means that the consequences of any design decision needed to be highly considered, permanently questioned, and discussed throughout the workshop. The complexity between artefact, actions, and values are a major design challenge of designing rituals, and point out the importance and the challenge of reaching an overall coherency. The making appeared to be the only way to validate the design decision taken over time.

Second, the workshop involved 17 design master students who work on one single project. Therefore, next to the challenge of designing for everyday rituals, this workshop was also addressing the challenge of making by a bigger group. 17 students working together required time for discussions (i.e., negotiations) as well as multi-perspective sharing, and finally compromises. Compromises appeared to be necessarily for the coherence of the project and the realisation of the artefacts. For these compromises to be fully inscribed in the process, tasks were divided in the way that (1) any decision needed at least two subgroups of students to be taken, and (2) no set of subgroups could be independent to other subgroups. In other words, all decisions would eventually impact all subgroups. In the case of this workshop, the three workgroups were respectively dealing with the artefacts used exclusively by the

host (e.g., teapot), the artefacts used by the guest (and possibly the host, e.g., guest cups and cup holders), and the structure used to gather all the artefacts used for the ritual (which also was eventually used as the locus where the ritual take place).

Making at societal scale

Our third example concerns making at societal scale. Making is social. The act of envisioning, designing and building together scaffold knowledge and skills.

In this example, educational games were developed in a co-design process that engaged people with different competences, roles and skills in different settings: a university archaeology lab, a fab lab and a primary school [6, 7]. The co-design process evolved in a series of workshops to exploit the local values and making practices, and to embed them in the design process. The design team included MA students in Experience Design from the University of Siena (Italy), a psychologist, archaeologists, designers with digital fabrication skills, school teachers, students of grade five.

Making at the Archaeology Lab. Archaeological findings were made available to participants to share their history and anecdotes on their role in the ancient time. Among others, the findings included: a Roman oil lamp from about 2nd century A.C, found in an excavation in Tuscany, near Piombino (Italy), a bronze coin representing the emperor Marcus Aurelius Carinius (257-285 A.C.) and his wife Magnia Urbica. The coin was probably lost during a trip that Carinius and Magnia Urbica did in Italy. This story stimulated the imaginary of participants who formulated curious and bizarre hypotheses on the coin and the trip. The workshops produced a list of design concepts and requirements of the game.

Making at the Fab Lab. Building on the outcomes gained from the activities at the Archaeology Lab a number of making activities were carried out starting with collages, storyboards, conceptual maps, and paper prototyping and proceeding with 3D scanning of the oil lamp, the bronze coin and potteries, and 3D modelling and printing or engraving of the artefacts. Two games were prototyped: *Archeo* and *Itinerarium*.

Archeo is a modular game composed a 18-piece puzzle depicting the story of a noble family living in Rome in 1527, and a collection of 18 wooden fragments of the replica of a bowl belonging to that family (Figure 5). The actual bowl was found during an archaeological dig and was presented during the workshop at the Archaeology Lab. The bowl was scanned in 3D and the resulting model was then 3D modelled and scaled on the basis of the actual size of the real artefact.

With the intention of creating a game based on handling and assembly of physical elements and building objects, the modelled bowl was “cut” into 18 slices 3mm thick, which could then be assembled. The slices are made of wood, using laser cutting and engraving on a 3mm thick plywood panel. The same technology was then used to make the 18 pieces of the puzzle telling the story that provides the background for the game. The different pieces in the puzzle serve both to reconstruct the story from bowl

to puzzle, or to reconstruct the correct order of assembly of the bowl starting from the puzzle.

Fig. 5: Students playing with Archeo at school

The second game, *Itinerarium* is inspired to the classic Game of Snakes and Ladders (Figure 6). It tells the story of Emperor Carinus and his wife Magnia Urbica as they travel from Germany to Rome, where Carinus is to be crowned Emperor. The game board is a reproduction of part of the *Tabula Peutingeriana* [8], a medieval copy of an ancient Roman road map (about 300 A.D.). The board was created using laser engraving and cutting techniques, and contains a representation of the map and 30 squares representing towns of the day with an imaginary road linking them in order. Players travel from one square to another by throwing two dices and following the instructions in the square they land on. The winner is the player who reaches the square representing the city of Rome first. Underneath the game board, corresponding to the squares, are cylindrical plastic containers, which may contain coins (reproductions of the ancient Roman coin explored during the workshops at the Archaeological Lab) or little sheets of paper. Players seek these items in the square, which provide instructions on how to proceed in the game or may offer trivia and stories about life in ancient Rome. 3 of the 30 squares are interactive, and when a token is placed on one of these squares, it permits reproduction of audio files telling stories linked both with the game and trip, contributing to the narration and development of the game.

An interactive lamp controlling time in the game was also developed from an accurate reproduction of the ancient Roman oil lamp presented during the initial workshops at the Archaeological Lab. During play, each player shakes the lamp after rolling the dices. An internal LED starts flashing with a “soft” fade-in and fade-out effect. The duration of the lighting of the lamp is randomly determined, and the player’s turn is over when the lamp goes out entirely.

Fig. 6: Students playing with Itinerarium at school

Making at school. Making at school consisted of playing and reflecting on the making process. Children tried out the games, learning through play. They were eager to quickly proceed in the games and disappointed when the stories contained difficult words to understand, pronounce and remember. Teachers observed that children were engaged and focused for the whole duration of the game showing a competitive but also collaborative attitude helping each other in case of difficulty. The material qualities of the games were greatly appreciated. Children positively commented about the aesthetics of the game, making questions about history and geography of the game elements. Construction and manipulation were winning aspect that encouraged exploration and also respect of turn taking.

The making of these educational games enabled a co-creation process from conceptualization to materiality that took various forms in the different setting where the design activities took place. Making developed in different societal contexts with their peculiarity, practices and cultural values. This enabled robust scaffolding to participants in generating new ideas, developing contents and fabricating the games.

Multi-perspective view of Making

As these examples illustrate, the views on and roles of making in design are rich and diverse, even within the likeminded collection of guest editors. Moreover, developments in and increased accessibility to tools for making by both professionals as well as laymen may well impact design as a profession, not only with regard to the artefacts that design brings forth, but also with regard to what we know as production chains, distribution, ownership and other socio-economic establishments. Following the Schönian argument posited in the introduction suggests that new making

inevitably leads to new thinking, but given that design is a commercial activity new making will also inevitably lead to new markets, economic models and ways to do business. We have already seen examples of this in areas such as on-demand limited edition book publishing, crowdfunding platforms, online craft stores, and more.

In this special issue we aim to portray a broad perspective on making, bringing together multidisciplinary contributions to give handles on making in the field of design, from different viewpoints. We briefly outline each of the accepted articles below.

The first paper in this Special Issue, "Approaching Makers Phenomenon" by Raul Tabares provides an overview of contemporary developments in DIY, hacker and maker cultures. Tabares addresses the distinctive features of these movements to set them apart, and continues to identify and illustrate three prominent challenges. The first refers to the lack of legislation when it comes to open source, co-owned intellectual property, contrasted by the over-protective nature of many companies when it comes to their IP. Tabares posits that alternative post-capitalist models are required. The second challenge concerns the lack of research on the impact of current DIY, hacker and maker movements; do these actually have an impact at all and how could this be evaluated? The third challenge refers to the establishment of what Tabares calls "Social Manufacturing", a new paradigm in terms of manufacturing and the relationship that has with society, design and the production of goods, based on peer-to-peer production, open source IP and the promotion of informal learning.

The paper "Material Practice as a Form of Critique" by Julian Stubbe provides a perspective on material practice as an alternative to established ways of knowledge production. The paper addresses how engagement with materiality becomes more than cultural expression or learning. Rather being a form of critical thinking, the material practice is seen as a form of critical doing.

The foundation of the argument lies on fieldwork in two projects: the RBO Hand and the Mirage. RBO hand is a robotic hand made of silicon, which explores the subtleties of grasping enabled by silicon and its material properties. The Mirage is a media art installation, which generates a moving laser projection resulting from the transformation of signals of the earth's magnetic field. Both designs were developed in their own technical domains and were subjected to an ethnographic study of their making process. The outcomes show the significant role that engaging with materiality had on the design choices.

From the theoretical foundations and fieldwork Stubbe develops three elements of critical material practice: embodiment and imagination instead of linear progress, performance instead of representation, and allegories instead of symbols which are proposed as heuristics for understanding better how material objects are integral part of social order and how they can take part and re-configure the process of creating knowledge.

The paper "Hacking Things to Making Things" addresses on the democratisation of maker spaces towards non-expert makers, i.e., positioning these spaces as a locus for participatory design communities. The two case studies structuring the argument focus mainly on engaging youngsters (respectively 16-20 years and 6-16 years old for each case) in activities taking place of the maker spaces. Findings point out the importance of creating a favourable context for self-organising communities within the maker space and the importance of meaningful relationships within these

communities. The reading of this paper reminds us again of the importance of the social dimension in learning making and the long-term relationships it demands.

"Making: On Being and Becoming Expert" by Yana Boeva and Ellen Foster is a short paper that offers a critical perspective on expertise in making, challenging the claim that making democratizes "*technology, design and production*". In this it mainly focuses on 'maker spaces' and it takes the position that there are in fact a thresholds to participate in making in this context. The paper points out that expertise is required to engage in making and explains through brief case descriptions that expertise moderates access to such 'maker spaces' in multiple ways. In our view this paper provides an interesting counterpoint to [insert the title of the other paper on expertise here].

In the paper "Community-based business models: Insights from an emerging maker economy", Peter Troxler approaches the topic of 'making' from a very different perspective when compared to the other papers; it explores the business models that emerge in the emerging maker community. After a brief primer on business models it examines a series of startups in the maker community to uncover the business models that are employed. This analysis points out that most of the businesses combine different business models. Next to this the authors find altruism and hedonism to be drivers of business models in these small maker movement businesses. The paper adds to "*the understanding of business models and strategies in non-traditional contexts* […] *here: maker communities governed by peer production principles*".

Making IoT with UDOO by Rizzo, Burresi, Montefoschi, Caporali, and Giorgi presents a prototyping platform, called UDOO IoT, which provides both hardware and software facilities to allow non-expert programmers to develop IoT applications. The perspective on Making promoted by the authors is that User Experience design can play an increasingly important role in the Internet of Things world if the technical complexity can be hidden and the technology simplified for non-expert developers. The authors state that an optimal User Experience is achieved when rapid prototyping and user-centred design are seamlessly integrated into the development process of end-user products. A field study concerning an installation at the Buonconvento Sharecropping Museum is provided to illustrate how UDOO IoT was improved while being used aa a prototyping and making tool in the museum.

In cnclusion

As we described in the introduction and illustrated through our examples, one of the lenses through which we regard 'making' lies in its social dimension: making for and by yourself, making for and by a small group, and making for and by communities. The six articles included in this special issue provide alternative lenses, which, superimposed on our model, create a matrix. We realize of course that in such a superimposition the articles will not fit neatly in individual cells of the matrix, but indicate (future) lines of investigation.

For example, the salient aspects of the articles in this special issue include: (1) the notion of making as critical thinking; (2) the democratization of making, including

tools platforms and toolkits; (3) connected to this, the notion of expertise; (4) making as social practice; (5) the tension between intellectual ownership and business. When addressing these topics through our lens of scale, reflections emerge such as "What does the democratization of making mean for the traditional craftsman, for the composition of maker teams of for the inclusion of laymen in the process?", "Is there such a thing as collective critical making?", or "Do the current models for intellectual ownership and business suffice at the level of the individual, small group or community?"

These are of course only three of the countless reflections that will emerge from the current dynamics in the world of making. Through this special issue we hope to provide a glimpse of these perspectives on making, and to provide inspiration for future research on making for the individual researcher, research groups and our research community.

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