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Engagement strategies within co-making environments bridging spatial and organisational design

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Abstract

Makerspaces and Fablabs are open access workshops that challenge traditional top-down approaches to innovation and workplace design dedicated to creative and innovative practices. Their built environments are the main stage where a complex ecology of stakeholders intertwine. To what extent does the interior design of a space make people more collaborative and innovative? What are the settings and platforms that may affect the way people feel, behave and interact? This paper presents the methodological journey of a PhD study conducted within 18 prominent Makerspaces located in five cities of Europe. The empirical study navigates the blurry boundaries of spatial design and organisational design, and the dynamic strategies employed to unleash patterns and congruencies, assuring the engagement and participation of the population researched. Through a constructive design approach denoted by the use of mixed methods from design thinking and qualitative ethnographic research, a Conceptual Framework is proposed bridging the interdependency of virtual and physical realms.

KEYWORDS: co-making environments, spatial design, organizational design, socially shaped innovation

Introduction

As complex sociotechnical environments, Makerspaces are an epicentre of intertwined subjects and components which are having a profound impact on contemporary society. Social, economic, and technological spheres merge with political and environmental ones, unearthing the intricate problems and pressing issues that pose a challenge to citizens, governments and organisations alike. Understanding human behaviour and the types of interaction that flourish within these physical spaces offers an excellent opportunity to uncover the key drivers that are shaping today's new ways of working and, even more specifically, the future of the workplace.

Innovation plays and increasingly valued role in responding to the demands and uncertainties that we all face in a global, post-industrial world. The establishment of a 'culture of innovation' is a challenge for every institution and organisation. Traditionally, this challenge has been conveyed by specialised people interacting in specialised spaces (Dickel, Ferdinand & Petschow, 2013). Until more recent times, innovation was mostly nurtured inside laboratories, research centres, and isolated R&D departments. In contrast, Makerspaces are identified as shared machine shops, that unite the tools, resources, and know-how within an openly accessible environment, for activities of learning, working and collaborating through participative and heterogeneous processes (Gershenfeld, 2005). They welcome and include a variety of actors and stakeholders – often non-professional and non-commercial – to form a decentralised peer-to-peer network that collaborates outside organizational boundaries (Nuvolari, 2004). Experimentation practices and a hands-on approach to learning by doing is also a common characteristic. Without a hierarchy-driven structure, they are able to successfully cultivate the freedom to experiment, explore, and fail, both individually and collectively (Maxigas, 2012).

Makerspaces are physical embassies of the so-called Maker Movement: a worldwide cultural phenomena characterised by the encouragement of human agency through the cooperative act of tinkering and making (Dougherty, 2012). Its actors proclaim that we are all 'makers', and that tinkering and fixing have always been a common practice of humanity – skills that were passed from generation to generation – until we became alienated by mass production and mass consumption. Post-consumerism values – where people engage in recycling, upcycling, and the repurposing of discarded materials and objects – are part of the daily conversation. The social component manifests itself in the form of open access, where diversity and inclusiveness aim to unite people that are often estranged from digital tools and virtual networks, via workshops and other types of learning activities. As we live in a period of material abundance, we can assume that the movement itself is not stimulated by necessity, but by a genuine need of people to be enriched and fulfilled, with a better sense and control over technology (Dellot, 2015).

Under the branch of the applied sciences, technology has always played a pivotal role in intermediating architectural practices given the incremental evolution of skills, techniques, methods, and processes that shape and define our ever-changing natural world. However, the technological upheaval of the last century has had an unprecedented and profound impact on modern society, and architecture has also been challenged to respond promptly to this ephemeral and shifting scenario. In many ways, our buildings and interiors were not designed to keep a pace with the speed of digital technologies, especially when we analyse the workspace and how new ways of working and social interacting are influenced by the interior landscape.

Many scholars have argued that the value of the Internet is less about information and technology and more about community since it is, more than anything, a tool for interpersonal communication (Negroponte, 1995). Analogously, Makerspaces might resemble community centres – or third-places – where objects, identities and discourses are socially shaped, but where the built environment is also socially shaped as well. Oldenburg (1997) coined the term third-place referring to 'third-party' social environments that differ from the two most familiar and consistent ones: home and work. These spaces are dedicated to the social life of a neighbourhood community, accessible to all, without special conditions of competence for participation and contribution (Oldenburg, 1997). These distinctions are common throughout the evolution of Makerspaces, stretching back to the first open hackerspaces (Maxigas, 2012).

Makerspaces are in essence service-based open areas and, with the diversity of people, needs, and interests of both insiders and outsiders, where their services must transcend the single role of supporting digital manufacturing activities. The 18 field research sites in five European cities illustrate that the built environment of a Makerspace is usually not designed in advance, it emerges and evolves daily as the result of ongoing negotiation between

founders, funders, members and other participants. Parallels between participatory design and participatory making have been the focus of some studies, attesting the shift from a traditional design-before-use approach, to a design-in-use one (Seravalli, 2012). As each independent community is self-regulating, the process of decision making with regards to design varies immensely from case to case. Even though a core characteristic of its practices is to be non-hierarchical, relative order and authority are needed when it comes to interior, mostly because of the costs involved with altering physical spaces, but also because such change will have a serious impact on people's behaviour.

Hypothesis Focus

From the point of view of research focusing primarily on the design and architecture of interiors, what are the specific reasons for investigating the built environment of Makerspaces? Firstly, as stated before, Makerspaces have a bottom-up approach to its construction and set up, a core characteristic of grassroots and peer-to-peer communities. Space usually grows organically, as a result of the participation and appropriation of its regular users, participants and stakeholders, giving purpose to the areas based on usage and demand (Dickel et al., 2013; Kohtala, 2014; Seravalli, 2012). Therefore, the emergent platforms and physical structures found on site are not designed by outsiders or experts; they truly demonstrate members' needs and shared solutions.

Secondly, Makerspaces are all about the hybridization between bits and atoms, between virtual and physical environments. The planning and design of the FabLab model, a worldwide chain of Makerspaces conceptualised at MIT, took place in an already digitalised world, circa 2002 (Gershenfeld, 2005). This gives the concept its edge and uniqueness. The interior design of a FabLab or a Makerspace embrace the properties and features from the so-called digital revolution, it is an organised chaos, non-hierarchical and in constant flux. It is a physical platform with a random diversity of components and participants ready to connect, create, collaborate, hack, remix, and distribute information and knowledge. Just like the Web, more than a fixed platform, Makerspaces are also a network and capable of adopting new configurations to shape new patterns and promote random networking opportunities.

For centuries, workspaces have been places built for collaboration and defined by their furnishings and fittings. Today they are constructed mostly of networks, which do not even require physical proximity. The digital realm became so pervasive and omnipresent that there is now a tension between these two worlds, they coexist, and can no longer be separated. For the participants of this research, the digital workspace became their primary workspace. The physicality of making might ask for a bodily presence and hands-on engagement with tools, people and machine, but most of the time they immerse themselves in small screens and digital arenas. For youngsters, even their social life is primarily digital. In fact, virtuality penetrates every dimension of our life simultaneously, blurring our levels of proximity (Groves and Marlow, 2016).

The preliminary participant observations inside the Makerspaces, following the grounded theory methodology (Glaser & Strauss, 1967; Charmaz, 2000), led to the chief hypothesis of the PhD enquiry: intangible qualities and behaviours from digital workspaces are being transferred and materialised in the built physical ones. In fact, Makerspaces' territories offer great opportunity for investigating this speculation as they present a random synthesis of both worlds. What does it mean to be digital? What settings and layouts resemble digital systems? Are there examples of furniture and furnishings that could serve as evidence? Does the way people use and manipulate the tools and resources available in Makerspaces have any relation to the way they act and behave inside virtual spaces? How can a workspace further embrace and support digital natives, the generation of members that were born into a digitalized network society?

In qualitative research, distinguished by subjective procedures and measurements, a hypothesis is usually not employed or recommended. However, the non-specificity and complexity of Makerspaces as socio-technical environments required an instrument to sharpen the focus, bringing clarity and direction to the research. Having a hypothesis would allow for accurate information to be gathered and discrete characteristics to be observed, enhancing objectivity. The practical outcomes of the research are a consequence of this choice and process. The participants collaborated with insights and analysis to create the Conceptual Framework collectively, and they saw value and purpose in following this path since the first qualitative interviews and focus groups.

Methodology Bricolage

As an emerging field of study, there is still a lack of academic literature and substantiated theory associated with the built environment of Makerspaces. The methodological process chosen can be described as theory building, or constructivist grounded theory, where the author proposes inferences by way of particular instances, involving the construction of theory through the continuous analysis and iteration of data, operating inductively in contrast to the hypothetico-deductive approach (Glaser & Strauss, 1967; Charmaz 2000). The author joined the first Makerspace, FabLab Milano, just two weeks after starting his PhD in Design at Politecnico di Milano, in November 2013. Blending in as a member, not as a researcher, he could garner direct experience of the collaborative social interaction, the hands-on approach, and the non-hierarchical innovative practices that underpin the Maker Movement pledge. FabLab Milano provided the open territory of early observations, identifying the first patterns and congruencies through an iterative process where findings are tested as they emerge and data is analysed as it is collected (Glaser & Strauss, 1967).

Inductive reasoning and open-ended exploratory methodologies proved to be the right choice inside spaces where innovation thrives via random collisions, uncertainty and freedom. Therefore, the strategy and the structure of the research became a continuous work in progress, with a degree of flexibility to adapt to sporadic decisions. Concerning reflexivity, the intention was to give full voice to the research respondents, raising the importance of the qualitative interviews as the primary method of data collection, assuming knowledge, objects and environments are a compilation of their social constructions (Blumer, 1969; Rudestam & Newton, 2007). Symbolic interactionism offered an investigation between materiality and symbology, as the members of Makerspaces build their identities and discourses collectively through their physical objects, social roles and ideologies. The built environment acts as an instrument of self-definition and self-promotion, being at the same time a platform and an outcome of their social interaction through an interpretative process where meanings are continually modified (Blumer, 1969; Strauss, 1978).

Even though the decisions about the overall methodology are logical and, to a lesser extent logistical, they were led by the theory building practice throughout the preliminary observations in the first year, mainly in Milan, London and Paris, due to their urban demographic and geographic importance. Later Barcelona and Amsterdam were added along with short visits to the towns of Turin and Boston, as homes to four of the most significant Makerspaces in the world, the FabLab IAAC Barcelona, FabLab Waag Amsterdam, FabLab Torino and Asylum Boston Hackerspace. In the end, 18 locations granted access to the research (Fig. 1). Other sites were investigated through desk research but were not included in the case studies list, mainly for lacking the fundamental criteria of offering access to participatory research or face-to-face qualitative interviews. The primary case study, Makerversity, in London, was assessed over five different periods, between 2014 and 2017. In total, almost ten months were spent at this particular location with active participatory research, as it offered more complexity by presenting a hybrid model of comaking and coworking settings and services.

Name	City	Walkthroughs Space Analysis	Participant Observation	Qualitative Interviews	Quant. Surveys	Cultural Probes	Number of Interviewees	Number of Visits	Period
FabLab Milano	Milan	X	X	X		X	6	32	Nov-Dec 2013; Fev-Jul 2014
The FabLab Santa Marta	Milan	X	X	X		X	2	12	Sep-Nov 2015; Sep-Dec 2016
Open Dot	Milan	X	X	X			2	7	Oct-Nov 2015; Sep-Dec 2016
Polifactory	Milan	X		X			1	9	Jun 2016; Nov 2016; Apr 2017
FabLab Turino	Turin	X		X			1	2	Sep 2015; Jun 2016
Makerversity	London	X	X	X	X	X	13	127	Sep 2014; Oct-Nov 2014; Apr-Aug 2015; Apr-May 2016; July 2017
Machines Room	London	X	X	X		X	5	16	May-Jul 2015; Apr-May 2016
FabLab London	London	X		X			2	2	Jul 2015; May 2016
Institute of Making	London	X	X	X		X	2	4	Apr-May 2016
MakerCafe	London	X		X			2	8	Apr-Jul 2015
FabLab Carrefour	Paris	X	X	X		X	2	5	Mar 2014; Oct 2015; Mar 2016
Le Nouvelle Fabrique	Paris	X		X			2	4	Mar 2014; Mar 2015; Oct 2015
Usine	Paris	X		X			2	3	Oct 2014; Sep 2015; Mar 2016
FabLab IACC Barcelona	Barcelona	X	X	X		X	2	4	Fev-Mar 2015; Aug 2016
Made BCN	Barcelona	X		X			1	3	Fev-Mar 2015; Aug 2016
Ateneu de Fabricacio	Barcelona	X	X	X			2	4	Fev-Mar 2015; Aug 2016
Makerversity AMS	Amsterdam	X	X	X		X	2	4	Aug 2016; Mar 2017
FabLab Waag	Amsterdam	X	X	X			1	3	Aug 2016; Mar 2017

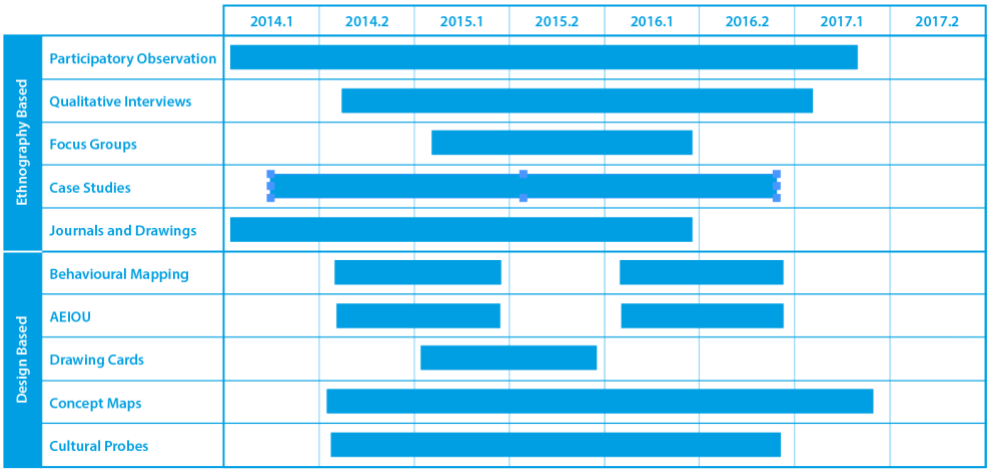
Figure 1: List of Makerspaces with corresponding locations, research activities, number of interviewees and visits.

The methodological decisions followed a 'bricolage' approach, using mixed methods and multiple means and schemes borrowed from the social and behavioural sciences, and also from human-centred and service design approaches through design thinking techniques that are effective in researching complex communities. It is also a trait from the constructive design research, where conceptual scenarios and prototypes can often be used throughout the enquiry (Koskinen & al., 2011). Affinity diagrams, conceptual maps, behavioural mapping, drawing cards, and cultural probes proved particularly important to generate not just valuable data, but mainly motivation and engagement lined up with the typology of the population, which emphasises practice (Fig. 2). Participation in workshops inductions, short courses, talks, breakfast meetings, even parties and happy hours, even though casual and unofficial, was also a source of deeper and accurate data. This intimacy, which naturally developed and grew over the months and years, demanded extra effort and attention so as

not to bias the investigation in some way.

Figure 2: All through the study multiple methods triggered engagement and participation among the sample population. Clockwise: conceptual maps, affinity diagrams, behavioural mapping, cultural probes, AEIOU, and drawing cards.

There was a list of methods at the disposal of the researcher. Data was collected in distinct phases and stages, but forward planning allowed for a large degree of flexibility (Fig. 3). In fact, the particular characteristics of each participant, the opportunities for engagement, such as the time and day that best suited them, and the contextual settings of each location would ultimately define the methods that could be employed. Direct observation, surveys, one-to-one interviews, and focus groups proved insufficient alone in engaging members with the research, helping them to cope with abstract concepts and intangible theoretical attributes, which were also part of the inquiry. The population was mainly made up of engineers, designers, architects, programmers, makers, and artists, characterised by a hands-on practical attitude. To fill this gap between theory and practice the solution was the design and development of several Conceptual Cultural Probes, using the same 3D modeling programs operated by the members themselves. Each cultural probe corresponded to a property of the Conceptual Framework making the intangible conceptions a bit more tangible. Cultural probes became a game changer. The researcher also started to be treated as as a designer and

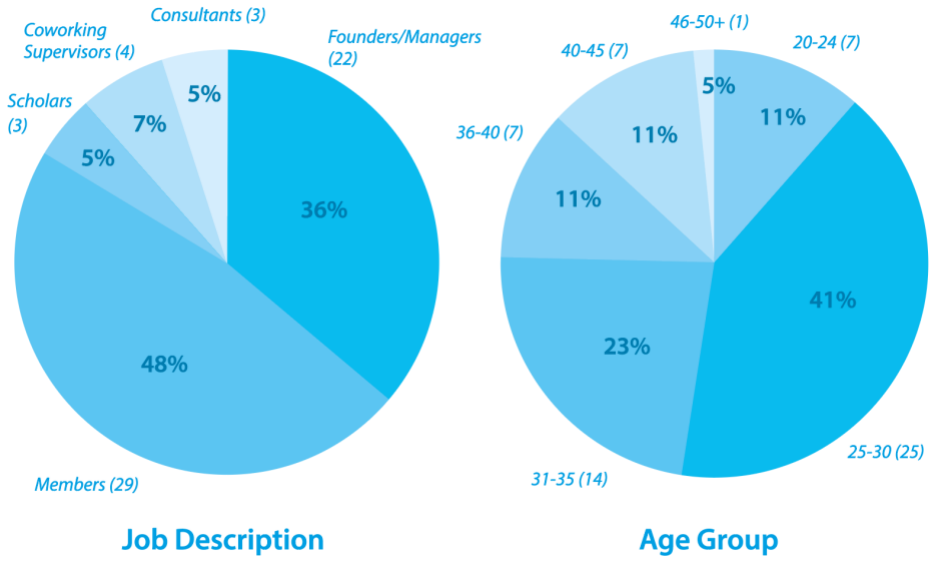


maker, and they could foresee a practical application of the study into their own territory.

Figure 3: List of ethnographic and design research methods according to each period of the research.

The semi-structured interviews involved 61 participants in total, from different age groups and job descriptions. They were all conducted face-to-face by the researcher with founders, managers, members, scholars, consultants, and coworking supervisors, and were recorded digitally both in video and audio, a total of 31 hours of conversation (Fig. 4). The

walkthroughs and space analysis produced more than 900 photographs and dozens of



sketches and drawings.

Figure 4: Pie charts visualising interviewees' age groups and job descriptions.

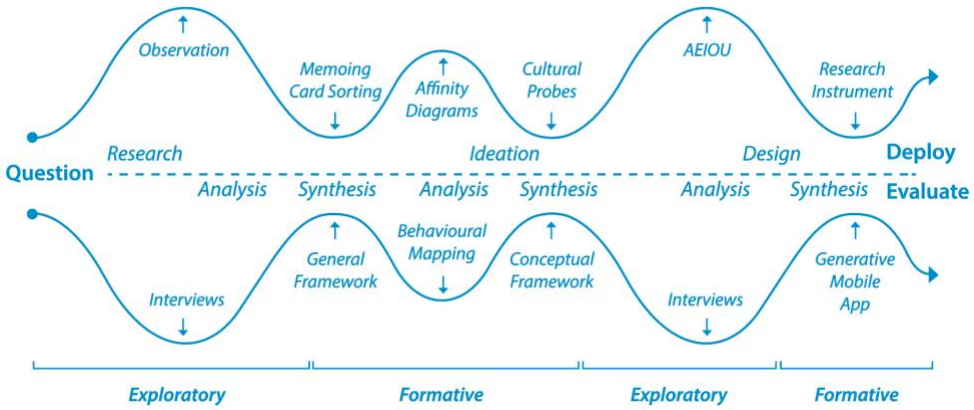
The sample selection of the population offered a comprehensive range of qualitative variables, representing a diversity of socio-professional profiles with varying ethical-political beliefs, enriching the standards of the data set. They are the leading actors and mediators of the selected Makerspaces, and also the representatives of organisations that relate directly to the Maker Movement realm, symbolising a substantial strata of prominent locations within important European cities. They personify what some authors call the 'pivotal target group', able to provide significant conceptualisations (Davies, 2007, Flick, 2009). This typology of interviewees is essential for the validity and reliability of the findings that have formed the Conceptual Framework and the mobile application as a research instrument.

Cultural Probes as Synthesis

As a design researcher, the author based the design of the study on social science models, but added several methods borrowed from the design practice, moving away from traditional positions where the researcher must be an impartial and isolated observer (Kumar, 2014), acting as a facilitator, uncovering new insights and discoveries through the multi-disciplinary approaches of service and organizational design. However, in constructive design research, doing design becomes a crucial activity. When researchers construct something, they may find issues and problems that could not be perceived otherwise (Koskinen & al., 2011).

The Conceptual Cultural Probes were at the same time a tool of analysis and a form of visual synthesis. Ideas and concepts taken from the field work combined with desk research would be synthesised in the form of visually designed 3D models. Debates and critique would give feedback to the analysis, starting a continuous process of analysis and synthesis with the creation of more cultural probes. Visualising concepts from the Framework as a form of theoretical and practical synthesis meant that the theoretical assumptions could be rooted in practice so that participants could find purpose and benefit from the research. Synthesis displayed through the Cultural Probes can be perceived as a creative outcome of research

from the common sense of the population, acting also as a tool for probing new data for a continuous loop of contextual analysis and further inductive synthesis (Fig. 5). The whole process was systematic and valid, perhaps unorthodox for the social science traditions, but



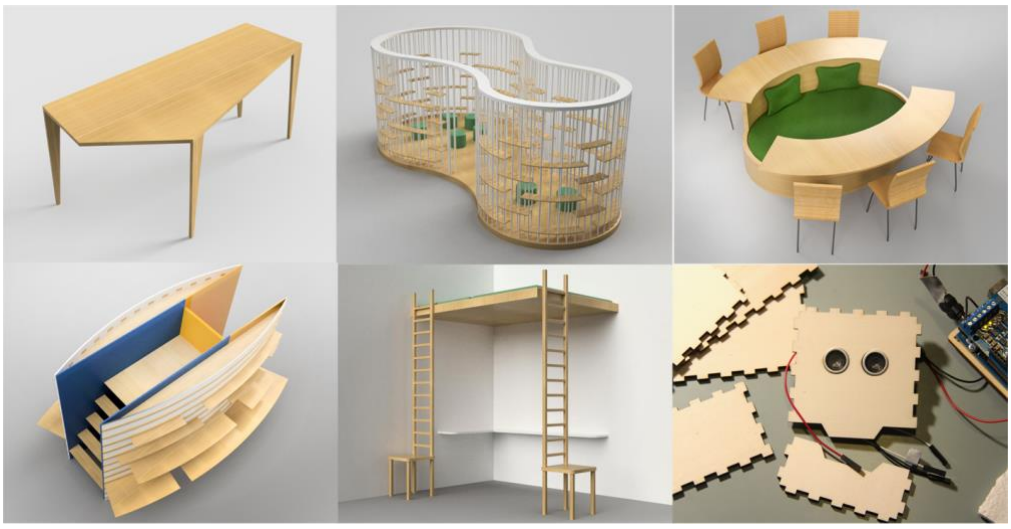
effective for the involvement of the maker community.

Figure 5: The process of analysis and synthesis informed by the use of mixed methods were also based on the design practice, with convergent and divergent thinking phases. Source: author, based on Systemic Design approaches, Jones, 2014.

Cultural Probes were hypothetical and crucial for analysing and clarifying abstractions, helping the participants' connection with the basis of the hypothesis and the research. There is an imaginary but still reliable aspect of design practice that was immediately relevant to the members' lives. Their first reactions consistently concerned design decisions, as if the Cultural Probe was about to enter a development phase. The discussion started with form and function analysis, the general look and feel, the choice of materials, and often moved on to cover its mechanical properties, processes of construction, cost, and other technical details. Gradually, all these aspects were dealt with and the theoretical concepts could be examined in more detail, giving rise to new insights and discussion. Encouraging imagination and facilitating communication also lead to a more critical approach to the Framework theoretical components.

Culture Probes were always introduced as a means of alternative explorations, rather than just relying on static responses. They acted as a form of provocation, materialised concepts and encouraged debate. The primary objective was not theory or hypothesis testing. However, they do represent a powerful tool for analysis, synthesis and participants' engagement. There was a constant tension and plenty of ambiguity, as the quality of each Cultural Probe relates to personal criteria, such as aesthetics and taste. Their unfinished appearance proved valuable to avoid any form of colonisation. Therefore, Cultural Probes could vary immensely, from solid objects or pieces of furniture to having more intangible features such as sound, light or digital messages sent via Twitter accounts. 'The Non-Hierarchical Table', 'The Meeting Library', 'The Shared Bed', 'The Multi Desk', 'The

Collision Chair', and 'The Meet Maker', represent attributes, features and concepts present



at the Conceptual Framework (Fig. 6).

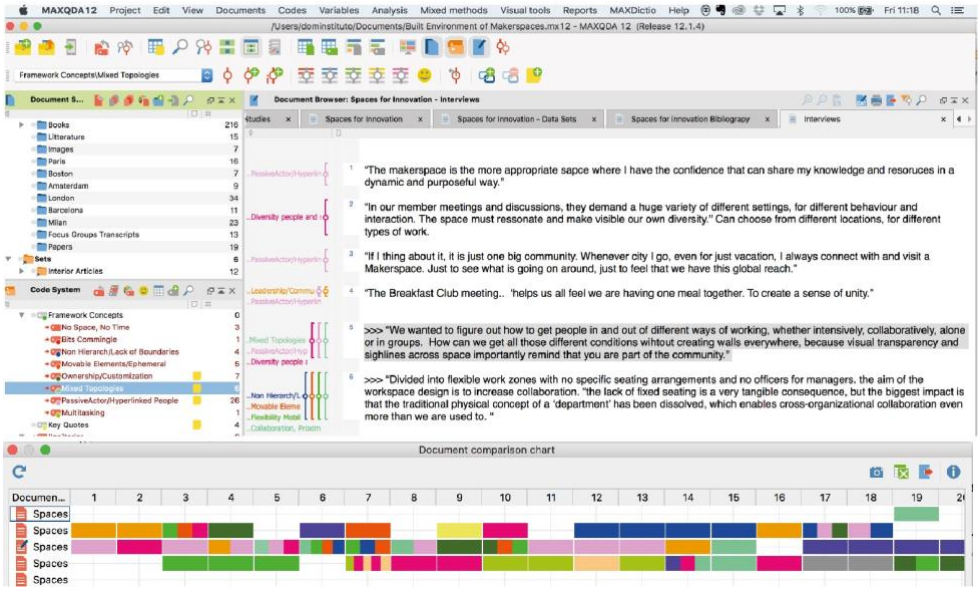
Figure 6: Cultural Probes typified attributes, features and concepts present at the Conceptual Framework.

Conceptual Framework

The primary hypothesis started as a mere intuition and assumption based on the initial participant observations and the core characteristics of the phenomena, but soon became the basis of the enquiry. As a consequence, since the beginning of the study, a set of methods were employed to reveal the members' perceptions about the digital qualities; the distinctive characteristics of bits and of 'being digital'. They helped them to reflect on their behaviour in the space that they occupy and identify commonalities between the digital environment and their individual and social actions. There was a general consensus that office buildings are not suited to the 21st digital lifestyle, and Makerspaces are more successful in merging digital qualities and patterns into their physical settings, maximising the chance of random interaction and optimal performance. Participants also pointed out that digital territories often lead to isolation; virtual connections do not always translate into social and collaborative encounters. Technology has become so omnipresent and pervasive that there is no distinction between life and work, between digital and physical realms. It is logical to presume that intangible environments will also affect the attitudes and social interactions within tangible spaces. They also impact the layout settings, and architectural elements, besides ethereal rituals and protocols.

The analysis strategy utilised both systematic and interpretative approaches, meaning that indexing and coding were applied concomitantly with cross-referencing and conceptual mapping (Kelle, 1997). The amount of data gathered informed the necessity of extra systematic research tools to give structure and reliability to the analysis and synthesis processes. The quantification and measurement of variables and indicators were never a particular concern in this qualitative study, but some degree of statistics were, of course, most welcome. The software program chosen for the computer-assisted qualitative analysis is called MAXQDA (Fig. 7). It was designed for qualitative, quantitive and mixed methods data, combining text, multimedia, pictures, tables and surveys. Its first use was for the interview transcripts, as it offers a powerful built-in tool for importing audio files with real time typing via its internal media player, as well as cross-referencing with added reflexive notes, such as memos, comments and annotations, reinforcing the elements of the

Conceptual Framework. Nevertheless, creating a code or assigning a data segment to a specific coding can also be considered an interpretative process. The analysis was built from data via an interactive process where categories and features presented in the Conceptual Framework came from the interaction between the interviewer and the interviewee, the observer and the observed (Charmaz, 2006). As stated before, the primary concern of the study was that any outcome should be based on the respondents' views of their individual



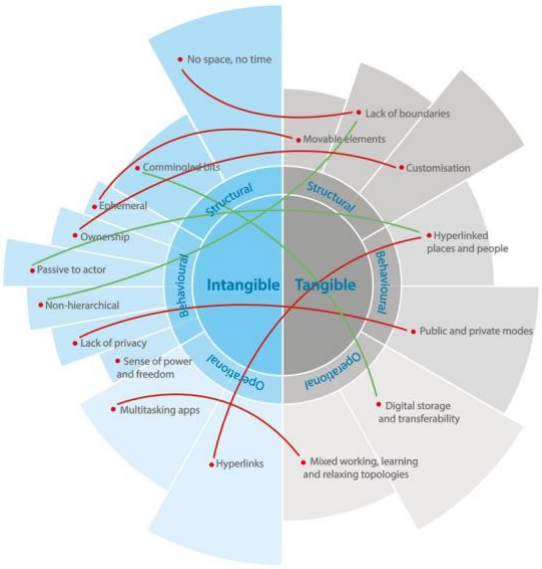
empirical environments and social realities.

Figure 7: Print screen of MAXQDA free coding systems with frequency analysis.

In fact, the Conceptual Framework is an outcome of founders, managers and members' visions and perspectives. The researcher acted as a facilitator, analysing and synthesising, but allowing plenty of participation from the sample population. There is a high level of subjectivity in the results, and the identified elements are somehow abstract, even if they eventually possess a visual or physical evidence, or are apparently supported by participants' interviews. They can also be described as 'modifiers', suggesting that they can affect and have a range, a certain level of strength, starting by discerning the intangible and tangible aspects (Fig. 8). The Conceptual Framework also highlights possible correlations and causalities among its components.

The intangible features are those characterised by not having a physical presence and usually relate directly to the qualities of digital realms. They are invisible but have a strong influence in the way people feel, interact and perform within the space. They prove that a Makerspace is not just about gathering people under one roof, in fact, they are about how people can collectively work together. The intangible ethos, the culture, and a set of hidden systems and protocols are crucial for this acquirement, and they are also governed by other intangible traits. In contrast, the tangible properties are those that are directly perceptible by the senses, visually or by the touch, with a more apparent physicality. They typify the final testing of the hypothesis, staging evidence that an abstract digital trait can cause physical phenomena, being transferred and manifesting itself tangibly into a piece of furniture, or a particular disposition of the floor plan. In total, 17 elements were identified and are present in the Conceptual Framework. The original intention was that they could be measured, offering a visualisation of each analysis from a particular individual and Makerspace location. This process proved to be too laborious to be performed collectively within focus groups. The 17

elements would later be reduced and clustered into eight attributes, through a more practical and feasible Research Instrument (Fig. 9).



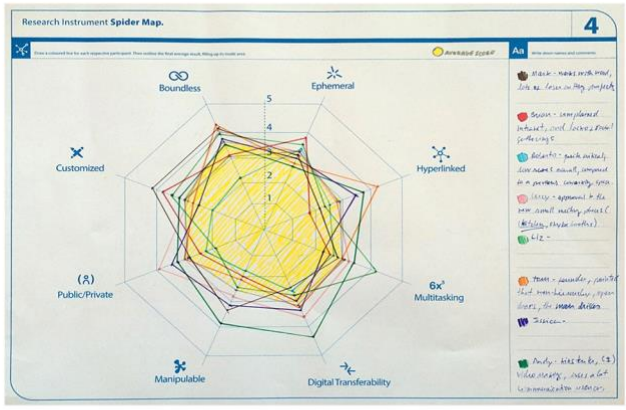


Figure 8: Conceptual Framework as the result of the hypothesis investigation, with two levels of categorizations and 17 distinct elements.

Figure 9: The participants' responses are layered on the Spider Graph for comparison. The visualisation reveals the average score, and make it easier to check for discrepancies.

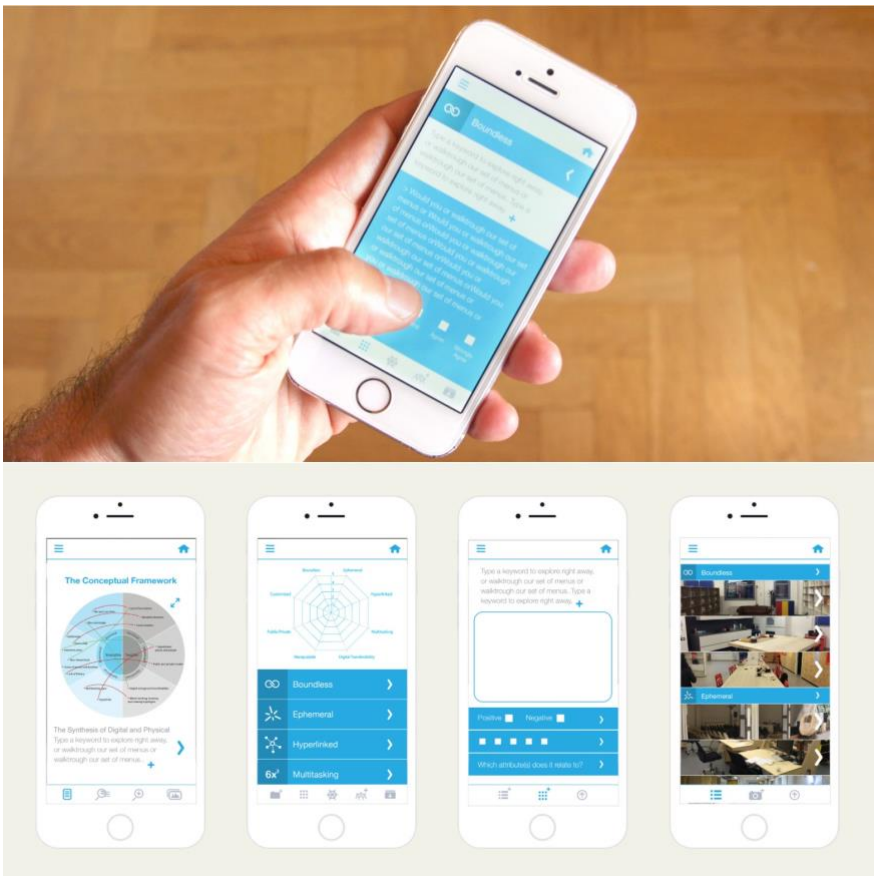
Participants also emphasised that the right balance of these elements, their presence and influence, is highly subjective and contextual. For instance, the concept of 'non-hierarchy' is welcome and nurtured in general, but it is more highly valued within a hackerspace than an environment designed for entrepreneurship and business modeling. Too much hierarchy leads to control and systematisation, too little leads to disorder and chaos, decreasing efficiency and productivity. Each attribute intensity is perceived as an individual choice and perspective, and the overall result is a social construct that reflects the community choice. This fact deemed as an important aspect of the Conceptual Framework: it is only by identifying, mapping, discussing and debating those aspects that they are able to understand their spaces and propose practical changes and enhancements. Managers were particularly interested, foreseeing the possibility of practical guidance for their decision making processes.

Generative Mobile App

Throughout the study, the Research Instrument (Fig. 9) also acted as a form of group interview. However, it was not easy to gather participants for many reasons: the lack of time, the difficulty in syncing different schedules, the laborious task of setting up the stage with paper templates, post-its, notepads and markers. It became evident that the Research Instrument needed to be more accessible and practical, even diminishing the need of a 'researcher' as a facilitator. Ideally, members should be able o access the research content effortlessly, to make amends and adapt to each particular context, to calculate measurements automatically, and to produce reports with ease. To use a figure of speech, the researcher needed to find a way to put the research 'in the hands' of the participants.

The logical path was the build of a mobile application, a piece of software with complete access to individual mobile devices, from data processing and cloud storage to built-in cameras. An ambitious goal, as the researcher didn't have any previous experience with mobile apps and UX or HCI design disciplines. However, the journey of building the app would also become a research experiment, testing the Makerspaces' ability to deliver collective learning, collaborative practices, and tools and know-how for the rapid acquirement of new knowledge and skills.

The mobile app presented at the PhD dissertation is as a working prototype. The wireframing can be tested directly on any mobile device, without the need of hiring servers or repository cloud systems. The app's structure aimed at breaking down the research content into basic building units that could relate to each other, forming progressive actions. The first session is the Interpretative area, where the Conceptual Framework and the hypothesis are explained. The Critical Area introduces the Research Instrument, with the eight attributes, the Linkert questionaries and the spider map graphs, providing visual representations of the individual rating scales. Groups can be formed remotely, and the research can be conducted simultaneously in different places or times. The Generative Area is where the participants can add their perspectives about the concepts or new statements for the surveys. These additions can be utilised solely in the current research session or added to the Research Instrument after online curation. Extra features include the ability to take pictures and categorise them among the eight attributes to create a visual repository of evidence. Geolocation services are able to help people find places, addresses and contact



information to enable open communication and the exchange of experiences (Fig. 10).

Figure 10: The mobile app screens from the Interpretative, Critical and Generative sessions, and extra features such as the repository of pictures. Adobe's Experience Design software allows prototyping and iterating directly on any mobile device, without the need of coding and software developers.

Since the first visit to the first Makerspace in Milan, it was clear that any theoretical framework developed to explain ideas, concepts, and facts, irregardless of whether based on objective data or speculative conjectures, should become a tool that could construct more than explanations and relationships. It should ultimately assist in the building of applicable systems and physical interventions, improving members behaviours and social interactions. This was implicit of the nature of the research theme: workspaces of a particular type of community that highly praise the act of making and changing the world around them. Therefore, the Research Instrument and the Generative Mobile App must be seen as work in progress, something that is flexible and subject to alteration and improvement following the use and participation in each context.

Conclusion

Digital has become central to our everyday life experiences. It is reshaping and blurring the divide between what is private and what is public, what is work and what is leisure, what is virtual and what is real, in every single space we inhabit. Makerspaces can appear to be like any ordinary workspace, as places framed by their furniture and furnishing for collaborative practices. However, it is mainly comprised of networks, physical and digital. Participants often state that a maker belongs to any Makerspace, that they feel part of a world of infinite locations. The digital workspace often becomes the primary workspace, with particular properties and qualities that may have existed in traditional workspaces, but now take on a whole different dimension, intensity and strength.

To better understand these merging qualities and map their features, concepts and principles that may rule the social interaction between and within these territories, research instruments were created to collect data from the participants and give them tools to construct the research themselves, under the lens of a Conceptual Framework. They are significant not just for each community studied but for the overall discipline of interior design, mainly because the hybridisation that has been challenging traditional perceptions of a workspace is undoubtedly favourable and constructive. The participants agreed that the outcomes of the PhD dissertation reveal components that boost their performance, increase their engagement, and encourage their collaborative and innovative practices.

The data collection required intuition, creativity, and imagination, both from the researcher and the participants, reflecting a constructive design approach with the belief that the act of design is able to achieve and deliver new knowledge. This strategy was also justified by the need to guarantee engagement and participation of a population that has a openly practical attitude, a lack of time and no direct personal benefit from the study. Some participants also showed less interest in grasping theoretical and abstract concepts. Even though supportive and helpful, it was a challenging population that showed more trust and attentiveness when the research was translated into practical instances, such as the 3D models of Cultural Probes. Once more, blending ethnographic and design thinking methods successfully unified the blurry borderlines of spatial and organisational design.

In the end, culture is the main force behind the designing of a Makerspace. The design of culture is both a subtle and tremendous endeavour, especially in the locations with financial constraints and overwhelmed managers and staff, which are the vast majority. The maker ethos is powerful and sometimes serves to overwhelm obstacles or preset strategies, and evolve naturally through daily social interaction. Here, once more, the digital workspaces influence the physical ones dramatically, because the social interaction is actually mostly a digital interaction. It is on the forums, the file repositories, the tutorials, the articles, the blogs, the podcasts, and the social media channels that the maker culture is promoted, reshaped, and reinforced. The visitor that arrives at a Makerspace for the first time is never completely blank or naive. The prospective member is already hooked into that culture. The built environment comes as the attractive, practical, and functional habitat, the stage on

which the culture will have the freedom to perform and evolve. Inside Makerspaces, designing the space is just one of the multiple activities that ultimately denotes designing the culture.

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