RESEARCH + EDUCATION FORUM 2022

Design for the Unimagined

Proceedings Document

WDO WORLD DESIGN ORGANIZATION

The following document is the published collection of technical papers accepted to the 2022 WDO Research and Education Forum that took place online, hosted by Economic Promotion Bureau of Shunde People's Government of Foshun (China) on 22 February 2022.

Special thanks

We would like to acknowledge and thank the Economic Promotion Bureau of Shunde People's Government of Foshun (China) who supported this process and enabled the successful execution of this event.

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455 St-Antoine Street West, Suite SS10
Montreal, Quebec, H2Z 1J1 (Canada)
WDO.org

About this publication

Held online on 22 February 2022, under the banner of Design for the Unimagined, the 2022 WDO Research and Education Forum hosted by the Economic Promotion Bureau of Shunde People's Government of Foshun (China) aimed to share perspectives and explore trends to better prepare young design professionals for new challenges and opportunities.

Bringing together academics, students and industry leaders online due to the ongoing COVID-19 pandemic, the event explored three sub themes relating to the new dawn facing designers in the aftermath of the largest pandemic in a century: response in extreme times, human centred technologies and the emergence of new learning. Through a series of online activities, the forum fostered engagement around the challenges universities and design schools had to overcome in remote environments, the ways we lean on technology at an increased pace and the possibilities available to us when we explore the unimagined.

The following proceedings are the collection of papers selected for publication.

To view the keynote presentations, panel discussions, as well as the poster presentations, please visit WDO.org/world-design-assembly

Theme 1
Response in extreme times

Our world is facing many complex challenges – from the ongoing COVID-19 pandemic to climate change, overpopulation and global migrations. These extreme circumstances have not only forced us to rethink how we live our lives, shifting daily habits and patterns, but have also brought us together in new ways that showcase how humans can adapt in times of crisis.

Theme 2
Human-centred technologies for social and environmental benefit

Big Data. Artificial Intelligence. The Internet of Things. These technologies are influencing our world, but questions loom about what value they can really bring to our everyday lives. The key, it would seem, to unlocking this potential is evaluating the balance between human-centred and performance-based technologies. As we look to address some of our most pressing social and environmental challenges, designing with people in mind allows us to better understand where we came from and how we can move forward together.

Theme 3
Emergence of new learning

Changes in society, student expectations, and technology continue to shift the ways in which we learn. A distinctive rise in online learning has caused both design educators and students alike to explore new tools to keep up with the demands of 21st century learning. As new forces reshape the academic landscape and conversations around educational accessibility pervade public debate, how can existing methodologies of design research and curricula evolve to enhance the student experience and equip them with the skills needed for future professional practice?

Thomas Garvey

How can we better prepare our young design professionals for new challenges and opportunities? In many ways, this has been the guiding question of the WDO Research and Education Forum since the event was reinitiated in 2019, and together with our community, the years that followed have fostered many insightful discussions exploring the future of design education around the world.

2022 marked the first time that this forum was held in a virtual format, an important reminder of not only our global context, but also of the digital age in which we find ourselves. There is no doubt that the rise of online learning and the influence of digital technologies have led to a significant shift in the way we teach, learn and apply the practice of design.

Under the theme of design for unimagined, the 2022 WDO Research and Education Forum sought to explore how these forces are reshaping the academic landscape, and how design students and professionals are adapting to this new reality to meet the relevant social and environmental challenges facing our world.

Centred around three key sub-themes: response in extreme times, human-centred technologies for social and environmental benefit and the emergence of new learning, we were able to shed new light on the evolution of design methodologies in the digital age.

We are happy to see that these themes and issues resonated across our global audience as we received a large number of abstracts and posters. This publication compiles the papers that were selected and presented on 22 February 2022 by international research academics, designers and educators. On behalf of WDO's Education Sub-Committee, we would like to thank them for sharing their insights on these important topics and for contributing to the discussion as we all endeavor towards a better future through design.

Thomas Garvey, Chair of the Education Committee

Srini Srinivasan

An integral part of the World Design Assembly, WDO's Research and Education Forum represents a key moment for designers, academics, students and design professionals from around the globe to gather and discuss the future of design education. Under the banner of 'design for the unimagined', the 2022 Research and Education Forum offered key insight into how design can continue to adapt and thrive in times of uncertainty.

As a reflection of the global context in which we found ourselves, 2022 also marked the first time the forum was held in a fully online format. Indeed, much of the knowledge exchanged helped to shed new light on the changes we've witnessed within the design discipline over the last few years – from the shift to online learning, to the emergence of new methodologies and the rising influence of technology on the way we design.

Thank you to the Government of Shunde, as well as WDO Member Industrial Design Society of Shunde for their collaboration and support in hosting this event. A special thanks as well to the WDO Research and Education Forum Committee who committed their time and expertise to overseeing the development of the programme. And finally, thanks to all the members who contributed to this Forum as we continue to find ways to improve the quality of life through design. Looking forward to the next edition of the Forum.

Srini Srinivasan, President of WDO (2019-2022)

Speakers

Keynotes

Karel Vredenburg
Director, Global Design Leadership, Culture, External Engagement, and Academic Programs, IBM

Karel Vredenburg has led design in various roles worldwide at IBM for most of his three decades with the company, and is currently responsible for IBM's Global Design Leadership, Culture, External Engagement, and Academic Programs. He chairs the Design Executive Team comprised of top managerial design executives in each business unit and the Design Leadership Board comprised of the technical and managerial design executives responsible for the review and appointment of Design Principals and Distinguished Designers.

Meikang Yao
Dean of School of Design, Shunde Polytechnic

Prof Meikang Yao, who is Dean of School of Design and Director of Academic Committee of Shunde Polytechnic. He is also the Chief Architect of Shenzhen Civil Engineering Tongji Architectural Design Institute. Professor Yao has been keen on research interests in architectural design and theory, urban planning and design and landscape and environmental art design. He was granted a National Innovative Design Skills Master Studio in 2019, a Top 10 Most Influential Designers in China from 2011 to 2012, and German Red Dot Award in 2017.

Panelists

Mariana Amatullo
President, Cumulus

A practitioner-scholar, educator, and design strategist, Mariana is the President of the Cumulus Association. She is an Associate Professor of Strategic Design and Management at Parsons School of Design. She serves as the Vice Provost for Global Executive Education and Online Strategic Initiatives at The New School, New York. Previously, Mariana co-founded and led the award-winning social innovation department, Designmatters, at ArtCenter College of Design in Pasadena, California. Mariana's research and publishing bridge the design and management fields and examine the role designers play in advancing social innovation and organizational learning.

Kari Kivinen
Education outreach expert, European Union Intellectual Property Office (EUIPO) Observatory

Kari Kivinen is involved with the Intellectual Property in Education Network-project, which promotes creativity, innovation, entrepreneurship and responsible digital engagement among young Europeans. He has worked in international schools in Finland, Luxembourg and Belgium. He is the former Secretary-General of the European School system and ex-Head of the Finnish French school of Helsinki. During his professional career, he has combined his everyday work with research and further studies.

Isabelle Vérilhac
President, Bureau of European Design Associations (BEDA)

Isabelle is the head of International Affairs and Innovation and coordinator of Saint-Etienne (France) UNESCO City of Design and the President of the Bureau of European Design (BEDA). Isabelle holds a Post-Diploma in design research, a Doctorate in material chemical physics, and gives lectures in industrial design. She was the director of the Saint-Etienne Medical Technologies Cluster from 2003 to 2007, and has worked in design, medical research and development activities. For 14 years she has been in charge of the relations with economic stakeholders at the Cité du design Saint-Etienne.

Theme 1

Response in extreme times

Title:

It starts at home! Design research for sustainable behavior in the kitchen

Authors:
Dr. Elif Kocabıyık Savasta[1,2,3]
Dr. David Kusuma[4,2]

Institutions:
[1]Izmir University of Economics, Izmir (Turkey)
[2]World Design Organization, Montreal (Canada)
[3]Izmir Metropolitan Municipality Mediterranean Academy, Izmir (Turkey)
[4]Oregon Tool, Portland (USA)

Abstract

This paper highlights the role of design research in industrial design education for overcoming unimagined futures. Accordingly, it presents the study of 'sustainable behavior for a zero-waste kitchen', which was explored during the Design Research undergraduate (online) course in the Industrial Design Department at the Izmir University of Economics in 2021. During the course, students followed the Double Diamond model and conducted a piece of research on specific topics which were: food waste, material waste, energy waste, water waste, space waste, and task waste in the kitchen. Students identified research problems and tried to give an answer/design a solution by using exploratory, generative, and evaluative methods. The results indicated that lack of awareness, knowledge, care, reuse, access, space, and messy use and laziness come forward while people act/behave in the kitchen regarding the specific topics determined. Students proposed design solutions as a response to these behaviors to propel a shift towards a more ecologically sustainable society.

Keywords: Design research, design education, pandemic, climate change, zero-waste kitchen, sustainable behavior

1. Design research education

The education of making (design) research is usually attributed to the graduate programs within the industrial design discipline in Turkey. One example that contrasts this current situation is the 'Design Research' course offered in the curriculum of the Industrial Design Department at the Izmir University of Economics for over 17 years. The course in specific aims at providing students with research-making competence starting from the undergraduate level.

Bruce Archer (1999) defines 'research' as "a systematic enquiry whose goal is communicable new knowledge or understanding". With this definition in mind, students of this design research course pursue a planned enquiry towards solving a design research problem whose answer could be an innovative design solution that can be exhibited, patented, etc. and/or a piece of research that can be published on course for contributing to the knowledge pool of the discipline to propel future designs.

John Langrish (n.d.) distinguishes design research from others regarding the questions asked, the methods used to answer them, and the type of evidence that is acceptable to a peer group of academics in the same area i.e., the visual evidence. Due to its features, design research falls both into sciences and humanities traditions and harmoniously swings between research and practice. This is well defined in the form of 'trinities' of design research concepts by Frayling, Findeli, Jonas, and Archer as: 'research into/about practice', 'research for (the purposes of) practice', 'research through/ by practice' (Archer, 1999; Jonas, 2007). Students of the design research course get acquainted with this challenging interconnectedness of research and practice and recognize it as the characteristic of making design research.

On this basis, students further get acquainted with the history, processes/models, and prominent methods of the design research field within the 14-weeks duration of the course. Concordantly, they also experience making a piece of research. They start with a topic given to them and are encouraged to identify their research problems, select and apply appropriate design research methods, analyze the findings, and synthesize them to give an answer(s) and propose a solution(s) to their research problems. Thus, students are expected to interiorize making systematic research within the design process during this course.

Introducing design research to the students early at the undergraduate level shifts and balances their fast, solution-oriented mindset -usually encountered at the research stage of the design process during the industrial design studio courses- towards a more questioning, reasoning, critical one. Being equipped with research-making competence, newly graduates may lead the companies without R&D departments towards more innovative actions e.g., aiming at receiving patents for their designs and participating in projects that are supported by public and private institutions. They may also possibly become the designers who can strongly resist the unimagined future of the planet.

2. Responses in extreme times: Sustainable behavior

The impact of climate change on the planet requires immediate action. We as designers and the residents of the planet should rethink the way we live our lives and act/design with a new mindset advocating the life on planet.

While poorly designed industrial systems, products, and buildings have greatly contributed to environmental and social degradation, the topic of sustainability has become a major focal point for the design fields since 2000s. However, sustainability is often narrowed down to the products and undertaken simplistically. Nathan Stegall (2006) argues that "The role of the designer in developing a sustainable society is not simply to create 'sustainable products', but rather to envision products, processes, and services that encourage widespread sustainable behavior".

To understand how designers can encourage sustainable behavior in a society, Stegall (2006) highlights the importance of examining the extent to which designed artifacts and new technologies affect society and individuals. Buchanan (1985) observes design as a form of persuasive communication in which products make arguments about how people should live and what values they should hold. Grounding on this, Stegall (2006) redefines "consciously designing products that encourage positive, constructive ways of life" as "intentional design".

He further develops a unifying ecological design philosophy in his article entitled "Designing for Sustainability: A Philosophy for Ecologically Intentional Design" to guide the design decisions for ensuring environmentally conscious and communicated designs and promoting an ecologically sustainable society. The greatest challenge that he raises about designing a sustainable behavior is the difference of cultures. Sustainable living would mean different things in different geographies. Here, Stegall (2006) suggests that "Overcoming this obstacle requires designers who can enter a local environment, observe, and understand how its people relate to each other and to the natural world, and develop methods for improving those interactions".

The COVID-19 pandemic has drastically changed our lives and inevitably affected the studies in the design fields. Especially, lockdowns at homes triggered home-related (design) research. As a response to climate change and the COVID-19 pandemic, we determined the research topic as 'zero-waste kitchen' and directed our focus on people's behavior rather than the kitchen itself.

3. Research project: Zero-waste kitchen

The Design Research course was planned alike in 2021 with the difference of contribution of a professional researcher/manager from an industry. David Kusuma, the Vice President of Research and Product Innovation at Tupperware Brands Corporation (at the time), contributed to the online course; gave lectures, shared his experiences, suggested the research topic, and followed the design research processes of the students. The research course brought academia, industry, and students together for the first time, which is commonly done in studio courses.

Starting from 'zero-waste kitchen', we clarified the research topic as 'sustainable behavior for a zero-waste kitchen within the context of Turkish culture' and followed British Design Council's Double Diamond model - a visual representation of the design and innovation process.

3.1 Discover & Define

Within the Discover and Define (inspiration) phases, students: i) conducted preliminary primary and secondary research to narrow down the broad research topic into a focused one, ii) identified a research problem and its keywords, and iii) prepared a research plan. These actions were realized iteratively concluding on specific topics that are: food waste, material waste, energy waste, water waste, space waste, and task waste in the kitchen.

The students conducted Diary Studies, Experience Sampling Methods, Photo Studies and gathered/reviewed related literature, as well as made Internet searches to create self-awareness and get knowledge around the topic. They worked individually, as well as in groups under the specific topics. They kept individual research logbooks and recorded/documented everything throughout the design research process.

Research problems identified under the specific topics were as follows:

- Food waste group: "How can behavioral design contribute to preventing food waste and compelling compost-making an everyday task in kitchens?"
- Material waste group: "How can design contribute to changing behaviors of people towards zero-material-waste in kitchens considering the reuse of paper/plastic egg packages in Turkey?"
- Energy waste group: "How can energy use caused by selection of cooking techniques and cooking equipment be reduced in kitchens?" (Potato-cooking example)
- Water waste group: "How do people behave while using water during the food preparation and cooking? How can design change behaviors of people towards zero-water-waste in kitchens and create a small-scale water cycling system?"
- Space waste group: "How do people organize the storing of seasonal foods in their kitchens? How can modular design contribute to this organization towards a zero-space-waste understanding?"
- Task waste group: "What are the behavioral patterns between the zones of equipment storage and food preparation in kitchens? How can design contribute to change these behaviors towards more task efficiency?"

3.2 Develop

Within the Develop (ideation) phase, students selected exploratory, generative, and evaluative methods appropriate to their research problems (using Universal Methods of Design book by Martin & Hanington, 2012 as a reference), and revised their research plan and preparation in detail. Then, they applied these methods systematically to collect data according to their plan. They made a literature review on their specific topic.

The research approaches that were undertaken were survey and design ethnography, and the research techniques that were mostly selected were Interview, Questionnaire, Observation, Photo Diary, Role Playing, Sketches, Persona, Scenario, and User Journey Map.

3.3 Deliver

Within the Deliver (implementation) phase, students analyzed and synthesized the collected data using evaluative methods and tried to deliver Proof of Concept by design proposals, tests, and discussions on the results. Unfortunately, this phase could not be fully completed and merely some design proposals could be delivered as answers to research problems.

In general, the following results were synthesized: lack of awareness on energy and water consumption, lack of knowledge on composting food-waste, lack of care, lack of reuse, lack of access (tall and deep cupboards), lack of space (small kitchens), messy use of kitchens, and people being lazy.

Accordingly, the following proposals were made: A guide for cooking techniques and cooking equipment to reduce energy use and cost; a sink design to collect water for reuse and warn people for excessive use; a vermicomposting kit design to function as an under-sink waste bin; an egg package that can be reused as a pot, bird nest, cup for stray animals; a modular freezer design for seasonal storing; and a hierarchical guide for frequency of use/task for things and spaces.

Figures 1-6 reveal the research problems and the proposed future scenarios and solutions in regard.

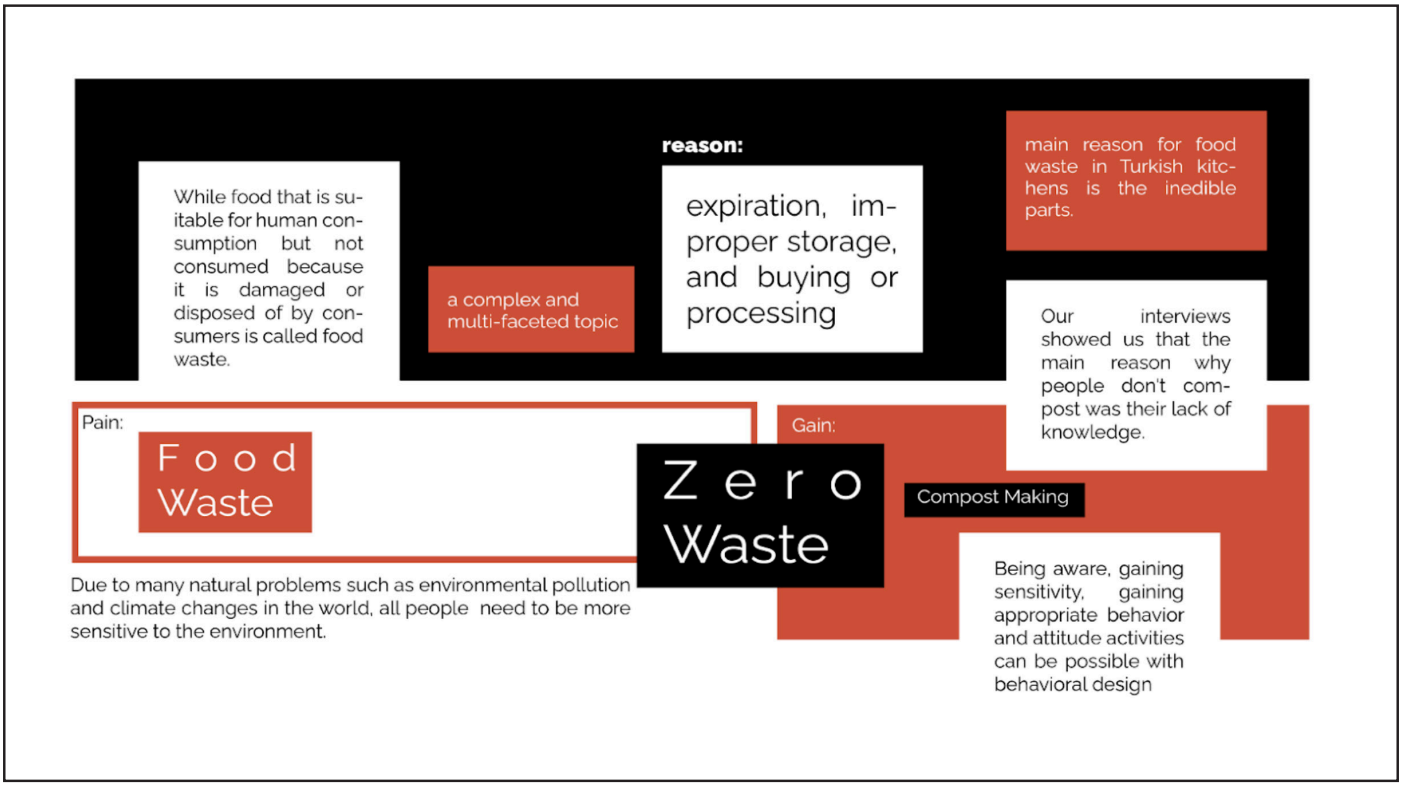

Figure 1: Food waste group: Research problem statement

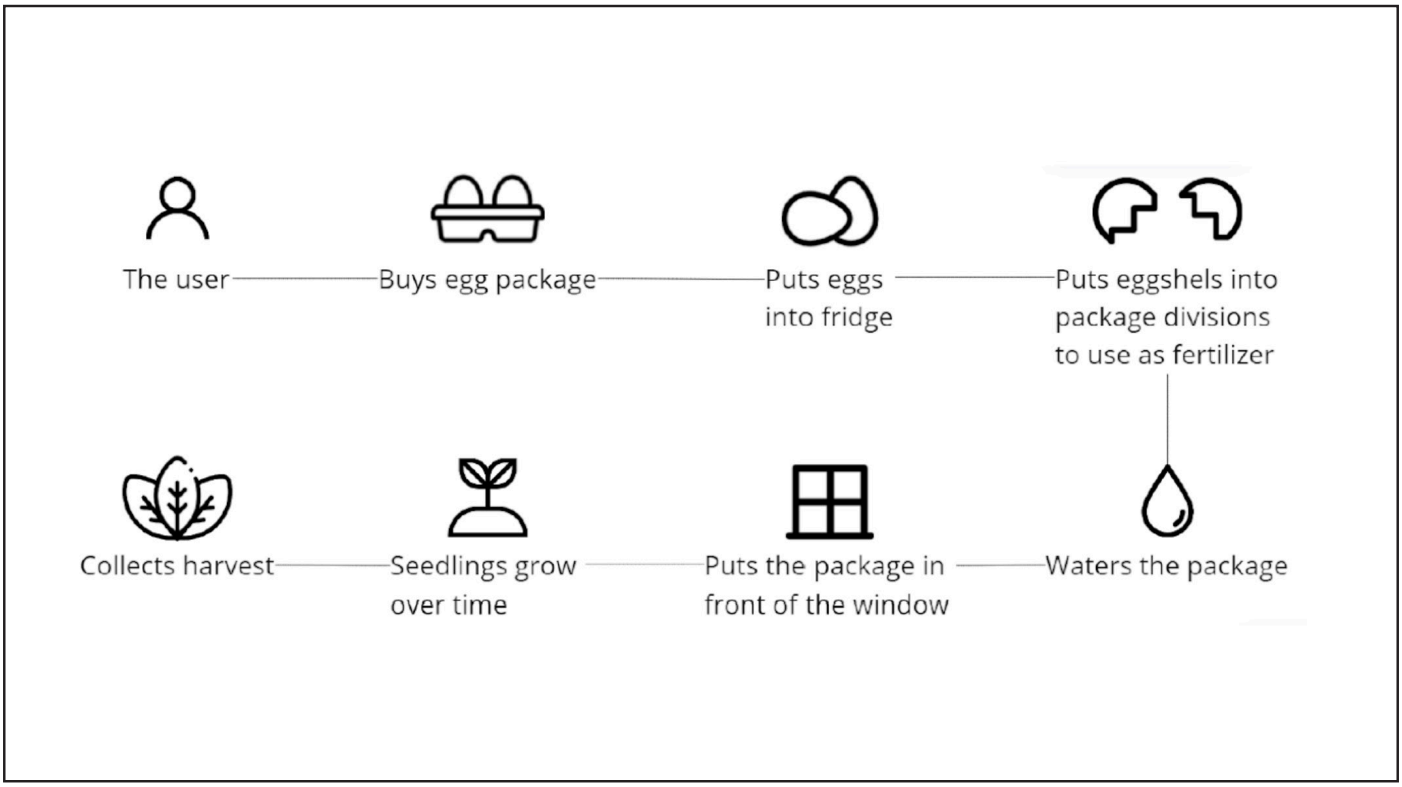

Figure 2: Material waste group: Solution proposal

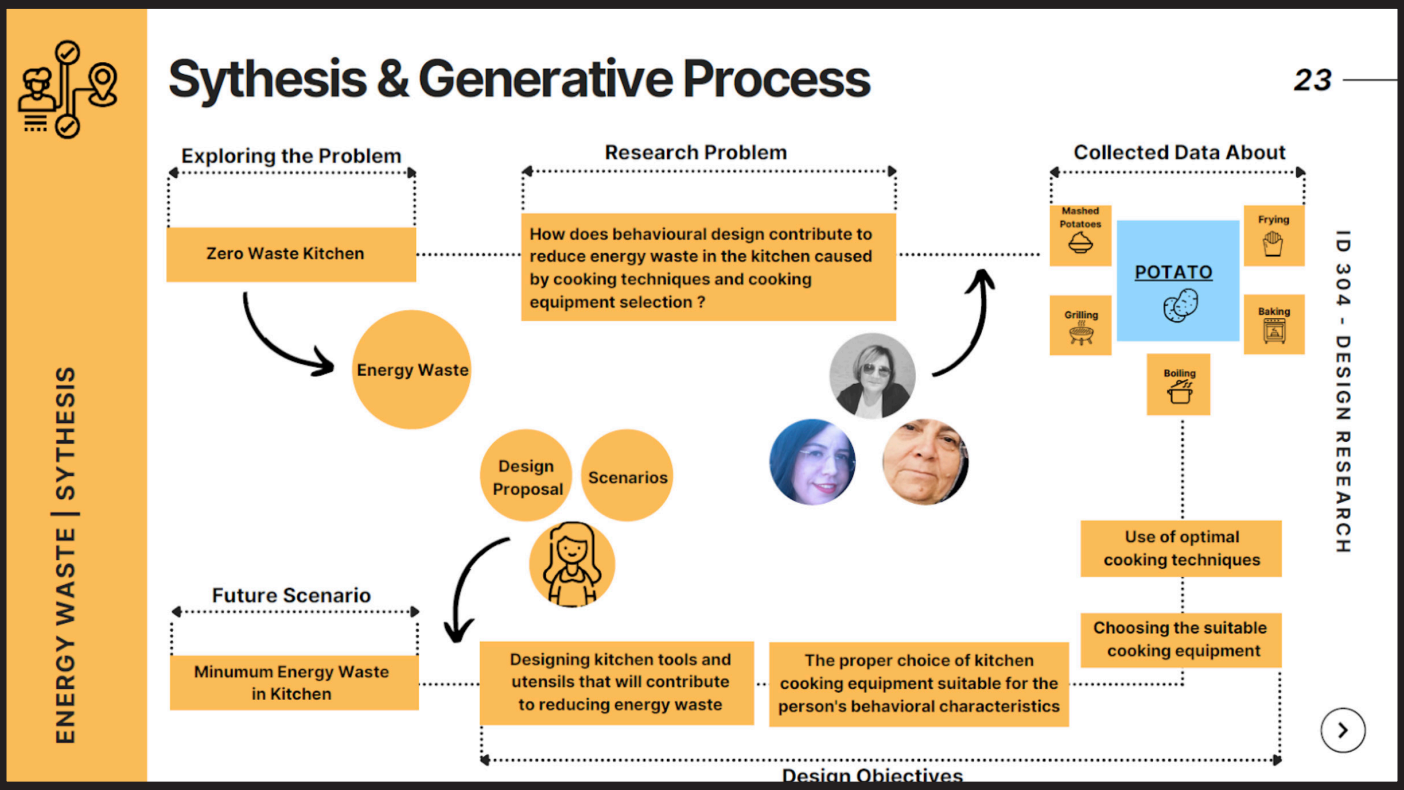

Figure 3: Energy waste group: Research problem statement

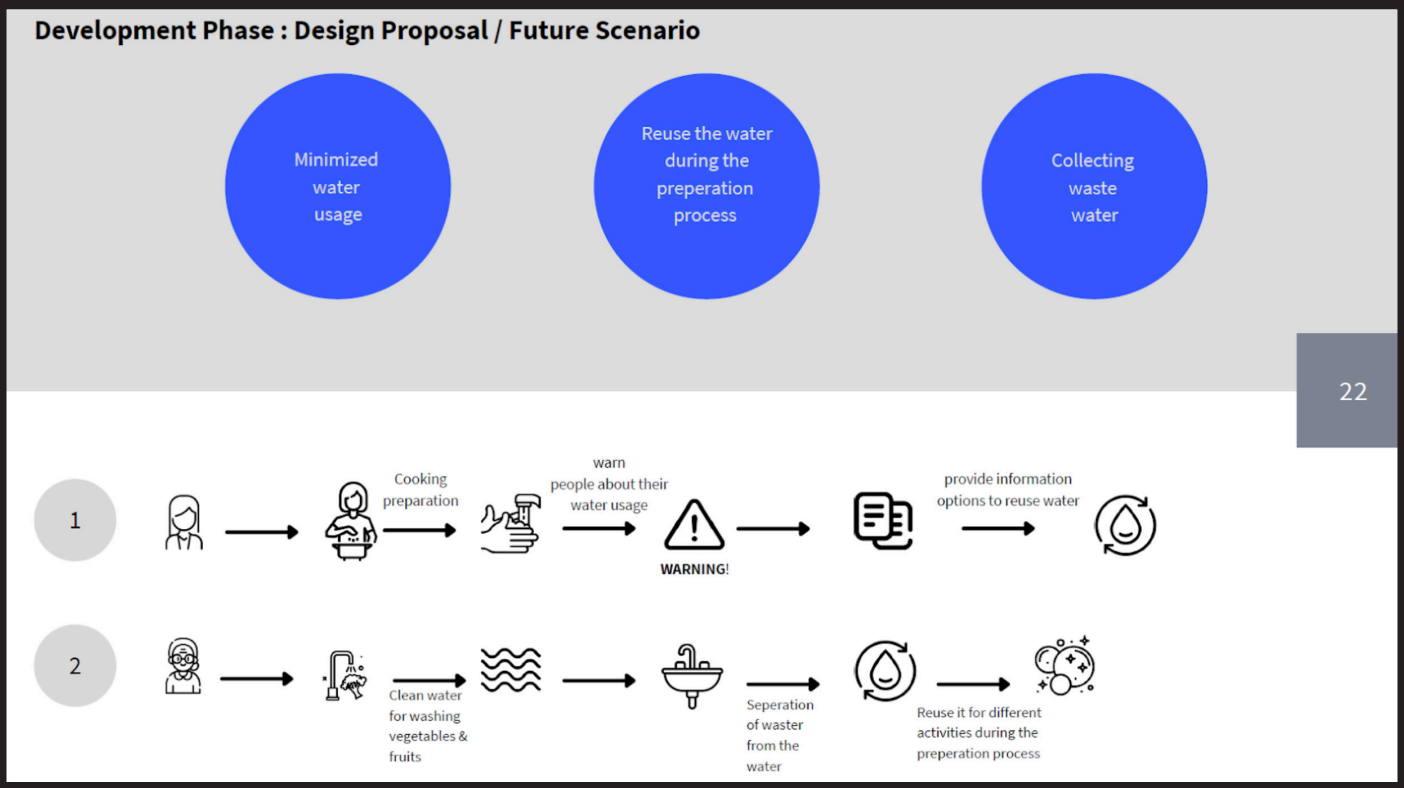

Figure 4: Water waste group: Solution proposal

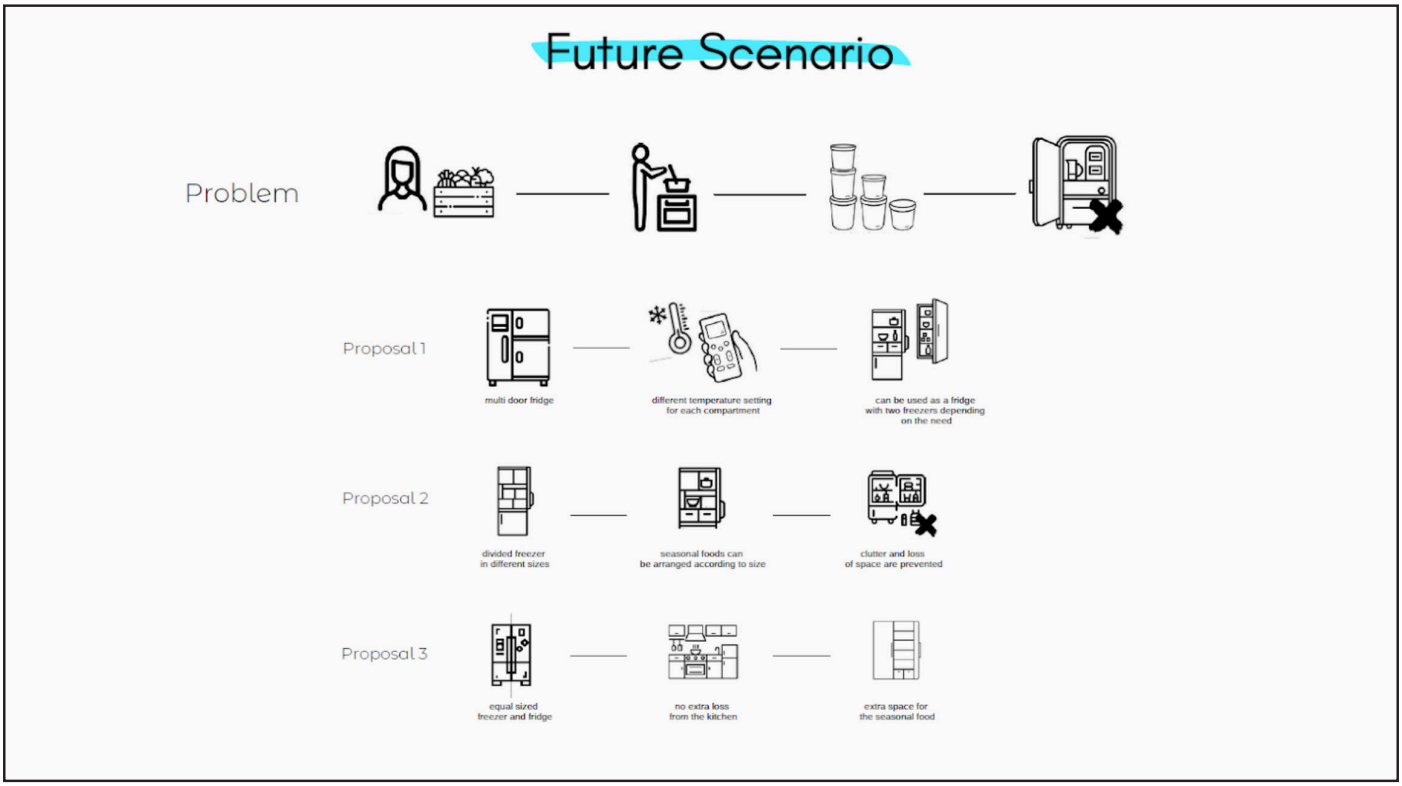

Figure 5: Space waste group: Solution proposal

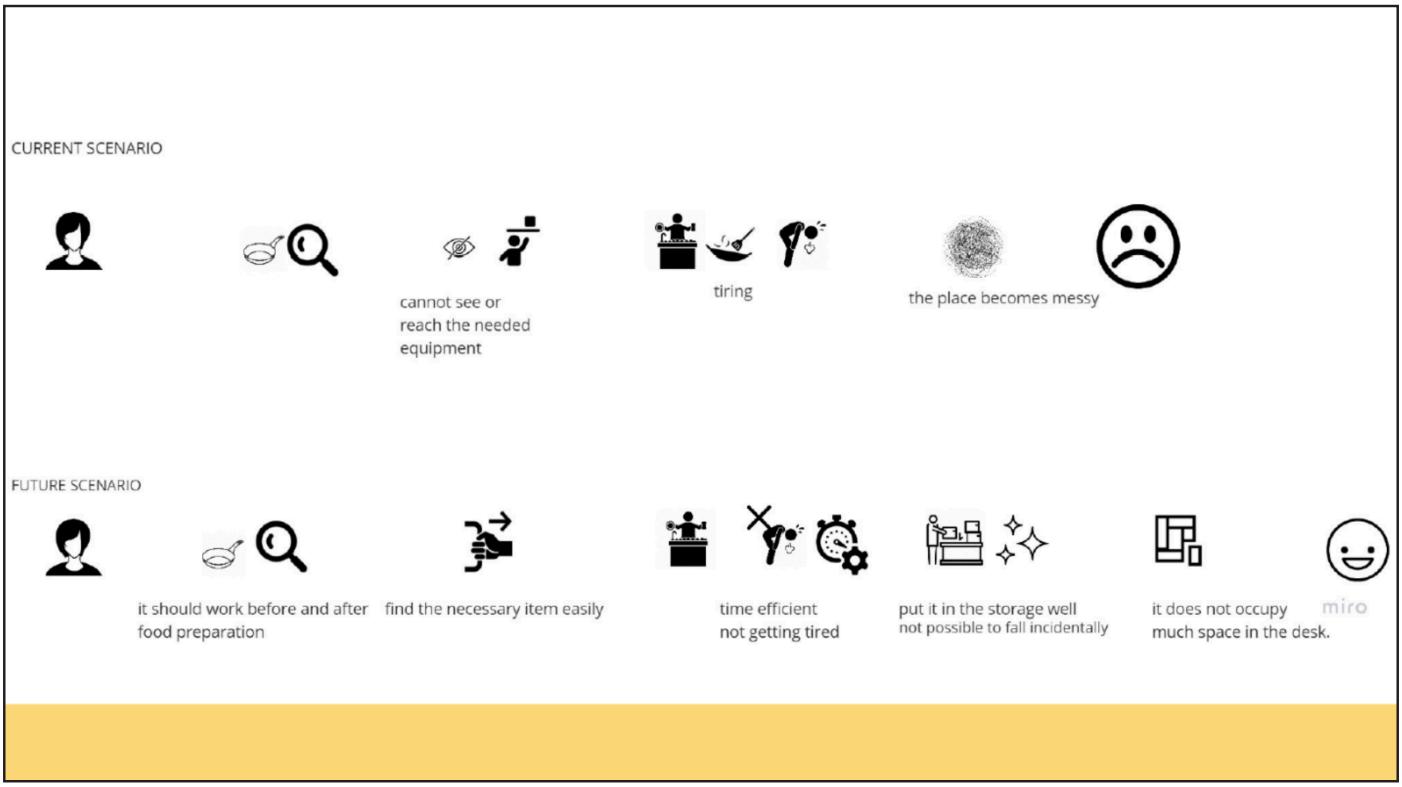

Figure 6: Task waste group: Solution proposal

Conclusion

This paper reveals a study on ‘sustainable behavior for a zero-waste kitchen within the context of Turkish culture’ undertaken during the Design Research undergraduate (online) course in the Industrial Design Department at the Izmir University of Economics in 2021.

This course aims at providing students with research-making competence starting from the undergraduate level. Feedback from the graduates/former students of this course indicate how the course has been advantageous for them while applying for a master’s degree and/or participating in projects called by the Scientific and Technological Research Council of Turkey.

The research topic studied during the course was determined as a response to climate change and the COVID-19 pandemic. The necessity of a change in behaviors towards building a more ecologically sustainable society and the extensive use of kitchens during the COVID-19 pandemic channeled the topic to start a change in our kitchens.

Being acquainted with the challenging interconnectedness of research and practice, students followed the Double Diamond model and conducted a piece of research using exploratory, generative, and evaluative methods on specific topics - food waste, material waste, energy waste, water waste, space waste, and task waste in the kitchen.

The results indicated that lack of awareness, knowledge, care, reuse, access, space, messy use and laziness come forward while people act/behave in the kitchens regarding the specific topics determined. The students proposed design solutions/ future scenarios as a response to catalyze these behaviors e.g., guiding apps, products designed specifically for reuse, and new product concepts.

The impact of cultural context was observed in identifying the research problems and delivering design proposals such as seasonal storing, egg consumption, people’s interaction with animals, etc.

The research was documented and communicated via presentations, reports, and individual logbooks.

Since the Deliver (implementation) phase of the process could not be fully completed - in terms of research and practice rather than the expectation of an outcome as in the studio courses, the determined research topic, specific topics, and problems are carried to the following year’s course to be further studied in detail.

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Title:

New design-oriented directions for the regional economy: proposal of a framework for classifying industrial conversions and product diversification cases in mature industries

Authors:
Eva Vanessa Bruno
Virginia Flavia Palazzolo
Beatrice Lerma
Francesca Montagna

Institution:
Politecnico di Torino
(Italy)

Abstract

Design and Innovation Management find common ground and interesting collaborations in defining strategies that manufacturing companies can implement in extreme circumstances. Design-oriented industrial conversion and product diversification could be an outcome of such strategies, identified to explore and manage emerging technological paradigms. This research focuses on manufacturing companies within industrial districts that are in difficulty and try to orient them towards new strategic directions, driven by product design. For this purpose, the research proposes a framework for classifying case studies of companies that have successfully applied the strategies mentioned above. It displays expansion directions, sectors, products or processes that could be of value for a territorial context.

Keywords: Industrial conversion, product diversification, design, framework, innovation strategy

Introduction and research context

The current economic-financial environment that Italy is going through calls companies in critical and unstable economic conditions to be guided by business strategies able to systemize the skills and assets they already possess. A growing body of literature recognizes that the discipline of design could be an enabling key to expand innovation strategies (Dorst, 2015), since it is intrinsically linked to business (Muratovski, 2015).

This paper describes a possible design-oriented framework to investigate (and ultimately orient) companies' industrial conversion or diversification strategies. New products with new shapes, materials, functionalities, purpose, meaning, as the key elements of design and innovation, with processes equal to or integrated with those already adopted, could be the tangible outputs of such strategies. Methodologically, the framework is built on 60 case studies of Italian companies that, in the last 50 years, have effectively succeeded in adapting and moving to more profitable markets or industries.

In this sense, the paper also helps to shed light, at least for the people that are not used to business analysis, on the terms 'conversion' vs 'diversification'. The expression 'industrial conversion', in fact, is often associated with the military sector when companies temporarily convert their production plants to produce military armaments. During the First and Second World Wars, for instance, metallurgical companies (i.e., companies with a strong know-how in processing metals to be exploited as automobile and household goods companies) converted to produce weapons and armaments.

Moreover, especially in the architecture and industrial design fields, the term is confused with a building renovation of industrial plants. In this paper, we intend for industrial conversion the use of resources and assets aimed at a product, by which enter a completely different industrial sector (Johnson, Christensen & Kagermann, 2008). Conversion embodies an extreme situation with respect to diversification, which instead (here) represents the different use of the same assets in other markets, maintaining in parallel the current business (Le, 2019).

It is worth noting that industrial conversion often is a suitable strategy for extreme circumstances. It was adopted not only during the Second World War, but the term finally returned to the pages of the newspapers during the COVID-19 pandemic. Textile, alcohol, and automobile companies converted for a moment to manufacture masks, hand sanitizer, respirators, etc.; all extremely urgent and rare goods in that time.

The framework presented here is a preliminary result of a doctoral research effort in collaboration between Torino's Chamber of Commerce and Politecnico di Torino. A multidisciplinary team of product designers and industrial engineers, experts of innovation management, has challenged steering companies towards unexplored markets or different business models.

Theoretical background

Observing a territory and its dynamics is essential to comprehend its features and potentialities, especially when considering a territory as the design object (Parente & Sedini, 2017; Bassi, Calogero & De Chirico, 2021), aiming at protecting, preserving, and transmitting the productive cultural asset of the territory. In Italy, for instance, one can observe that the majority of firms are included in production clusters and industrial districts made of small, medium companies. Clusters and districts provide strong relations between territory and companies, sometimes operating at the regional level, other times cooperating at the national level, also through material and immaterial transactions, when one also considers networks (Celata, 2009).

From an economic point of view, industrial districts embody a territorially delimited production system composed of companies with interconnected activities. They live because of agglomeration economies, which provide companies with benefits, such as transport cost savings, raw materials closeness, network externalities in sharing resources, competencies, and services higher to competition forces (Porter, 1998). These different benefits indeed also drive clusters' origin differently, so that they can be derived as geographical (such as the wine cluster in California, the flowers one in the Netherlands); sectoral (if companies are operating together from within the same commercial sector, e.g., Silicon Valley), horizontal (when interconnections between businesses at a sharing of resources level) and vertical (i.e., a supply chain) clusters (Greenstone, Hornbeck & Moretti, 2010).

If one adopts a design-oriented perspective instead, industrial clusters could be distinguished in view of products and services they provide to the territory (Vasquez, Celaschi, Formia, Iñiguez Flores, León & Triana, 2020) and how they characterize such territory through the design activity (Germak, 2008), as where design is an actor within a collaborative process between many players. In Piedmont, the Italian region where such doctoral research is developed, some design-oriented industrial clusters operate: the houseware industry (Alessi, Bialetti, Sambonet and Lagostina); furniture and complements (Gufram and Serralunga); fashion and accessories (Ermenegildo Zegna, Loro Piana, Cerruti, Herno, Miroglio, Carlo Pignatelli, Robe di Kappa, K-Way, Superga); gold-working districts of Valenza (1.500 micro and small companies and workshops) (Piemonte Agency, 2021). With regard to the entire Piedmontese territory, in 2017 some categories that had diffusion at the regional level without a particular geographical characterization stood out. In addition to traditional design for living (design of furniture, furnishing accessories, appliances, lighting and objects, street furniture), the development of communication represents the most representative sector. The design of services, social design, design for the food and wine sector moreover emerged as new sectors connoting "making design" in Piedmont, although still with small numbers or limited numbers (De Giorgi, Montagna, Coccimiglio, Dal Pozzolo & Albano, 2018).

Two elements can characterize and industrial district in terms of design: the complexity of the product architecture (intended as the interdependent subsets that compose the product structure) to which the cluster is devoted to, which induces specific industrial configurations and technological paradigms (Montagna & Cantamessa, 2019) and the degree of design orientation. The authors adopt Calabretta's definition (Calabretta, Montaña & Iglesias, 2008) of design-orientation, namely when design represents "a major force for innovativeness, in the sense that designers drive and support actions throughout the entire development process and across a broad scope of functional activities". Design orientation (Venkatesh, Digerfeldt-Månsson, Brunel & Chen, 2012) can have a positive impact, creating competitive advantage through creativity in the meanings of a product and qualities that Verganti attributes to "radical design-driven innovation" processes (Verganti, 2009; De Goey, Hilletofth & Eriksson, 2019). Indeed, Design could be considered as a key strategic asset and a source of value added for companies (Celaschi, Celi & Garcìa, 2011) and should start to be considered as a repeatable and systematic approach that companies can apply to sustain innovation (Van Der Pijl, Lokitz & Solomon, 2020) and to lead a relationship between design, identity and company culture (Bargellini, 2014).

That said, especially in mature industries, economic crisis, emerging technological paradigms, and, nowadays we could say, emergencies (such as a pandemic), could push companies toward industrial conversion and product diversification strategies to exploit internal resources and capabilities, sustain their competitive advantage (Grant, 2015), expand the product portfolio (Lüthge, A. 2020), embrace new trends and increase the potential for new geographic markets (Denis, Denis & Yost, 2002).

However, often, perhaps also given the context of needs/opportunities from which they derive, these strategies are driven by purely managerial and economic levers, without considering that industrial conversion and product diversification can lead towards goods or services capable of characterizing a territory. In this sense, therefore, it could be essential foreseeing industrial designers to collaborate in the definition of such strategies, contributing to technological vision and context and leveraging on the existing company's capabilities. The design culture is a value added for manufacturing companies that have not exploited it yet, especially because design can be a booster for the company's ability to cope with change (Borja de Mozota, 2010).

Therefore, this research's primary goal is to create a sharable design-driven framework for the analysis of possible industrial conversion or diversification strategies to be provided to companies that are exploring new opportunities of business.

Research approach and methodology

The framework is built on 60 case studies of Italian companies that, in the last 50 years, implemented design-oriented industrial conversion and product diversification strategies. Among all the case studies possible, this research has considered only companies that were in difficulty or in decline. In these cases, in fact, it is demonstrated that there is a greater awareness for the necessity of a change in product service offered to counteract a possible crisis/bankruptcy (Sarkar & Osiyevskyy, 2018); as well as, post-conversion products or services and/or production processes are completely different from the previous one.

The case studies have been collected according to the well-established iterative path proposed by Yin (2017, in Fig. 1). The sources consulted for the collection are many and varied: reports from research centres (such as Deloitte, 2019 and Symbola 2020), articles from national newspapers and territorial institutions (such as the Chambers of Commerce), as well as already known business cases (such as the ones from the Harvard Business Review library).

These case studies have been also characterised through the information about the territory and its resources (geographical location, production system), the size of the company, the factual and causal knowledge that allowed the diversification or conversion, and the materials and production processes used before and after the strategies.

The research has considered adverse events and historical crises, such as international conflicts, the 2008 economic crisis, the industrial district's crisis, and the COVID-19 pandemic.

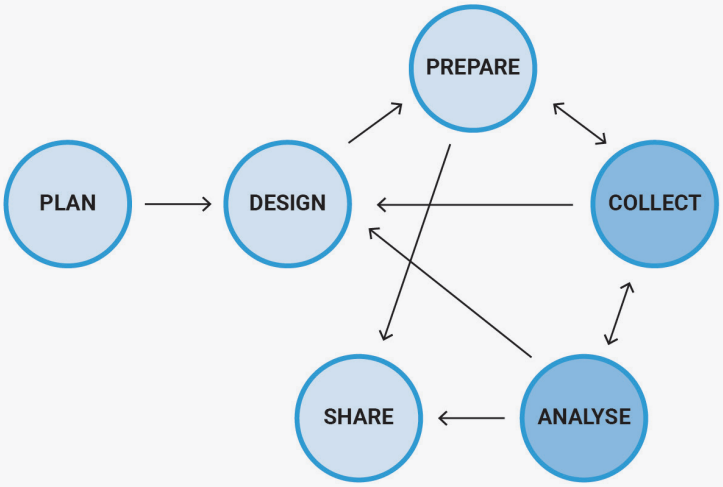

Figure 1: Doing case study research by Yin, 2017

A preliminary outcome: a classifying framework

From this preliminary analysis of the case studies, some preliminary variables for the analysis have been defined (in Fig. 2). First of all, it has been possible to understand if the company has operated a strategy of diversification (i.e. the different use of the same assets in other markets, maintaining in parallel the current business) or a complete industrial conversion (i.e., the use of the assets for a product entering a completely different industrial sector). Then, it has been possible to investigate whether this modification has involved only the product, sustaining technological competencies and maintaining the production process or vice versa, or instead if it has led to a completely different production process from the original assets, resources and competencies.

The knowledge of a specific family of materials (ceramics or porcelain stoneware), for instance, can not only support a change of product, such as from sanitary ware to outdoor tiles, but even a change of process, from moulded production (sanitary ware) to slab production possibly enabled by recycled components to support product robustness.

This can then be further characterized, distinguishing precisely whether it has been a geographical, market, segment, or business diversification, what has been the extent of this change (small change, total change) and whether this has occurred from shrinking, stable or expanding sectors.

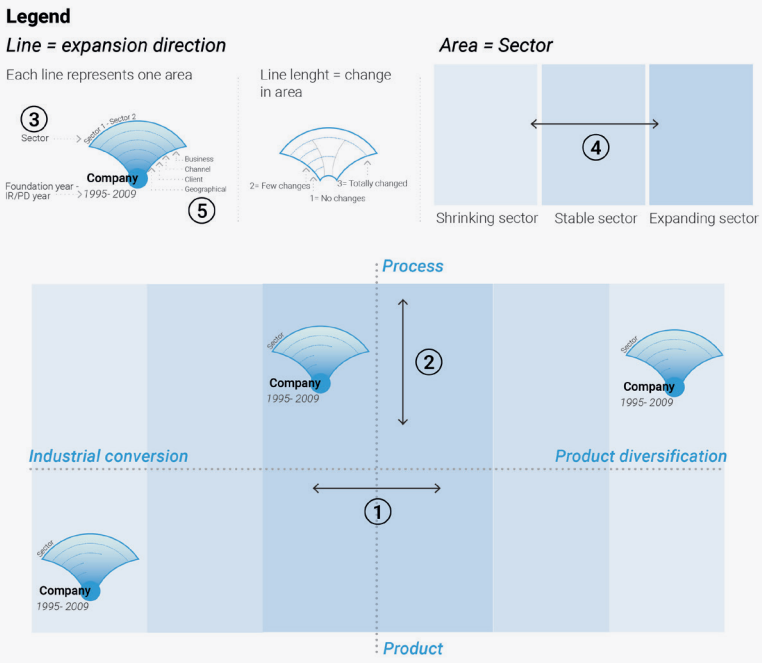

Figure 2: The structure of the designed framework

The further phase of the research will consist in validating this conceptual framework by interviewing companies that have tried to implement the above-mentioned strategies. Selected companies, to be representative of the Italian territory, will be small or medium-sized; they will be studied according to the economic and design-oriented criteria, which emerge from the theoretical framework:

- Industrial manufacturing sector (semi-finished product, component, product);
- Within a production sectoral cluster;
- Presence of a business instability/economic distress;
- Post-conversion product or process far from the previous core business;
- Low to medium complexity of the product architecture;
- Degree of design orientation: overt or potential.

The following section will describe a company included in the framework, Serralunga, an Italian company based in Piedmont in the province of Biella that produces modern outdoor furniture. Such a description will exemplify how the framework can be methodologically adopted to read the path companies have followed, but also (when it will be validated) to drive design-driven strategic decisions for further cases.

The Serralunga tannery case study

Pietro Serralunga founded the Serralunga tannery in 1825 to produce leather for soles and uppers. The existence of an industrialized economy, centred on textiles, and with high rates of mechanization of manufacturing processes, and his son, Giovanni Battista, guided the company towards the production of transmission belts and articles for textile machinery experimenting with new tanning processes (Corbetta & D'Alessandro, 2006). The first crisis that marked the company dates back to around the 1930s when the European market for rawhides was under the influence of the German market, and in Italy, the increase in imports had resulted in a greater volume of stocks than production and national exports dropped significantly. Among the leather substitutes, natural rubber was the favourite due to its lower cost advantage and shorter production cycle.

After the Second World War, the tanning sector faced new challenges concerning the technological and innovation aspects related to the introduction of alternative materials to leather and the search for new industrial applications. The company took steps to acquire the technical skills to adapt and guide new production processes to treat new materials. The quality improved and the availability of synthetic raw materials, synthetic rubber and thermoplastic resins, which had characteristics that were more able to satisfy market demand, increased.

The real revolution came around the 1950s when advances in the chemical industry led to the spread of synthetic rubber and plastics. Despite the crisis, the company concentrated its efforts on continuous and systematic research and updating materials, machinery, and equipment. This strong drive for innovation and the perseverance of the new generations led to the introduction of plastic injection moulding and the rotational moulding technique imported from the USA towards the end of the 1950s.

The experience in America was probably the most important formative experience in Marco Serralunga's studies. Although employed in management and production roles, Marco Serralunga found ways to take advantage of the experience to gain familiarity and expertise in the technical aspects of the production process and see new business opportunities. Parallel to the company's traditional activities, Marco Serralunga, driven by market needs and the desire to explore new businesses, began producing plastic vases using the rotational moulding process. The new vases replaced the terracotta ones and had features that favoured their popularity: they were lighter and easier to transport. A slow transformation process began within the company from this moment on and lasted ten years. During this time, the older generation continued to produce components for machines in the textile industry, while the new generation explored the plastic vase market and made the first collaborations with relevant design personalities. The production process of making the vases was different and required an economical and technological effort. Rotational moulding is an industrial technology that results in limited production to a few dozen pieces per day and requires a great deal of skill and excellent manual dexterity from specialized technicians. Therefore, the company's efforts were many: the purchase of new machinery, equipment and skilled labour, identifying new suppliers, key partners and a new target market, and finally, the definition of a new communication strategy to reach new customers. Therefore, the previous business was fundamental in this transition phase for the economic sustenance of the company itself. The process of industrial conversion ended in the early 1990s, when Marco Serralunga, driven by personal motivations, decided to definitively abandon the old reference market, making Serralunga a design-driven company (Fig. 3).

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Figure 3: Illuminated pots and lamps of Serralunga, photo by Federico Villa; Holly All vase, designed by Philippe Starck; Santavase vase, designed by Denis Santachiara; Paloma, designed by Eero Aarnio.

If one looks at Serralunga according to the variables suggested by the framework (Fig. 4), one could say that the company operated an industrial conversion leaving an industry that was suffering a crisis. Serralunga changed entirely its reference industry by taking a forward-looking view and entering the outdoor furniture sector through investment in an innovative and pioneering production process. For this reason, it can be displayed on the “Industrial conversion - process” quadrant of the framework, in the “shrinking sector” area. While maintaining its previous location and building, the company implemented several changes in terms of business model, distribution channel, and customers. The new family of design-oriented products allowed entering a B2C market, specifically devoted to that segment of customers interested in ‘made in Italy’ and the refined taste of Italian design.

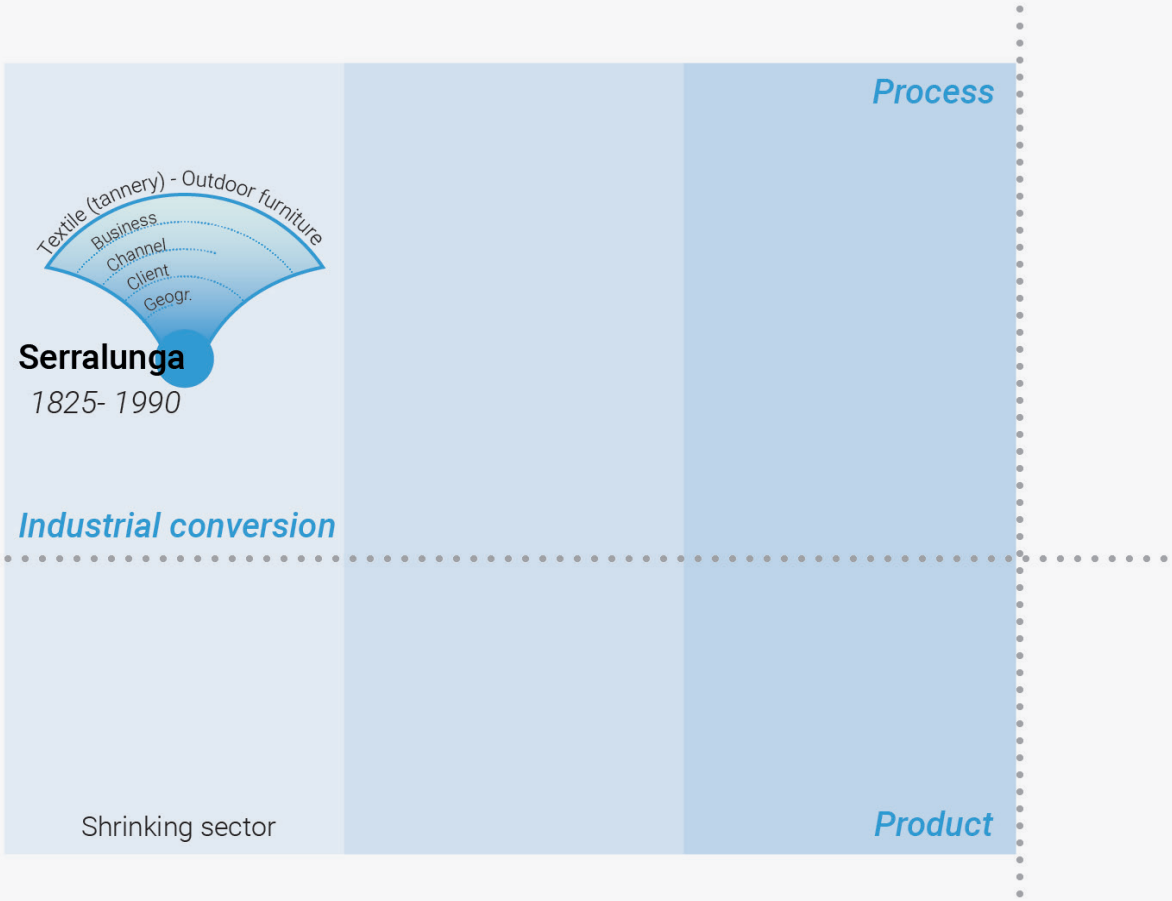

Figure 4: Serralunga in the framework

As mentioned, the slow decline of the tanning industry began after 1950 with the entry of rubber and plastics into the field of technical articles. In Biella, the number of employees halved in 10 years and of the six tanneries only two remained, which were able to face the challenge of new materials and completely changed production, machinery, plants, retraining the workforce. Today, the old factories are industrial archaeology (Fig. 5).

Figure 5: Industrial ruins in Biella, photo by Ibello

Discussion and conclusions

The case study shows how the framework can guide the analysis of industrial diversification or conversion choices made by companies and help understand the importance of a pioneering and far-sighted vision in anticipating a crisis and riding the wave of change. Furthermore, by placing the single company in the same frame as other companies in the sector, it is possible to observe how other companies of the same sector operate. Thus, it is possible to qualitatively observe, for example, the trend of analogous territorial specializations, production clusters and industrial districts. In some cases, the framework can highlight cases where low innovation possibilities or ineffective implementation strategies could be due to cognitive traps and organization inertia (Anthony, Trotter, Bell & Schwartz, 2019; Bertolini, Duncan & Waldeck, 2015). Obviously, in this case, this eventuality should then be explored more rigorously through the appropriate tools from Management.

Operatively, Torino's Chamber of Commerce does not currently have a list that details the various conversion and diversification paths of companies in the territory. Therefore, the framework will be a helpful tool to analyze the current state of the art and forecast possible re-categorizations of Piedmont production, exploiting the territorial capital (Camagni, 2017). The next step envisaged is an analysis of production trends in the Piedmont/Turin region to combine quantitative and qualitative research. What emerges from this tool is the power of industrial districts, as in the case study described. These strategies can weave new forms of relationships between district enterprises and territorial contexts, recognized as large pools of potential intervention (Arquilla, 2005).

Currently, the major limitation is represented by the number of case studies. Few companies in Italy have implemented diversification according to the above specifications, and even fewer have implemented an industrial conversion. In future work, the authors intend to test a hypothesis: can the industrial conversion of companies of a district give rise to collaborations and mutual support?

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Title:

Rivers as Persons in Human-Centred Design: Centring Indigenous Leadership and Knowledges in the Design Process

Author:
Sara Hubberstey

Institution:
Human-Centred Design
Algonquin College
(Canada)

In 1960s British Columbia (Canada), the provincial government partnered with entrepreneurs, engineers, and geologists to construct a hydroelectric dam on the Peace River. While the dam brought electricity to many households in Canada and the United States, it also displaced locals, including First Nations members, destroyed crops, and disrupted habitats (Loo, 2007). When First Nations made recommendations to address the social and environmental devastation caused by the dam, those involved in the dam's construction misunderstood the different relationships people had with the river and inadequately evaluated the scope of the resulting problems.

In contrast to the damming of the Peace River, the legal recognition of personhood – rooted in Māori knowledge – of the Whanganui River in Aotearoa New Zealand in 2017 reframed how settler policymakers and citizens viewed human relationships with the river. Today, the river's rights must fundamentally inform decisions where the needs and frustrations of different users may conflict. Kramm (2020) proposes the use of "functionings" of the river to evaluate wellbeing, such as "being clean," "flowing unhindered," and "being respected as an ancestor" (p. 314). Central to recognizing the personhood of the Whanganui River has been the Māori leadership and knowledge that challenged colonial frameworks to go beyond centring humans in decision-making to centre more-than-humans (O'Donnell et al., 2020). This paper uses the examples of the Peace River and the Whanganui River to explore the risks of leaving more-than-humans out of the design process and the need for Indigenous leadership and knowledges to be central in more-than-human design.

As the world pays more attention to how human activities affect the planet on a massive scale, designers working in Euro-Western frameworks are coming to grips with the difficulty of separating humans from the environment (Allenby & Chester, 2018). Recent scholarship introduces participatory research centred on more-than-humans, such as plants or other animals (Mancini, 2016). Not doing so risks continuing the processes of harm that have led us to environmental crises today. While many Indigenous worldviews assume personhood and relationships among humans and more-than-humans, the language of design in Euro-Western frameworks assumes a divide between humans and the rest. As designers from Euro-Western disciplines shift the design process to include more-than-human subjects, the risk arises that design takes from and overwrites existing Indigenous knowledges and legal codes rooted in deep understandings of human and more-than-human relationships. At the same time, an opportunity arises to place established Indigenous knowledges and leadership at the centre of the decision-making process. A design process that moves beyond centring humans has the potential to help us make more sustainable decisions through expanding Euro-Western understandings of human and more-than-human relationships, helping us better evaluate the impacts of human activities, and allowing established Indigenous frameworks and leadership to be central to the design process.

More-Than-Human? Nonhuman? Centring Indigenous Scholarship

Scholars mean different things when they refer to what is 'not human', 'nonhuman', or 'more-than-human'. Some think of what Euro-Western worldviews consider to be 'living', such as plants and animals, while others refer to any object or thing that is not human, like a mobile phone. In this paper, I am learning from the works of Indigenous scholars such as Zoe Todd, Kim TallBear, and Vanessa Watts, who consider relationships between humans and more-than-humans in their work. While each scholar approaches more-than-humans differently, discussion tends to include subjects such as mountains, rivers, animals, plants, rocks, fire, thunder, and other elements that in a Euro-Western worldview we typically point to as 'natural'. But this can also extend beyond what we tend to consider natural, for example in how oil can be more-than-human if seen as fossils and fossil-beings that are then weaponized by corporate and political bodies (Todd, 2017). I use the wording more-than-human instead of nonhuman to place emphasis on the relationships between humans and more-than-humans, an emphasis clearly drawn in Métis scholar Zoe Todd's works. To reframe common Euro-Western understandings of these relationships, including my own understandings writing as a settler with a mixed European and East Asian background, I aim to move away from the assumption that nonhumans are less than or lacking in intention and abilities that humans have.

I look to Watts' (2013) examination of agency in Indigenous (Haudenosaunee and Anishinaabe) knowledges, where habitats and ecosystems are societies that have "ethical structures, inter-species treaties and agreements, and further their ability to interpret, understand and implement" (p. 23). This understanding is an important starting point given the centrality of Indigenous action in global movements to centre more-than-humans. Sisseton Wahpeton Oyate scholar Kim TallBear (2011) points out that as non-Indigenous members of the academy begin "articulating the idea that life/not life is too binary and restrictive" (para. 25), it is ever more important that Indigenous voices be part of the conversation. Along with centring these voices in exploring more-than-human-centred design, it is also important to not generalize Indigenous knowledges. For example, Whanganui Iwi relations to the Whanganui River in this paper exist in a different framework than the relations between members of Tsay Keh Dene First Nation and the Peace River. At the same time, Indigenous leadership in recognizing rivers as persons is prompting and inspiring change worldwide, thus it can be beneficial to see the connections between these actions to understand how they can become central to more-than-human-centred co-design processes.

While many Indigenous worldviews assume personhood and relationships among humans and more-than-humans, the language of design in Euro-Western frameworks assumes a divide between humans and the rest. As designers from Euro-Western disciplines shift the design process to include more-than-human subjects, the risk arises that design takes from and overwrites existing Indigenous knowledges and legal codes rooted in deep understandings of human and more-than-human relationships.

Designers Reframing Relationships with More-Than-Humans

While different Indigenous frameworks have long centred more-than-humans, Euro-Western frameworks must undergo change to deconstruct views that separate humans from nature, and in the process become aware of how these changes relate to existing Indigenous knowledges. In Euro-Western-rooted design, the limits of centring humans are becoming apparent as designers come face to face with the vast environmental impacts of human activities. Scholars of design are showing that in areas where it once appeared sufficient to design for human needs, we need to consider indirect consequences of our decisions in order to truly design for sustainability. As the environment in which we design is saturated with devastation, resource depletion, and climate change caused by human interventions, we also see that different humans and more-than-humans experience impacts unevenly (Bastian et al., 2016). Allenby & Chester (2018) point to how engineers now must engage with the unintended environmental and social impacts of human-built infrastructure systems in their work. Design challenges become more complex when they include 'natural systems'. In one example, the authors point to how engineers cannot simply build an airport in a protected part of Peru without understanding the ecological and cultural effects of such a project (Allenby & Chester, 2018). By including a wider understanding of the considerations at play, an engineer might decide to down-design an infrastructure system to be less robust if the natural system calls for a temporary system, rather than designing by default a long-lasting system to serve only human interests (Allenby & Chester, 2018, 62). By necessity, including natural systems in the design process leads us to recognize that human needs alone cannot inform design choices. Indeed, centring environmental realities can help create more sustainable futures for humans and more-than-humans alike.

Beyond environments typically seen as needing protection from harmful interventions, designers can reframe relationships with more-than-humans in spaces densely populated with humans. In the design of cities, Forlano (2016) advocates for designers to decentre humans in order to properly take on a mediating role between contradictory perspectives from humans and nonhumans – in this case including technological agents – and properly engage with ethical considerations. If we combine the approaches of human-centred design with participatory design and speculative design, we can better imagine and reflect on our needs in a city and recognize nonhuman agency (Forlano, 2016). As Forlano (2016) puts it, "Designers who consider the nonhuman might find themselves reorganizing entire social and environmental systems" (p. 50). In a time of global environmental crises, reframing our understandings of human and more-than-human systems becomes necessary for sustainable design.

Even areas of design which have traditionally been viewed as more narrowly focused than infrastructure or urban design are having to move beyond direct human needs to address needs for environmental sustainability. The future of fashion in a world where human activity has become a planetary force, according to Payne (2019), rests on finding an environmentally sustainable way forward, whether through advancing technologies or through shifting to a local make-and-mend model. Given fashion is heavily reliant on raw materials, will extreme weather cause disruptions in supply? How will environmental regulations affect fossil fuel use in textiles (Payne, 2019)?

Central to this vision of the future for fashion is recognition that humans cannot ignore environmental realities. Our individual desires for clothing are absent. Shifting our understanding of the fashion space to include focus on our relationships to more-than-humans may help draw a more direct connection between unsustainable practices and the clothes we buy, reshaping the many levels of disassociation we currently have from field to purchase in our relationship with fashion today.

Scholars from different areas of design, including human-centred design, are exploring the limitations of placing human needs and frustrations at the centre of complex problems. Some scholars have introduced methods which go so far as to explicitly place more-than-humans at the centre. Bastian et al. (2016) explore the possibilities of more-than-human participatory research (MtH-PR) in response to "the need to take environmental devastation seriously" and to "better support more sustainable ways of living together" (p. 2). This process goes beyond attributing agency to more-than-humans and instead brings more-than-human subjects into the research process (Bastian et al., 2016). For example, in animal-computer interaction environments such as the automatic voluntary milking of cows, design has not focused on the user, the cow, but instead on the human stakeholder, the farmer. As a result, farmers may lose out on profits if they cull cows that are not engaging with voluntary milking (Mancini, 2016). In this case, a shift to centring the cow's perspective can also shift our understanding of animals, as well as our relationship to them, while working towards a common goal of sustainability.

By shifting our understanding of problem spaces in design to allow for more-than-human subjects at the centre, we can better assess the totality of human relationships with more-than-humans. In designing infrastructure, decisions that centre environmental realities can prevent unsustainable solutions. Looking to the complex problem of urban design, transforming our understanding to include more-than-human agency can redefine how we see the systems in which we live. In more traditional design fields such as fashion, placing emphasis on our relationships to elements essential to the manufacturing process can shape our ultimate goals in a design. In MtH-PR, instead of viewing more-than-humans as one aspect of a problem space, we reframe the problem when we place them at the centre. When designers seek to better understand our relationships to more-than-humans, we introduce possibilities for sustainable design. In this shift in understanding, it will be important to understand the colonial roots of the discipline to be able to centre relationships with more-than-humans in a way that engages existing Indigenous knowledges within the same problem space.

Risks of Leaving Out More-Than-Humans

Before we look further into the potential of designing with more-than-humans at the centre, we can first establish the practical risks of leaving more-than-humans out of the design process altogether and ignoring existing Indigenous knowledges. Now understanding how the way we perceive relationships among humans and more-than-humans informs our design decisions, how does ignoring the agency of more-than-humans affect not only how we frame design problems, but also how we assess the impacts of our designs? The case of the damming of the Peace River in British Columbia through the 1960s offers a clear example of misunderstanding, miscommunication and difficulty in assessing environmental impacts due to inconsistent understandings of the centrality of more-than-humans in the design problem.

Through the 1960s, in an initiative put forward by the British Columbia provincial government, engineers, scientists, construction workers, businesspeople, and politicians worked together to transform the Peace River and the Athabasca Delta (the Peace) through the construction of a hydroelectric dam that would generate significant electricity for Canadians and Americans (Loo, 2007; Loo & Stanley, 2011). The impacts of this transformation spread widely and unevenly. For some, it meant jobs and an industry boom, such as when BC Forest Products, given access to cheap power generation, decided to build a forestry complex that would directly and indirectly employ thousands of people (Loo, 2007). For others, it meant displacement and loss of livelihood, such as when reservoir waters submerged the settlements and traplines of forty to fifty members of the Tsay Keh Dene First Nation who were then forced to new reserves, or when the dam increased the cold and humidity of surrounding farms and prevented the drying of crops (Loo, 2007). The dam inflicted several other impacts on more-than-humans: Animals drowned, mountain caribou were blocked from their migration paths, birds in surrounding areas disappeared, beavers were left to the mercy of winter, sediments and toxins accumulated in the water, and wetlands declined as the delta dried out (Loo, 2007). The significant changes brought on by the damming led to opportunity and prosperity for some and loss of autonomy and the influx of social problems for others.

Because social and environmental changes were intimately connected to the Peace River and Athabasca Delta, everyone understood the scale of the problem space and impacts of the damming differently based on uneven experiences and understandings of the Peace. The engineers and geologists had built their knowledge through the experiences they had had during the dam's planning and construction, resulting in detailed knowledge such as of the Peace's hydrology or minerals (Loo & Stanley, 2011). In 1971, when it came time to propose solutions to the devasting social and environmental impacts of the dam, an intergovernmental task force aimed to "restor[e] the role of the water to the delta" (Loo, 2007, p. 909). For those who designed and planned the dam, the devastating social impacts could be solved by building a new dam that would simply restore the delta to its 'original' pre-dam water levels. Of course, for the Peace, there was no such thing as original water levels, as change was a feature of its ecosystem (Loo, 2007). The taskforce's solution did not approach the problem with a perspective shared by other stakeholders.

For the people displaced, restoring previous water levels did not acknowledge their relationship to the Peace and the extent of the social and health effects the dam caused.

Thus, when the Athabasca Chipewyan and Mikisew Cree band councils instead responded to the task force's proposed dam with recommendations for an "all-weather road, improvements to the airport, better schools, help with starting a quarry, and jobs in tar sands development," the task force was left confused (Loo, 2007, p. 910). In this case, the band councils evaluated the problem based on their relationship to the Peace River and the history of colonialism, while the task force evaluated the problem as an entire watershed from 1968 – the point of the damming – onwards (Loo, 2007). As we see in this example, different stakeholders with different relationships to and knowledges of the river and delta evaluated the damming of the Peace and its social and environmental effects in drastically different frameworks. For residents who delineated the problem space based on their relationship to the river, solutions that ignored these relationships addressed issues that were irrelevant to the problems at hand.

Unfortunately, what followed was indeed the building of a second dam on the Peace River in 1980. While the province and BC Hydro compensated Tsay Keh Dene Nation in 2009 for the impacts of the first dam, and despite the B.C. Hydro's Bennett Dam Visitor Centre creation of an exhibit that acknowledged the devastation, these actions sit in stark irony against present-day events (Loo, 2016, para. 13). Today, a controversial third dam on the Peace River, the Site C dam, is currently under construction, which will flood an estimated 5500 hectares of land. As Loo (2016) notes, the dam will further "compromis[e] Indigenous peoples' hunting and fishing rights as well as the lives and livelihoods of settler farmers, trappers, and guide-outfitters" (para. 1). First Nations and other landowners have waged several legal and organized actions against federal and provincial approval of Site C (Cox, 2017). Failure to centre to river and the extent of its relationships with other humans and more-than-humans when evaluating the problem space has allowed decision-makers to continue averting their eyes as devastating impacts continue to unfold.

The damming of the Peace River is not a singular event in Canadian history. Canadians have long relied on controversial resource extraction. Luby (2015) writes that hydroelectric generation after the construction of the White Dog Dam on the Winnipeg River in the 1950s "disrupted the environment's ability to provide resources necessary to maintain [Anishinabek] women's reproductive health (especially breast milk)" (p. 365). Luby's phrasing gives agency to the environment and points to how the hydroelectric project disrupted the relationship between the river and the Anishinabek women who had once been able to feed their children from the river. We see patterns of events like these throughout Canada in different natural resource spaces, playing out in present-day conflicts and presenting opportunities for a more-than-human centred co-design process to take shape.

In seeing the Whanganui River as a person in a network of relationships, the river can be centred in decision-making and humans can assess potential impacts of human activities in terms of effects on the river's functionings.

Evaluating Impacts Based on the River and its Needs

If understandings of the impacts of damming the Peace River differed based on how the problem was framed by various stakeholders, what happens when instead, we frame the problem based on the needs of the river? In the case of the Whanganui River in Aotearoa New Zealand, Whanganui Iwi (the Whanganui Māori tribe), negotiated with the federal government to embed their understandings of the river in legislation. In 2017, the New Zealand federal government recognized the Whanganui River as a legal person. Two guardians were appointed from the federal government and from the Whanganui Iwi to maintain the health and wellbeing of the river (Kramm, 2020). This means that should a company with existing land rights intend to build a hydroelectricity dam on the river, it must now interact with the guardians who are responsible for defending the river's rights.

Understanding the Whanganui River as a person is rooted in Māori philosophy and concepts. Kramm (2020) explains the Te Awa Tupua (Whanganui River Claims Settlement) Act from the starting point of the Māori notion of whakapapa, where "each human being is born into a network of relationships that comprises living human beings, but also human and non-human ancestors (tupuna)" (p. 308). In this framework, the Whanganui River has intrinsic value because it is an ancestor with life force and spiritual integrity (O'Donnell et al., 2020). The spatial limits of the river are defined by its relationships with Māori people. These relationships are reciprocal and based on mutual obligations and a Māori concept of duty (Kramm, 2020). We have seen that limits based on relationships with more-than-humans were not an aspect of the problem space outlined by the intergovernmental task force in evaluations of the Peace River and Athabasca Delta.

Rooting the river's personhood in Māori philosophy shapes how the health and wellbeing of the river is maintained. Kramm (2020) proposes the use of "functionings" of the river to evaluate wellbeing, such as "being clean," "flowing unhindered," and "being respected as an ancestor" (p. 314). Functionings can also distinguish between reversible and irreversible harm to help evaluate decisions that affect wellbeing, such as "flowing unhindered by dams and rerouting projects," versus "being free from agricultural use" (Kramm, 2020, p. 315).

Put in other words, "While it would be forbidden to reroute the river for irrigation purposes, it would be permissible to use it for the irrigation of fields that are located next to the riverbanks" (Kramm, 2020, p. 315).

The functionings listed by Kramm correspond easily to the notion of needs in a human-centred design process. In line with Bastian et al. (2016)'s notion of bringing more-than-human subjects into the research process from the beginning and not as a stakeholder, evaluating the Whanganui River's health and wellbeing based on its functionings helps to centre the river in the decision-making process from the start as defined by its relation to Whanganui Iwi as an ancestor. Centring the river's needs in the problem space avoids situations such as in the damming of the Peace where understandings of impacts conflicted and diverged based on different understandings of the problem space. In seeing the Whanganui River as a person in a network of relationships, the river can be centred in decision-making and humans can assess potential impacts of human activities in terms of effects on the river's functionings. The granting of legal personhood to the Whanganui River has inspired similar cases around the world. Recently, in Canada, the Innu Council of Ekuanitshit and the Minganie Regional County Municipality declared the Muteshekau Shipu (Magpie River) to be a legal person. The river has nine rights, such as the right to "evolve naturally and be protected, to be free of pollution and to sue" (Townsend et al., 2021, para. 7) and the "right to flow" and to "maintain its biodiversity" (Lowrie, 2021, para. 3). Such rights would be infringed upon should a hydroelectric dam be built. While the governmental context differs from the Whanganui River in Aotearoa New Zealand in that the Canadian federal government and courts were not involved in the declaration of Muteshekau Shipu as a person, time and efforts will show how this declaration will play out in decision-making processes.

Centring Indigenous Leadership and Worldviews in the Design Process

As designers begin reframing the relationships between humans and more-than-humans and centring more-than-humans in the design process in response to recent environmental crises, the discipline must also acknowledge that such shifts are not radical or new. Actions such as the legal recognition of personhood did not come about simply as a result of societies coming to terms with climate change, but instead relied heavily on established Indigenous knowledges and leadership. In discussing movements toward recognizing the rights of Nature in the context of river personhood, O'Donnell et al. (2020) argue that "rights of Nature either simply would not have happened, or would have been much less effective in delivering tangible environmental outcomes, without the leadership of certain Indigenous peoples" (p. 405). In the case of the Whanganui River, it was Māori Iwi who negotiated for Māori concepts to become recognized in law and for co-management of the river. O'Donnell et al. (2020) caution that within settler-colonial frameworks, a river becoming a person can also lead to scenarios in which someone may try to sue a river and its guardians such as in the case of flooding. Indigenous leadership has been central to the success and prevalence of recognition of personhood, and such efforts should not be dismissed as design processes shift to centre more-than-humans. Rather, it may present an opportunity.

Given design thinking and human-centred design have their roots in western institutions (Camacho, 2016), as design expands into social and political domains it is important for designers to assess how our designs fit within the colonial projects of many western nations. As the role of the designer extends into new spaces, there are possibilities and risks in living up to the role of designer as mediator or facilitator, particularly as designers come to a table where there has long been a turbulent dialogue in play. At the same time, this is perhaps where designers familiar with co-design and human-centred design processes can challenge colonial realities and assist in letting go of power in favour of facilitating dialogue around a common problem. In my research to date, I have found little human-centred design research that investigates colonial realities, much less that explicitly centres Indigenous worldviews. Thus, it is important when addressing a topic such as the potential for more-than-human-centred design, to consider the roots of our assumptions and how they relate to Indigenous worldviews and ongoing forms of colonialism.

Taking on the role of designer as mediator or facilitator does not make designers immune to how the history of design disciplines have contributed to and been created by Euro-Western worldviews that have historically colonized and been opposed to Indigenous was of thinking. Indigenous leadership risks being sidelined when publications and the media, as O'Donnell et al. (2020) put it, "bury the lede," or leave out the important part of the story (p. 405). For example, when Willems et al. (2021) discuss how new ways of governance can protect the rights of nature in line with the UN Sustainable Development Goals, the authors frame the ecosystem as having a board or representatives like a corporation would have, where the ecosystem can "participate as a stakeholder at the table and represent its own needs" (p. 4).

This definition does not make space for Māori concepts which include relationships to more-than-humans as an ancestor (Kramm, 2020). Meanwhile, Willems et al. (2021) mention benefits to Indigenous peoples last in their argument, and notably do not centre Indigenous leadership in this process, stating instead that Indigenous communities "can be included in the group representing the ecosystem" (p. 4). Designers, too, risk sidelining Indigenous involvement if taking on facilitation without also grappling with existing power structures in play. More-than-human design offers the potential to transform traditional Euro-Western constructs of nature away from the notion of pristine wilderness, separate from humans, and work instead towards sustainable designs, but to be successful it must go beyond responding to current environmental crises to recognize the contributions of non-western and Indigenous Peoples and embrace an approach that does not overwrite existing knowledge and continue processes of colonization. O'Donnell et al. (2020) argue that "only by recognizing, and empowering, Indigenous leadership as part of an ongoing co-design and co-management approach" can a "pluralist, truly transformative ecological jurisprudence" emerge (p. 427). More-than-human design offers the opportunity for transformative co-design that can restructure Euro-Western frameworks and move towards more sustainable designs while centring Indigenous leadership and worldviews in the process.

Conclusion

As design makes its way into the social, political, and cultural aspects of society to address more and more complex problems, and as design responds loudly to the environmental realities of our time, more-than-human-centred design offers the potential to address problems in a way that human-centred design cannot. When we centre more-than-humans in the design process, we reframe the problem to recognize the relationships among humans and more-than-humans that shape our society. Within this shift, however, continued work is needed to interrogate Euro-Western assumptions present in the field and to not overwrite existing practices. Given human-centred design already reframes problems and challenges assumptions, more-than-human design could allow for even greater centring of Indigenous knowledges in decision-making. There may be applications in reshaping colonial relationships that play out in resource issues and land claim settlements.

More broadly, in areas where it has historically been difficult to hold humans to account, such as in cases of environmental devastation from resource development, more-than-human-centred design offers the potential to provide a more complete picture of the problem space and build common understanding. We can shift focus to the needs of and relationships with more-than-humans to help us better evaluate the impacts of potential actions and come to sustainable solutions. Given Indigenous-led initiatives to date in which Indigenous knowledges and worldviews have been negotiated into law and legislation, such as in recognizing the personhood of a river, design that centres more-than-humans presents settler societies with the opportunity to deconstruct colonial ways of thinking and enact true co-design processes that centre Indigenous knowledges with reconciliation in mind.

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Title:

The Innovative Design Ecology of Intangible Cultural Heritage in Social Transformation: Based on 12 Years of Design and Social Innovation Practice in Rural China

Authors:
Xiaolei Min
Tie Ji
Tianyi Tang
Yinman Guo

Institution:
School of Design,
Hunan University
(China)

Since UNESCO issued the Convention for the Safeguarding of Intangible Cultural Heritage in 2003[1], Intangible Cultural Heritage (ICH) has continuously attracted the attention and participation of interdisciplinary and intercultural groups. However, under the influence of the COVID-19 epidemic, facing the constant social transformation in extreme times, the inheritance and innovation of ICH are confronted with more complicated and unimaginable challenges, such as decontextualization, over-commercialization, and fragmentation. It is necessary to establish a systemic and dynamic frame to drive the sustainable development of ICH by asking: how can the cultural ecology of ICH be systematically structured? What are the best ways to promote the innovation of ICH through innovative designing? Can rural areas be revitalized by ICH creative industries?

This research is derived from the NewChannel Design and Social Innovation project[2] that has been continuously organized by the School of Design at Hunan University (China) since 2009. Deeply rooted in Chinese rural areas, this project conducted field investigations in the Dong, Yao, Tibetan, Mongolian, and other minority communities, collected abundant first-hand material of local ICH resources, fully explored the relationship among cultural resources, cultural industries, new technologies, and innovative design. As the main participants, the authors analyzed and summarized the method system of ICH innovation from the perspective of cultural ecology, and constructed a cultural innovation ecology of ICH with multiple paths of design participation. According to the structure of “Context – Cognition – Method - Practice”, this study consists of these four parts.

1. Context layer: The development path and main problems of China's ICH protection in social transformation

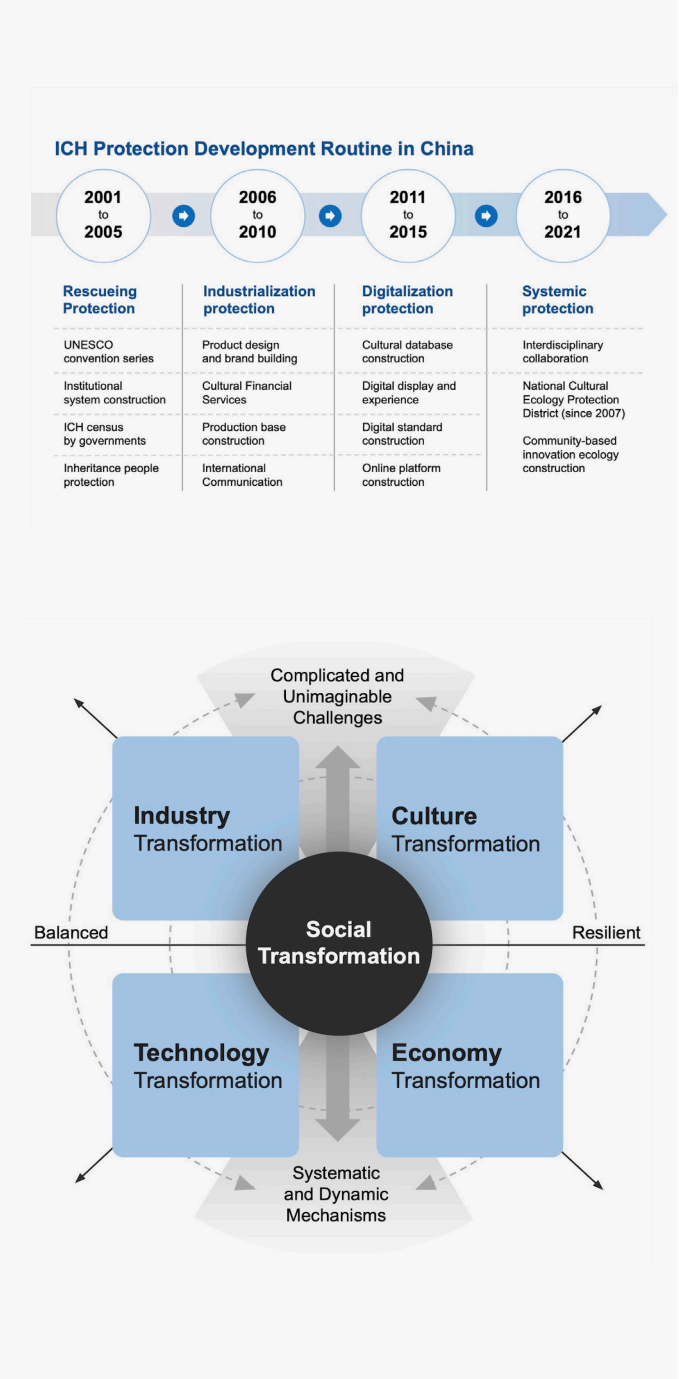

Figure 1: The Development of China's ICH Protection System

Social transformation is a complex process influenced by political, technological, economic, cultural, and other comprehensive elements[3]. Under the constant changing of social and cultural context, the protection concept and innovation methods of ICH urgently need to be reconstructed and transformed through establishing a systematic and dynamic mechanism.

It has been 20 years since Kunqu Opera was selected into UNESCO's Masterpieces of the Oral and Intangible Heritage of Humanity in 2001. During these 20 years, the process of ICH protection in China can be divided into four stages:

- Stage 1: Rescuing protection and institutional system construction (2001 - 2005);
- Stage 2: Industrialization protection and international communication (2006 - 2010);
- Stage 3: Digitalization protection and public services improvement (2011 - 2015);
- Stage 4: Systematic protection and collaborative innovation (2016 - 2021).

Under government leadership and public participation, the protection of ICH has become a significant part of the cultural construction in China and therefore has been seen as an influential "Chinese paradigm" to the world [4]. (Figure 1)

However, with the rapid development of Information and Communications Technology (ICT), as well as the deep integration of culture and technology, significant changes have taken place in people's living patterns, production methods, and consumption behaviors. Taking traditional handicrafts as an example, under the impact of industrialization, handicraft skills have been gradually replaced by mass production and customized 3D printing services. The living space of craftsmen in modern society is constantly being compressed, slowly being eliminated and forgotten. In addition, as of 2020, China has built 5,788 museums of different types. Although most of the museums are beneficial for the safeguarding and dissemination of ICH, in some marginalized areas, it can be found that some ICH projects are 'captive' in museums, so their original cultural ecology has somehow been stripped and destroyed. Therefore, there are multiple questions to examine: can body memory be replaced by technology? Should ICH be integrated with people's everyday life and how? How can the transformation of ICH be understood in this new era?

2. Cognition Layer: The elements and interrelationships of ICH's cultural ecology

2.1 Theoretical basis of cultural ecology

Cultural ecology is a theory that studies the composition and interaction of elements in the process of cultural development[5]. It is the ecological relationship formed by all the internal and external elements and their interactions that make up the cultural system[6]. Since the concept of "Cultural Ecology" was first put forward in 1955[7], the theory of cultural ecology has continued to diverge with the times and has had a profound influence on the world. Since 2007, China has started the National Cultural Ecology Protection District project.

Established with the approval of the Ministry of Culture and Tourism of China, the Cultural Ecology Protection District refers to specific areas with rich ICH resources and distinctive cultural characteristics. As of 2021, China has established a total of 25 national and 197 provincial Cultural Ecology Protection Districts, which are not only innovative explorations during the process of ICH protection, but also a valuable practice in the application of cultural ecology theory to the Chinese context.

2.2 Knowledge graph analysis and field investigation

In 2018, UNESCO successfully created the *Dive into Intangible Cultural Heritage* project [8], applying the technologies of web semantics and graphic visualization to build a dynamic and interactive space for the expression of the ICH knowledge system. It can be seen that the construction of a knowledge system is crucial for the holistic protection of ICH. Therefore, this research took Web of Science, Scopus, CNKI databases as data sources, and used knowledge graph analysis tools, such as CiteSpace and VOSviewer, to conduct cluster analysis and comparative research (specifically including keyword co-occurrence analysis, time axis analysis, etc.). By extracting, summarizing, and analyzing the key nodes in the ICH knowledge system, it can be found that the focal points of ICH protection and inheritance include the ecological environment, space-time system, subject participation, protection methods, policy support, sustainable development, etc.

In addition, this research conducted a seven-year field investigation in 15 villages in the central and western regions of China. Through questionnaires, unstructured interviews, and other research methods, resources of more than 45 ICH projects have been collected, such as handmade bamboo-paper in Jiajiang, Sichuan; Dong brocade in Tongdao, Hunan; Thangka in Shangri-La, Yunnan; and the Khumai in Inner Mongolia, etc. Through in-depth research and comparison analysis of the historical background, inheritance status, main challenges, and industrial formats of these projects, the fundamental elements of the ICH cultural ecology can be summarized.

2.3 Key elements and characteristics of cultural ecology

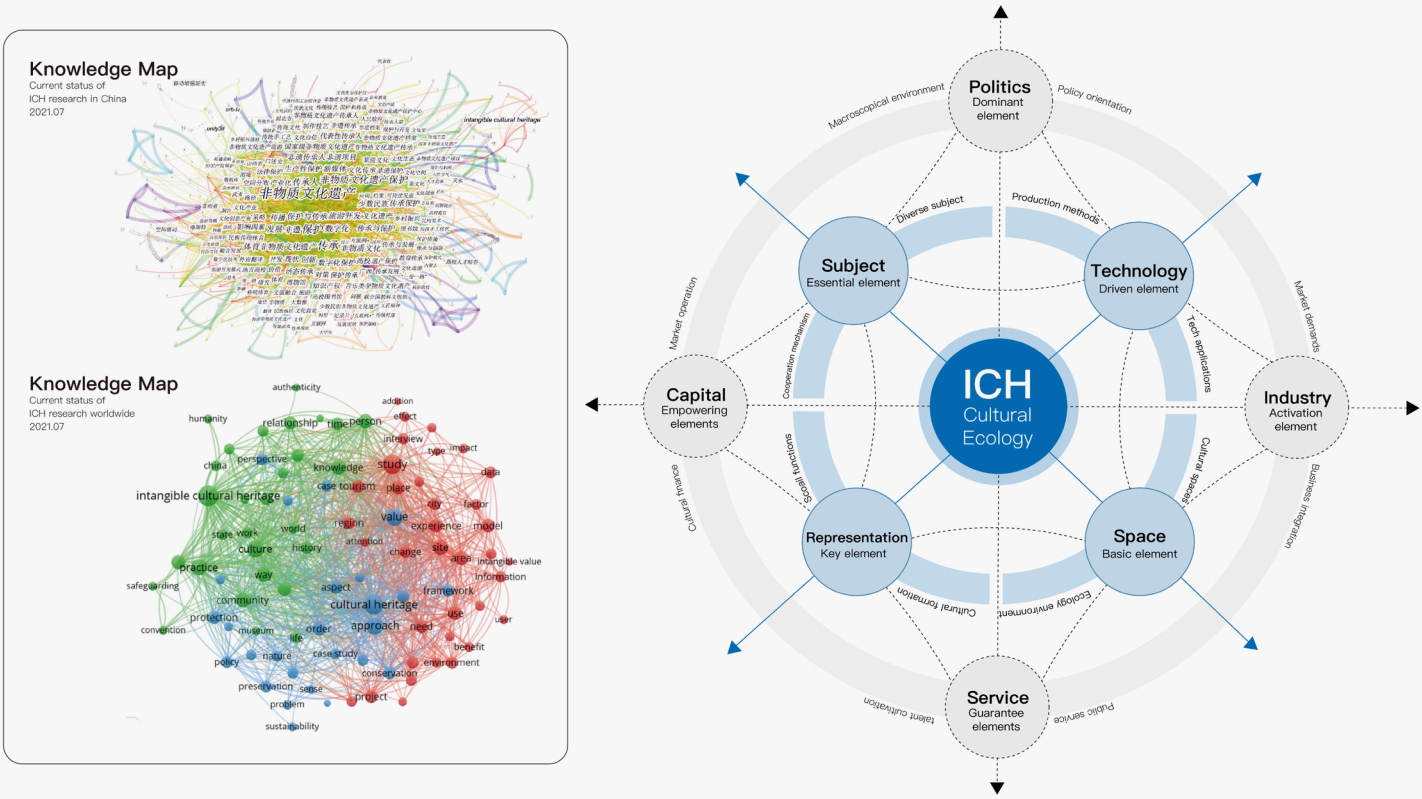

Figure 2: Knowledge graph and Cultural Ecology of ICH

The Cultural Ecology of ICH is constructed of two layers: the central layer and the ambient layer, which have complex characteristics with multivariate association (Figure 2).

2.3.1 The central layer

The central layer is composed of four elements: Subject, Space, Technology, and Representation.

- Subject refers to diverse subjects and cooperation mechanisms. Diverse subjects include individuals, institutions, communities, companies, universities, etc. The subject is the most essential element, also the main force for the inheritance, dissemination, and innovation of ICH.
- Space refers to the ecological environment and cultural spaces[9]. Space is the basic element of the cultural ecology, mainly including the natural ecological environment, local resources, cultural scenes, presentation space, historic development, etc.
- Technology refers to the production methods and technology applications. Technological innovation will directly affect the existence and mutual relationship of all other elements and is an important driven element of cultural ecology.
- Representation refers to the cultural formation and social functions, including the manifestations, symbols, images, etc. Social functions can be expressed through cultural forms, and cultural forms affect their social functions, which are the key innovative elements of cultural ecology.

2.3.2 The ambient layer

The ambient layer is composed of four elements: Politics, Industry, Service, and Capital.

- Politics refers to the macroscopical environment and policy orientation, which plays an important top-level guiding role in the cultural ecology, affecting the developmental context, government focus, and participation mechanism of ICH.
- Industry refers to the market demand and business integration. Industrial application is the activation factor in the cultural ecology, which can drive and motivate the endogenous power and inheritance vitality of ICH.
- Service refers to public services and talent cultivation. A comprehensive cultural service system and training mechanism can ensure the sustainable development of ICH, so the factor of service is the guaranteed element of cultural ecology.
- Capital refers to cultural finance and market operation. In the era of the information economy, we must accept the large influence of capital, which gradually becomes one of the most empowering elements of cultural ecology.

2.3.3 Characteristics of cultural ecology

- Integrity is the constituent elements in the system are organic, unified, and inseparable. The changes of each factor lead to the changes of the overall function, and the overall transformation also requires the adjustment and cooperation of each factor.
- Complexity denotes the relationships between ICH knowledge and the cultural ecology environment are complicated and complex. So, there are more diversified internal relationships, external relationships, logical levels, and interaction mechanisms in the cultural ecology of ICH.
- Openness shows the main elements and relational structures in the system are not fixed and stationary. People from different cultural and disciplinary backgrounds can continuously participate and innovate in this system.
- Sustainability refers to ICH as a living organism that is constantly evolving and developing. The system can achieve the functions of self-sustainment, self-circulation, self-renewal, self-regulation, and self-organization, so a flexible and resilient organizational structure is built.

By constructing this cultural ecology system, the integrity, complexity, openness and sustainability of ICH can be excavated, which can not only provide a cognitive framework for systematically understanding ICH but also effectively improve cultural resilience and sustainability.

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3. Method level: Construction of the ICH innovative design ecology

In recent years, scholars such as Richard Buchanan [10], Terry Irwin [11], Ezio Manzini [12], Fabrizio Ceschin [13] have studied and discussed the changes of design under social transformation from various perspectives. With the rapid development of modern technologies, digitization becomes one of the crucial paths for innovation and dissemination of ICH. At present, the international innovative platforms for ICH digitalization can be divided into five categories: collection, transaction, learning, social networking, and creativity. Successful cases include Europeana, Memory of the World, I-Treasures, REACH, Gallica, ICHPEDIA etc.

Facing the participation mode of digital and intelligent technology, through the design ecology methods, this study integrates and reorganizes various innovative elements, and constructs the ICH innovative design ecology of Deconstruction-Reconstruction-Expression-Regeneration (DRER), running through the whole process of Cultural Resources - Industrial Transformation - Global Communication - Regional Revitalization, forming a closed-loop ecology of ICH's sustainable development. (Figure 3)

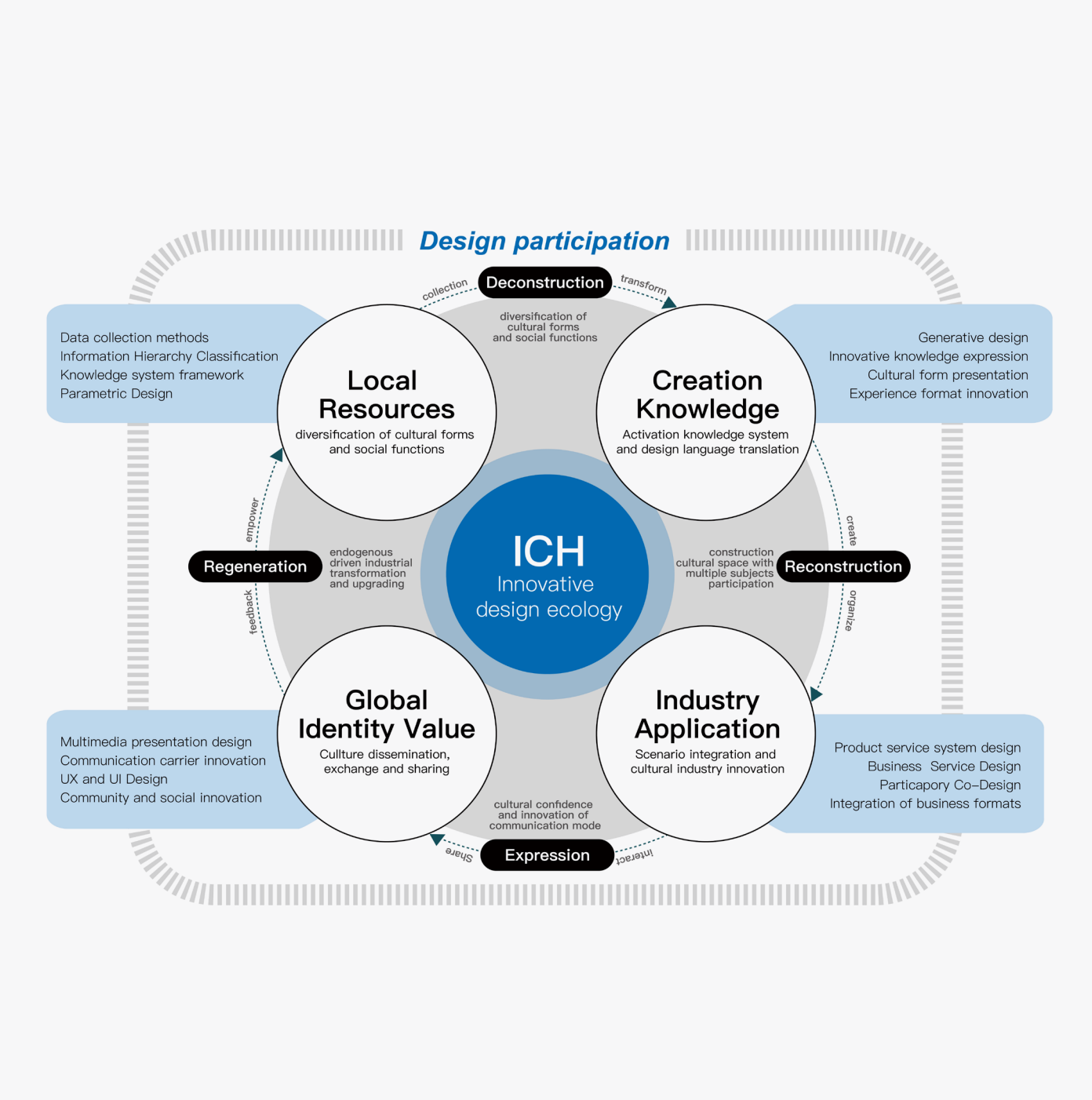

Figure 3: Innovative Design Ecology of ICH

3.1 Deconstruction: Diversification of cultural forms and social functions

How to "deconstruct" the indescribable cultural resources of ICH into design knowledge that can be developed, reused, shared, and created under new technical conditions, and promote the diversification of cultural forms and social functions, is the primary problem to be solved in the process of the innovative design of ICH. Facing this demand, digital collection and transformation of cultural resources can be carried out to build an activated and open knowledge system. Through the intervention of advanced design methods such as generative design, parametric design, distributed collaborative design, computational aesthetics evaluation, technology and design can be the drivers of cultural innovation.

3.2 Reconstruction: Construction of cultural space with multiple subjects' participation

Under the new economic and social development structure, the characteristic cultural industry has become an important strategy for changing the mode and adjusting the structure of economic development. In what ways can the integration of ICH culture with market demand through the participation of design by promoted? How can the relationship between design, industry, and society be reconstructed? The power of design can promote the comprehensive innovation of cultural forms, presentation methods, carriers, channels, and integration mechanisms of ICH, and drive the integration of emerging businesses and scenes.

3.3 Expression: Cultural confidence and innovation of communication mode

In the era of globalization, ICH is a significant carrier to express the core values and wisdom of a nation. How to establish a discourse system for external communication for the global participants and enhance the cultural identity and cultural self-confidence of the nation is another key issue faced by the ICH innovation design ecology. Using the transformative power of innovative design can strengthen the use of digitalization and media integration in the process of global dissemination of ICH, promoting the establishment of a distributed, ubiquitous, agile, and flexible modern communication system from these 3 aspects: presentation methods and media carriers, communication channels, and platform construction, cultural experience, and cognitive environment.

3.4 Regeneration: Endogenous driven industrial transformation and upgrading

To truly achieve the innovative and sustainable development of ICH, it is crucial to return to the local area, feeding back local communities, excavating their endogenous wisdom and motivation, and driving regional revitalization through innovative design. Approaches to regional revitalization include industrial transformation, brand building, consumption upgrade, and scene integration, running through the path of Content-Design-Production-Market-Value, building an endogenous creative system, and completing the transformation from 'design knowledge' to 'group wisdom'.

By building this ICH innovative ecology, the creative knowledge of ICH cultural resources can be transformed into cultural industries, promoting global communication through design language. Additionally, this ecology can activate regional revitalization through design participation, finally feedback to the local community.

4. Practice level: Building an innovative design ecology of ICH communities in rural China

Since 2013, the Chinese government has begun to implement the policies of rural revitalization and precise poverty alleviation. Rural communities, therefore, have become a significant stage and platform for innovative design. Based on the 12-years practical experience of the NewChannel Design and Social Innovation project, this research rooted in local communities with rich ICH resources, such as Tongdao Dong Autonomous County in Huaihua, and also other areas, to conduct deep research on ICH cultural ecology and design methods (Figure 4).

By participating in the process of cultural resource database construction, cultural and creative product development, brand market channel construction, etc., the team has accumulated rich practical experience in design and social innovation.

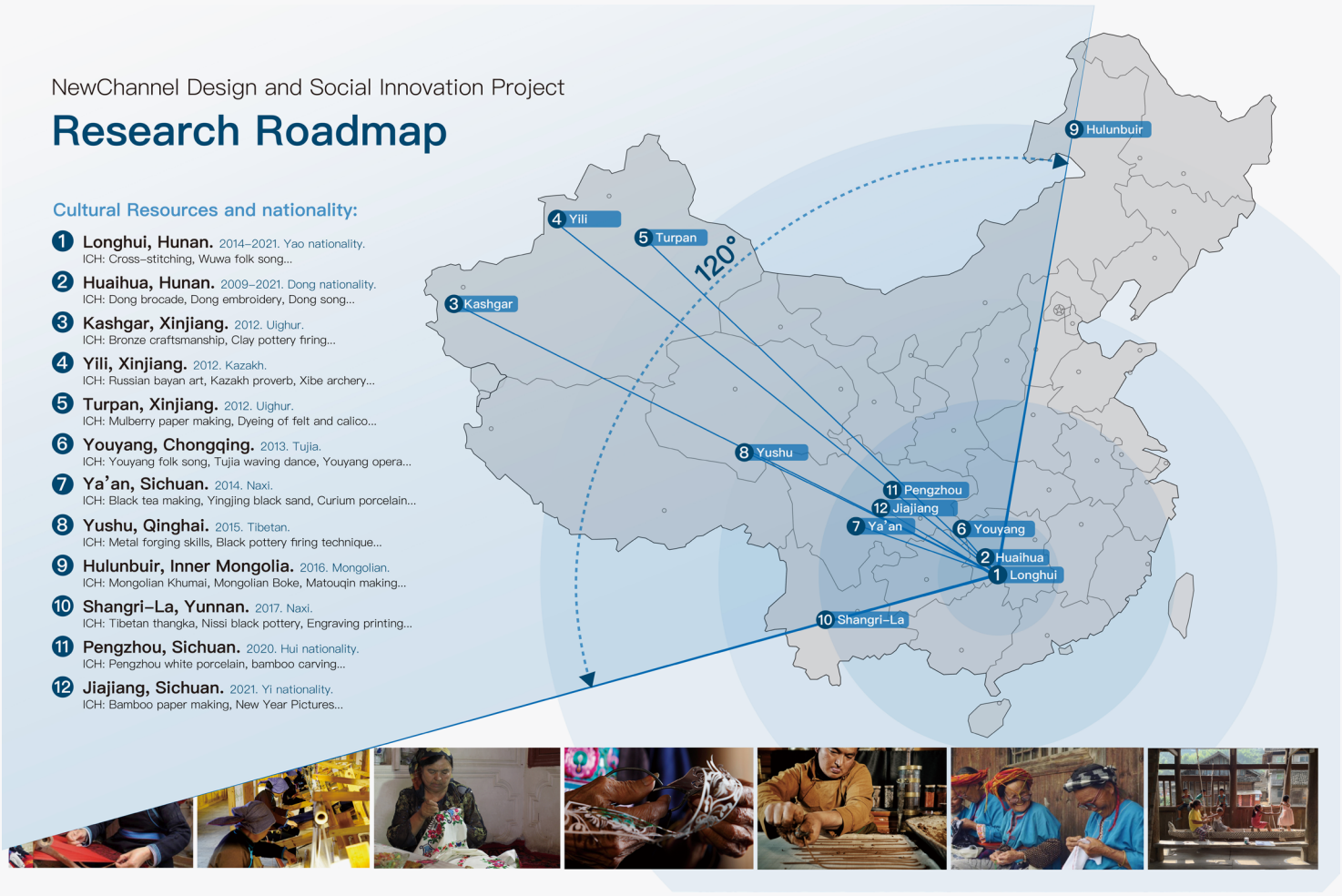

Figure 4: Practice Roadmap of NewChannel project in rural China

Through practical verification, it can be found that in the process of social transformation, the development of ICH has formed a cultural innovation ecology of integration and symbiosis, which consists of three sub-ecosystems: handmade production, industrial transition, intelligent creation. It represents the transmutation of the concept of ICH protection and development under different socio-technical systems. Different participants can locate their roles in this ecosystem, which demonstrates the value of diversification. Many scholars have also explored the possibilities and methodologies to maintain the core value of ICH under the constantly changing technological conditions. With the in-depth participation of design, the innovation ecology of ICH shows an ever-expanding development trend. Driven by social transformation, ICH continues to break out new possibilities.

In conclusion, with the participation and transformation of innovative design, the complicated elements of ICH constitute a cultural innovation ecology featured by integration and symbiosis, also, the value of ICH and design culture is gradually being highlighted. In the future, design will show the new spirit of the times under the integration of culture and technology, and constantly promote the cross-dimensional integration of ICH between traditional and contemporary, regional and global.

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Title:

Universal Design and Disabling Environments: What we can learn from the COVID-19 pandemic to strive to design for unexpected environments

Author:
Julia Dickson

Institution:
Carleton University
(Canada)

Abstract

People are not disabled, but rather their environments are.

One of the many things we have learned from the COVID-19 pandemic is that environments can change drastically without warning. Not just a small group of people, but the entire world as we previously knew it was disrupted, requiring societies and individual lives to adjust greatly in the span of a few months.

Adjustments such as mandatory masks indoors, maintaining a six-foot distance apart, plexiglass everywhere, and many more. These changes inevitably came with new limitations.

One can argue that our environment shifted to a more impersonal experience. With masks and glass everywhere blocking our voices, communication was just one aspect of our lives that certainly became more difficult and often frustrating. One can say that the hearing population became more limited in an environment they never had to experience before. On the other hand, deaf or hard of hearing people who communicate with sign language did not face this new barrier to the same extent, as they do not use hearing or talking as their primary form of communication. Therefore, the new environment was more disabling for hearing people than for deaf people, considering the change was in our ability to hear each other. So, the question is are people really the ones who are disabled, or are the environments disabling?

The problem being examined is how environmental design should strive to be more universal and accessible to all. We do not know if events such as COVID-19 will happen again or how long they will last. This paper aims to argue that by collecting information gained from this pandemic, along with other events, we will be able to apply a new perspective to our designs.

Groups such as the aging population, the visually impaired, people in wheelchairs and every day users will be highlighted and discussed based on how their environments may be redesigned for the unimagined future. This is an important topic to discuss since the majority of the population can, and will, be considered 'disabled' at some point in their life, but only due to the environments that give them that label.

The easiest way to predict the future is to learn from the past. In this case, referencing past experiences and designs that were created for a more accessible world will help designers prepare for the unexpected future. Past innovations such as clear masks, automatic doors, and raised crosswalks are only a few examples we can learn from and apply to COVID-19 and future pandemics to enable our environments for all.

Keywords: Disability, Environments, Future Design, COVID-19 Pandemic, Universal Design

Introduction

Environments continue to change throughout our lives. Every day we wake up and the environment around us can be different due to weather, aging and societal norms. We as human beings are constantly interacting with our surroundings and our ability to interact with said environments are determined by our characteristics and abilities. This includes but isn't limited to height, age, intelligence and strength. Our environment can either help us or deny us the success of achieving our daily goals, whether they are the everyday action of getting out of bed in the morning or climbing Mount Everest. Unexpected extreme events such as the COVID-19 pandemic however can come in an instant and effect those goals we have made. But living organisms are used to having their surroundings change frequently and are used to adapting to overcome these changes (Steinfeld & Maisel, Universal Design - Creating Inclusive Environments, 2012). Most of the time this adaption is through design.

Design is a method and tool used to adjust people's world to their needs (Steinfeld & Maisel, Universal Design- Creating Inclusive Environments, 2012). Through it we remove barriers and develop better environments to continue to achieve those goals we humans have. Some individuals have more limitations in their surroundings than others, but we all face obstacles. Due to this, design should be about more than just one person's aspirations, it should be universal. Universal design seeks to make our social and physical environments as enabling as possible for not just one specific group (Wilkoff & Abed, 1994). This paper will discuss how environments are disabling to everyone, how universal design is the key to overcoming those barriers and applying these theories to improve the current on-going global pandemic and prepare for future extreme environments as well.

Disabling environments

The term disability has many different definitions. The World Health Organization (WHO) defines it as "...any restriction or lack (resulting from an impairment) of ability to perform an activity in the manner or within the range considered normal for a human being" (World Health Organization (WHO), 1980). This definition is assumed to be about people, but in fact it can be applied to the environment.

Environments can be the restricting factor for a user to perform normal human tasks, whether they have an impairment or not. Steinfeld and Danford contradict WHO's definition by stating that "... a physical environment that provides the condition necessary to sustain functional independence can prevent the occurrence of a disability or a handicap whether or not impairment is present" (Steinfeld & Danford, 2013). They are stating that if environments are designed properly, barriers can be avoided for someone who has a limitation but also someone who does not. Therefore, confirming that the environment is the root cause for limitations faced by people, not the individuals themselves. Disability is an environment-based phenomenon (Hamraie, 2017).

In a person's life they will be, at least once, considered restricted due to their surroundings. This can be though injury, illness, becoming a caregiver or the most common and inevitable one, aging. (Hamraie, 2017), (HAPI, 2015). As we age our bodies start to break down over time impairing our mobility along with hearing and sight (Swain, French, Barnes, & Thomas, 2004). If our goal set every day is to continue to take the stairs, we now face more limitations in our environments due to our aging bodies and decreasing mobility. Examples of being disabled are less obvious if you rely on WHO's previously referenced definition of it. In order to argue against it, let's look at some scenarios. One case is a parent with a baby stroller. Upon initial reflection, do they have an impairment? No. Can they do every-day activities with ease? Yes. Now perhaps they are trying to get onto a bus or cross the street. If design hasn't been applied yet, pushing a wheeled object such as a stroller onto an elevated bus puts a barrier in place since the bus is elevated higher than the curb. This is the same scenario with the unleveled street curbs the individual must try to push the stroller over.

The environments the parent is in are now obstacles since it is not designed for wheeled objects, which includes strollers and wheelchairs. In this scenario, the parent did not have anything change about themselves physically to make them limited, but rather their surroundings caused the barriers. Another example is darkness or nightfall. If someone is driving at nighttime, the amount of light provided by the sun is nonexistent. Has their eyesight ability changed since earlier in the day that would impact their driving abilities? No. The only change that occurred was their surroundings which makes them face a new obstacle of driving without being able to see clearly. The person driving at night now is put at a disadvantage, one that visually impaired people experience frequently. Therefore, it can be argued that people are handicapped by their world, not their abilities. "...handicap is a function of the environment. A person is handicapped if the environment (physical or social) puts him or her at a disadvantage..." (Wilkoff & Abed, 1994).

On the contrary, just because someone is labelled as disabled by society at large, it does not mean they necessarily have a disadvantage in some environments. A prime example are deaf people. In the book Deaf in America it tells the story of a deaf boy who grew up in a deaf family. He did not even know he could not hear until he was six years old. (Padden & Humphries, 1988). This was because the environment he was in did not limit him or his goals. He was able to communicate successfully with the people around him using American Sign Language rather than speaking. He did not have any barriers since the ability to hear was not an obstacle he had to overcome for those six years. It was only when he switched environments and attended a hearing school that he was then made aware of his perceived limitation. Therefore, looking at the scenarios and examples mentioned in this section, it is true that every human at some point will face barriers from environments, (HAPI, 2015) so we should strive to design universally. We do not know if we will wake up tomorrow and our environments will have changed, presenting us with new obstacles. So, the next question is, how do we design these environments to be less disabling?

Designing for everyone seems like an impossible task to achieve. We are aware that the 95th percentile and the 5th percentile are typically left out of the ergonomic designs for a reason; they are just too unique.

Universal Design

Designing for everyone seems like an impossible task to achieve. We are aware that the 95th percentile and the 5th percentile are typically left out of the ergonomic designs for a reason; they are just too unique. The same goes for people who are labelled with disabilities and people who are handicapped by environments (Hamraie, 2017). But that needs to change. The term Universal Design often gets confused with accessible design. Accessible design is intended to benefit only those who are labelled with a disability (Steinfeld & Maisel, Universal Design - Creating Inclusive Environments, 2012). This theory of design is very specialized and focuses on only assisting one group. As that can be helpful, it also contributes to the idea that only individuals who are labelled as disabled face barriers in their environments. And as it is argued previously, all humans deserve to overcome obstacles in their surroundings. Universal Design is "...the design of products and environments to be usable by all people, to the greatest extent possible..." (Hamraie, 2017). It is an important definition because unlike accessible design that only focuses on one group of people to assist, it aims to benefit all. It removes the concept of "them" and changes it to one focused on 'us'. Designing universally is crucial since we do not know who will be disabled by each environment and as mentioned previously, everyone is considered disabled at some point, so we cannot easily just focus on one division of people at a given time.

Some key examples of Universal Design already used in environments today are raised crosswalks, elevators, automatic doors, subway displays, wide shop aisles, signage with big letters, and closed captions. Raised crosswalks (refer to figure 1) are designed with the intention of assisting pedestrians with crossing busy intersections safely. It forces cars to slow down to go over the built-in speed bump which changes the environment's focus to one centralized on the citizens walking.

This also benefits people with ambulatory limitations such as wheelchair users, along with other wheel-based objects such as strollers (US Department of Transportation, 2021). This is due to removing the level difference between the street and the crosswalk. Automatic doors (refer to figure 2) are also designed to benefit more than one group of people. Wheelchair users, the elderly, pregnant women, and people who have their hands full with groceries or packages all benefit from the lack of action required to open a door. These doors are the perfect example of universal design (Steinfeld & Danford, 2016). The mentioned examples help demonstrate how useful design can be if applied universally. Now the next step is to learn from them and apply the same theories to the current environment; the COVID-19 pandemic.

Figure 1: Raised crosswalk

Figure 2: Automatic doors

COVID-19 Design problems

In the short span of three months, the whole world was in a pandemic (Public Health Ontario, 2021). Coronavirus had spread across the globe and dozens of countries were in lockdown. Our typical environment changed quickly and drastically with no real warning. Fast forward a few months and new regulations were implemented. Masks became mandatory, social distancing was essential, stay at home orders were in place, and many more changes had to be made to our surroundings (Government of Ontario, 2021). Some agreed and followed the rules, others weren't as willing to comply. With these essential modifications to our lives, we nevertheless saw new barriers for society. People who were used to completing their everyday goals with ease were now facing limitations in their environments they were not anticipating.

Peoples' home environments switched to become a combination of their daycares, schools, offices, and gyms while office buildings, restaurants, shopping malls, salons and more became temporarily insignificant. Locations such as nursing homes and hospitals became a hot spot for the virus and affected those who used to feel safe in those spaces (Canada, 2020).

The typical day-to-day environment people faced was different whether they liked it or not. The main environmental changes that caused new obstacles and will be focused on in this section was maintaining a distance of six-feet from people and wearing face masks.

Staying six-feet apart

Maintaining six-feet (or two meters) apart was a huge influence on our built environment. Line-ups became longer since people needed to be spaced out, restaurants sat fewer people overall due to rearranging their table set ups, people taking Ubers were not able to sit in the front seat anymore costing users more money, and even grandparents were not able to be in the same room as their newborn grandchildren or family members (Government of Ontario, 2021). To try to help people maintain distances, new markers or stickers were placed on the ground for visual enforcement. Visually impaired people, however, would be disabled by this environment since they cannot distinguish them. On the other hand, users of wheelchairs would benefit from the requirement of new physical distance from other people as it allows them more space to move around, which is an obstacle they typically face (Hamraie, 2017). This contributes to the argument that people are only disabled by what is around them not their own limitations.

Masks

Facial Coverings are another example that contributed to the new disabling environment from the coronavirus (Public Health Ontario, 2021). Not being able to see half of a person's face while communicating denies humans the intimacy and strong information transfer they are used to. Add this to the other environmental factors such as plexiglass shields and standing two feet away from someone, and miscommunications were more common than ever. There was a newfound disconnect in the public's surroundings at a time where information was essential to stay safe (see Figure 4: ClearMask™, n.d.). Deaf people who use sign language, however, were affected less than those that relied on hearing for information since their language uses physical gestures with expressions, not sound. Therefore, facial coverings changed the environment to one that was more disabling for the hearing population, proving again that people are only limited by their surroundings not themselves. Now, bringing the environmental problems from the pandemic to light is just the beginning. It is time for design to do what it does best; solve them.

Improvements

As a designer our job is to solve problems in the world. This includes the ones surrounding the disabling environments from the pandemic so if another unexpected one happens in the future, we will be a step ahead. We also are unaware how long we will be in this pandemic so the current environments should be considered as well. I will outline some design suggestions for improvement of the COVID-19 world based on designs that currently exist already. It is not about reinventing them; it is about reimagining their potential.

Floor signage

An issue mentioned previously was the six-feet distance stickers or markers most stores have installed on the ground. This is a disabling feature mainly to visually impaired people since they are unable to see these stickers or the people located around them, therefore denying them the awareness. They have no way of discerning their proximity to others and cannot use the markers to assist them. A potential solution is to use tactile floor markers like the ones used in Barcelona subways and some hotel lobbies (refer to figure 3). The current use of the tactile guides is to lead people in hotels from entries to reception areas, or on subway platforms to show people where unsafe elements are. They use either button patterns or longitudinal bands to communicate if there is a warning/ waiting action or crossing action in place ("Tactile Paving Stones," n.d.), (Steinfeld & Maisel, 2012). This design solution can be applied to the 2 meters apart floor signage to allow for the stickers to be made more aware in their environments. This will be a universal design too since it will assist any sighted people with adding an affordance to help remind everyone to stay six-feet-away.

Communication

A major issue mentioned is how difficult it became to hear or have conversations with people in public. With everyone covering their faces with masks and standing behind protective shields, hearing became a huge barrier for a society that relies heavily on verbal communication. Back before the pandemic in 2017, a team of graduate students from Johns Hopkins University created the idea of a clear face mask they called, ClearMaskTM (refer to figure 4). It allowed for full-face visibility and was available in adult and children sizes. The ClearMask provided communication barrier removal making exchanges more human, natural and accessible again. The markets that were assisted are universal of course, reaching a range of people such as teachers, children, caretakers, speech language pathologists, translators, and the hearing or hard of hearing user. Now with the current pandemic ongoing and masks are not only mandatory indoors but also a frequent part of our environments, this design should be applied to remove the barriers so many citizens are experiencing.

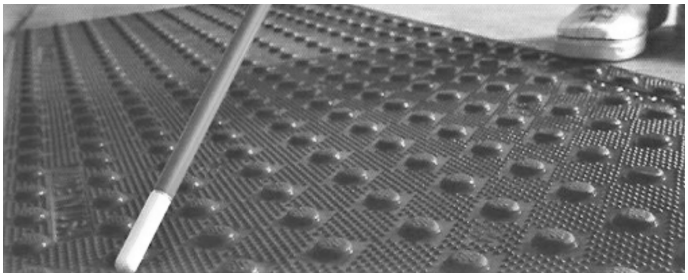

Figure 3: Tactile guides example of button pattern

Figure 4: ClearMask™

The unexpected future

Overall, Universal Design is the key to making environments less disabling for everyone. Whether it is a global pandemic, or just a regular Tuesday, every person deserves to be independent and not limited by what is around them. We as designers need to apply it to our projects and strive towards benefiting everyone. Designers should be taught to think more about the inclusion of Universal Design earlier in their process, rather than a correction measure or afterthought. If Universal Design is already in place, our environments will continue to change but this time to be more enabling. Therefore, if another global outbreak, World War III, or other extreme events come along, and it likely will, we will already be ahead of the game. So, bring on the unexpected future of extreme environments, because we as designers will be prepared and ready to solve them if these theories are applied.

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Theme 2

Human-centred technologies for social and environmental benefit

Title:

Aim for Change: New Ways to Address Youth and Gun Violence

Authors:
Amarjeet Singh
Anna Ranger
Cathy Matovu
Shelby Richardson

Institution:
Human-Centred Design Lab
Algonquin College
(Canada)

Introduction

Aim for Change is a youth-focused workshop developed for the International Action Network on Small Arms to tackle the growing issue of gun violence worldwide (International Action Network on Small Arms [IANSA], 2022). The workshop gives youth who have been affected by this issue the opportunity to share their experience.

Funded by the United Nations (UN), Aim for Change was created as part of IANSA's response to the UN "civil society engagement in support of gender mainstreamed policies, programmes and actions in the fight against small arms trafficking and misuse, in line with the women, peace and security agenda" (United Nations Office for Disarmament Affairs, n.d.).

This nine-week project was developed at the Human-Centred Design Lab by a multidisciplinary team of students from Algonquin College's Computer Programming, Graphic Design, Public Relations and Victimology programmes. After consulting with IANSA and its partner organization, Gun-Free South Africa (GFSA), the team defined the project objectives as the development of programming that provides youth in South Africa a platform for sharing their experience of living with gun violence in their community and empowering them to become advocates for change.

Studies show that school-based interventions can effectively address mental health and trauma in children because of its playful approach to treatment (Beauregard, 2014). For participants to gain optimal benefits, art therapy needs to be held in a safe, trustful, and empowering environment, and led by facilitators who respect their ideas and experiences (Complex Trauma Western Australia [COTWA], n.d.). After interviewing subject matter experts, the team identified several emergent themes that contribute to gun violence in youth. These themes include lack of access to safe spaces for children to discuss their experiences (especially for boys and men); lack of mental health facilities; lack of positive role models; and lack of recreational activities for youth. Tasked with addressing these themes, the team developed the following problem statement: How might after-school programming provide youth a positive platform for not only sharing their experience of living with gun violence but becoming advocates for change? In developing a solution, the team had to consider feasibility given the availability of resources in the South African region where the workshop would be implemented. They found a lack of reliable access to computers, internet, projectors, and printers in schools and homes that could be used to conduct digital activities. Moreover, the target age group generally did not have direct access to camera smartphones, which disallowed activities involving videography and interviews. This led the team to design a workshop that could effectively take place even with basic art and craft supplies like pencils, paper, crayons, chalkboards, etc. The workshop was structured to keep children actively engaged throughout its duration. This meant including interactive hands-on activities and giving short refreshment breaks. A brief discussion time with the participants was also included at the end of the workshop to collect future themes and feedback for improvement.

Along with resource-bound logistical constraints, the team also had to consider the workshop on a larger scope in that IANSA has an existing network of partners across the globe. Therefore, the workshop had to be flexible enough to adapt to regional contexts and the resources available in the region it was hosted. This was achieved by taking a modular approach to designing the workshop playbook whereby themes and supplies could be easily adapted.

Workshop

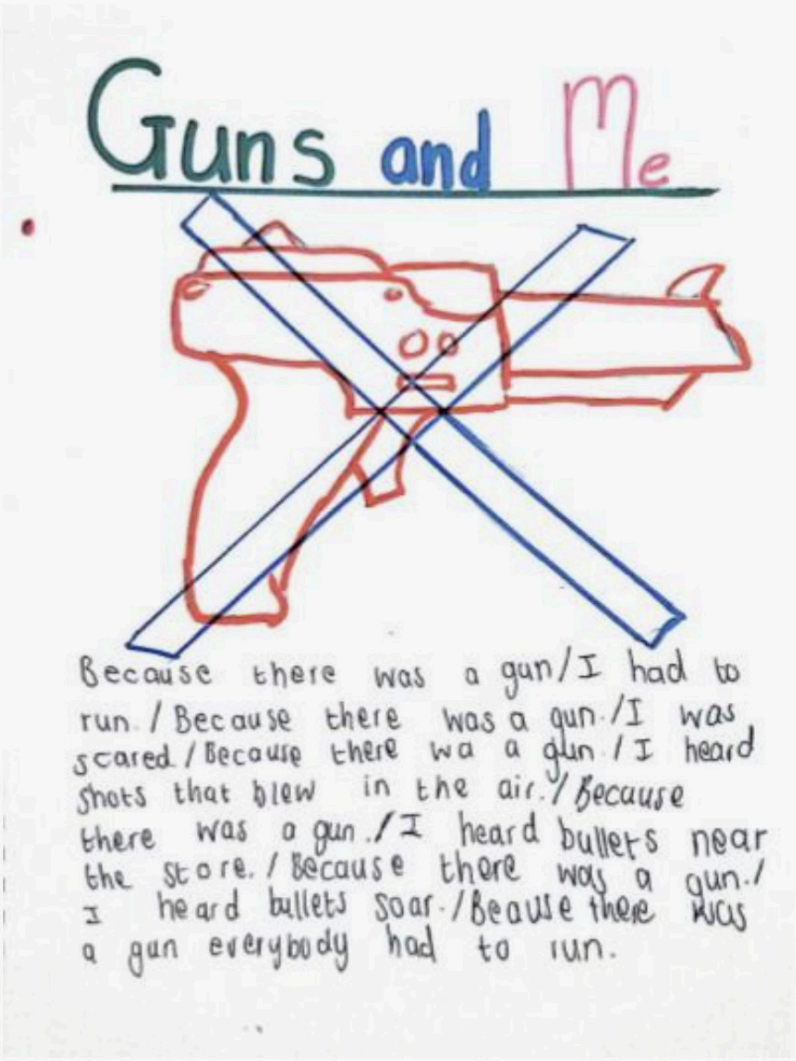
Aim for Change is a two-hour after-school workshop that challenges 11 to 15-year-old students to develop a publication of their own illustrations, short stories, song lyrics and collages (Figure 1). This type of informal written publication is called a zine. By creating a zine, youth might positively discuss gun violence in their communities, voicing their thoughts and feelings in a safe, fun, creative and engaging way.

Figure 1: The team created a zine workshop that provided youth an opportunity to creatively express their experience of living with gun violence in their community.

GFSA was consulted to provide implementation logistics at ground level. Working with several GFSA youth workers in South Africa, the team learned firsthand what it was like to be a child growing up in a community affected by daily gun violence and gang activity.

Aim for Change was piloted by GFSA in South Africa (Figure 2). A week later, the team presented project outcomes to the UN at the Programme of Action on Small Arms and Light Weapons – Seventh Biennial Meeting of States.

The workshop has since been translated into Spanish and French for global distribution through IANSA's network of partners. Workshop facilitators are also distributing the zines in local communities. It is IANSA's hope that as the workshop expands worldwide, youth from different countries can one day exchange their zines with one another.



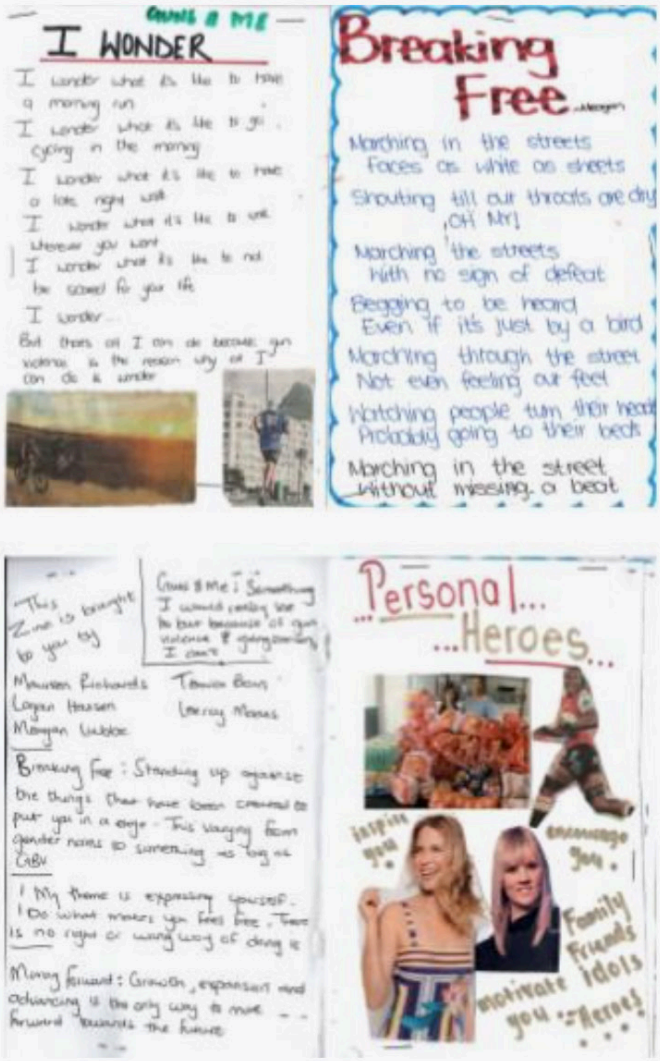


Figure 2: Artwork from the zine workshop that was piloted in South Africa. The team presented outcomes to the United Nations Programme of Action on Small Arms and Light Weapons.

Playbook

Drawing from her studies in the Victimology postgraduate programme, Anna developed an evidence-based, trauma-informed approach to working with violence-exposed youth. Safety, trust, choice, empowerment, collaboration, and respect (COTWA, n.d.); these themes formed the theoretical basis of the playbook and acted as a guideline for the workshop facilitator to ensure successful programme delivery. The playbook is intended to provide guidelines for workshop facilitators to follow (Figure 3).

It lays out the workshop's principles and goals, as well as precautions for facilitators to consider when working with youth who potentially suffer from trauma. The playbook also describes the supplies needed to make a zine before breaking the workshop down into a series of suggested activities. Anna also recommended that the workshop facilitator have available a selection of local trauma counselling services to which they can refer participants should any of them become distressed during the workshop.

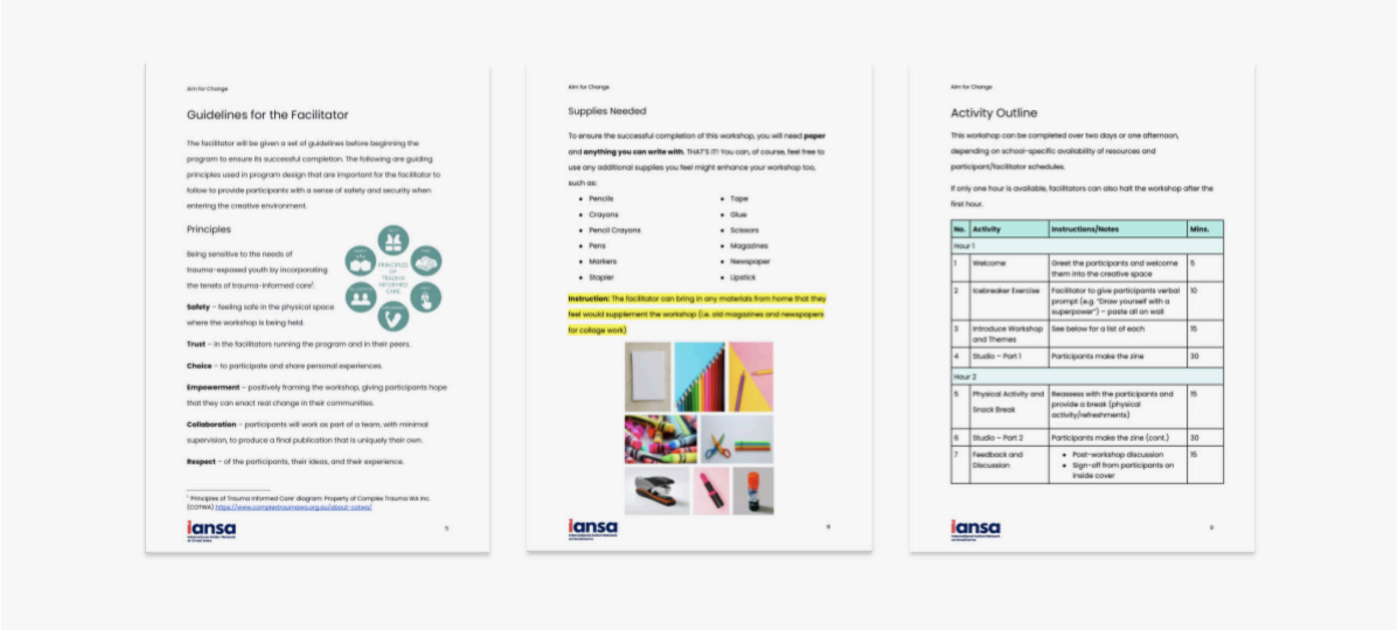


Figure 3: The team developed a playbook for workshop facilitators that outlined approaches to working with youth suffering from trauma, to supplies and activities and the workshop schedule.

Shelby worked on messaging and copy for the campaign. She drew on her experience in the Public Relations programme to draft written content that was informative and accessible to all audiences. Given the complexity of the issues, she made sure to avoid jargon and use simple, plain language to ensure audiences could understand campaign objectives. Core components of the messaging included website copy for the campaign website, a boilerplate to be used in media releases and news articles, and an introduction to zines. Shelby also guided the written content in the workshop, ensuring the direction for creation of the zine was clear and concise.

Cathy led project art direction, creating the Aim for Change brand. Her main focus was to create a visual identity that spoke to two main target audiences: youth affected by gun violence and IANSA's global partners (Figure 4). On the one hand, she created a campaign that resonated with the youth. It was important that they see themselves and recognize that it was their voices and stories that needed to be heard. On the other hand, the campaign had to speak to a wider and more global audience as the goal was to have the campaign be recognized and applicable in communities around the world.

Figure 4: Drawing from their multidisciplinary strengths, the team developed the supporting messaging and marketing assets that helped IANSA promote the campaign.

In the first round of the design process, Cathy created a series of posters that were presented to both IANSA and GFSA for feedback. At this time, the name of the campaign had not been finalized. Although IANSA liked the art direction, GFSA felt that it did not resonate with their audience and would not identify with the youth in their community. The imagery was considered too serious, requiring a more playful and youthful tone. Once the name of the campaign had been finalized, Cathy began the process of designing a logo and revising the posters. Her objective was to give both a more organic feel, to reflect the hand-made aspect of the zine workshop. Moreover, younger children were featured in order to capture the idea that gun violence affects young school-aged children. Both IANSA and GFSA approved the design and from there, web banners and the cover of the workshop playbook was developed. These assets were incorporated into a media kit that was handed off to IANSA.

Amarjeet designed the Aim For Change campaign web page to spread awareness through IANSA's online marketing efforts. The web page was designed with the goal of presenting visitors with a comprehensive overview of the campaign. A digital version of the workshop playbook was included to encourage IANSA's partners to download and implement the campaign in their respective communities. The web page was designed following the existing structure of the IANSA website. It also had to be designed to showcase the graphics designed by Cathy, messaging written by Shelby, and the photos from the workshop provided by the GFSA volunteers who piloted the workshop in South Africa.

Discussion

Since completing the project, the team has spent considerable time reflecting on project methodology and their experience. Collaborating in an online environment posed challenges. In this kind of design workshops, teams typically share ideas with sticky notes that are physically arranged on a wall. Working virtually due to the COVID-19 pandemic, we were unable to collaborate as we would in a design studio. Meeting with our partners on the ground in South Africa was also challenging due to the time zone difference and their busy schedule.

The team was multidisciplinary, with students coming from Algonquin College's Computer Programming, Graphic Design, Public Relations and Victimology programmes (Figure 5). Working with a diverse team with members from different academic backgrounds might have been a challenge as each viewed the problem with a unique different lens. However, we found this to be a strength, with each member contributing knowledge and expertise that led to an in-depth response to the project objectives.

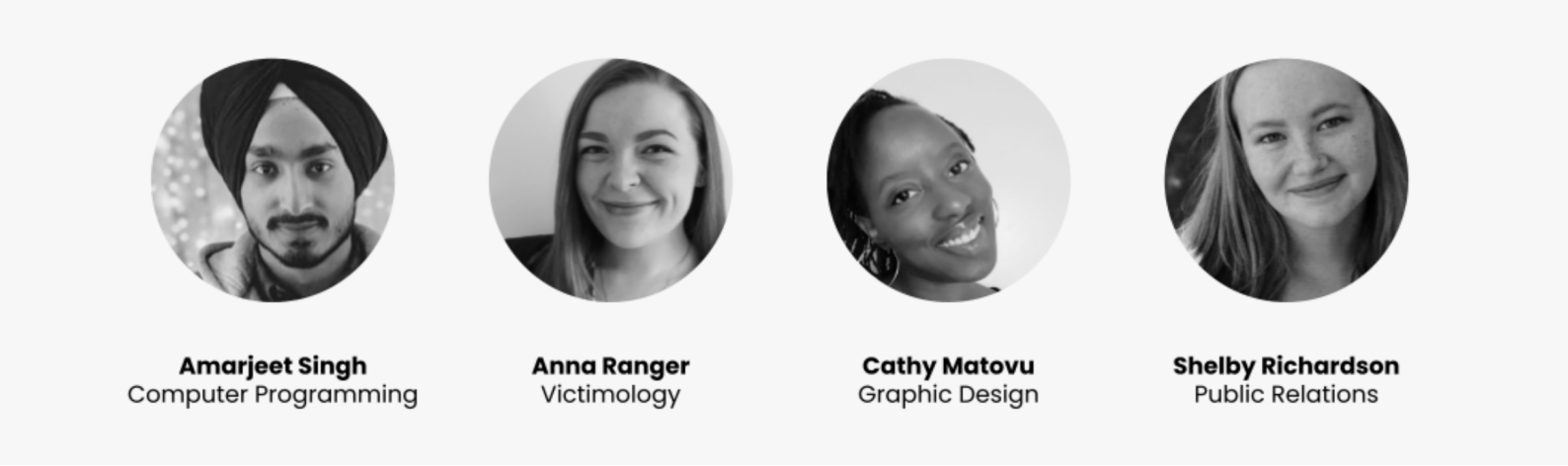


Figure 5: The multidisciplinary team came from Algonquin College's Computer Programming, Graphic Design, Public Relations and Victimology programmes.

Miro, an online collaborative whiteboard tool, simulated the experience of physically collaborating in a design lab. The multidisciplinary nature of our team leant itself to dividing up tasks according to each student's strengths and area of expertise. Although Zoom had limited interaction, it allowed us to meet frequently with our partners in South Africa, which we would have been unable to do outside of the virtual environment.

Being a part of this project was an extremely rewarding process. Every member of this team acquired design research and virtual project management skills.

It was truly incredible to watch the campaign evolve into the finished product it is today. We are humbled that our workshop has been piloted and that we had the opportunity to present outcomes to the United Nations. Looking ahead, we are excited to see Aim for Change translated into several languages and running in different cities around the world.

Looking back, the team remembers one particular subject matter expert, a former investigative journalist. He said youth voices needed to be heard because they are honest. They are raw. They are unvarnished. Aim for Change provides a platform for these voices.

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Title:

Envisioning Safe and Sustainable Labs with Human-centered System Design: An Experimental Study on Disposable Material Flow

Author:
Sheng-Hung Lee

Institutions:
Massachusetts Institute of Technology
Integrated Design and Management
Technology Department of Mechanical Engineering
Office of Sustainability
Institute of Technology
AgeLab
(USA)

Abstract

The purpose of the study is to explore disposable laboratory material flow on campus using Human-centred System Design (HCSD). We used Massachusetts Institute of Technology (MIT) campus as a testbed to conduct the experimental study for sustainable innovation. We selected four types of labs: biological, chemical, material, and mechanical engineering, and two makerspaces to interview principal investigators (PI) and shop managers about building safe, sustainable labs. Besides field research and interviews, we launched a survey of lab pipette tip boxes as a case study to have more in-depth material flow information from procurement to disposal. The aim of the study is to refine lab material purchasing, inventory management, recycling and disposal to identify pain points and opportunities to make lab material flow more sustainable and safer on campus.

Keywords: Sustainability, Safe, Lab, Material Flow, Human-centred System Design

1. Introduction

Massachusetts Institute of Technology (MIT) has announced a goal of reducing greenhouse gases to achieve a 32% reduction of overall emissions by 2030. Labs at MIT collectively used over 65% of campus energy, even though labs only occupy 25% of the physical footprint [1, 2]. In the study, we researched disposable lab material flow as a starting point to envision how to build a safe, sustainable laboratory on campus and provided a case study of pipette tip box usage in laboratories. Understanding laboratory material flow is an integral part of this study.

At MIT, they use the latest technologies and research to promote the campus not only as a testbed for sustainable innovation but also as a living lab to enable the creation of a safe and sustainable blueprint in the most efficient and socially impactful ways. MIT Green Lab Program [3], founded in 2016, is a great example demonstrating how they collaborate with schools across MIT to enable laboratories to establish guiding principles, communication channels, collaborative platforms, shared visions, tools, knowledge, and training programmes to operate in a sustainable manner.

In this study, we conducted two types of research to collect the first-hand material. First, we completed field research. We visited four different types of labs: biological, chemical, material, and mechanical engineering and two campus makerspaces: The Deep and Metropolis. Second, the pipette tip box survey: we used pipette tip boxes as a case study to demonstrate the material flow, from procurement, to disposal, and recycling in laboratories.[4] Since this is a one-year experimental study, we defined this initiative as an entry point for us to understand users' pain points, the challenges of the institute, and how complicated it is to build a safe and sustainable laboratory on campus.

2. Literature review

The study used MIT campus as a case study. We emphasized journals, papers, and laboratory reports of disposable laboratory material flows. We also conducted interviews with MIT Office of Sustainability (MITOS), MIT Department of Facilities, MIT Environment, Health & Safety Office (MIT EHS), MIT Office of the Vice President for Finance (MIT VPF), and two makerspaces: The Deep and Metropolis to help define the scope and problems regarding disposable laboratory material flows (Figure 1.).

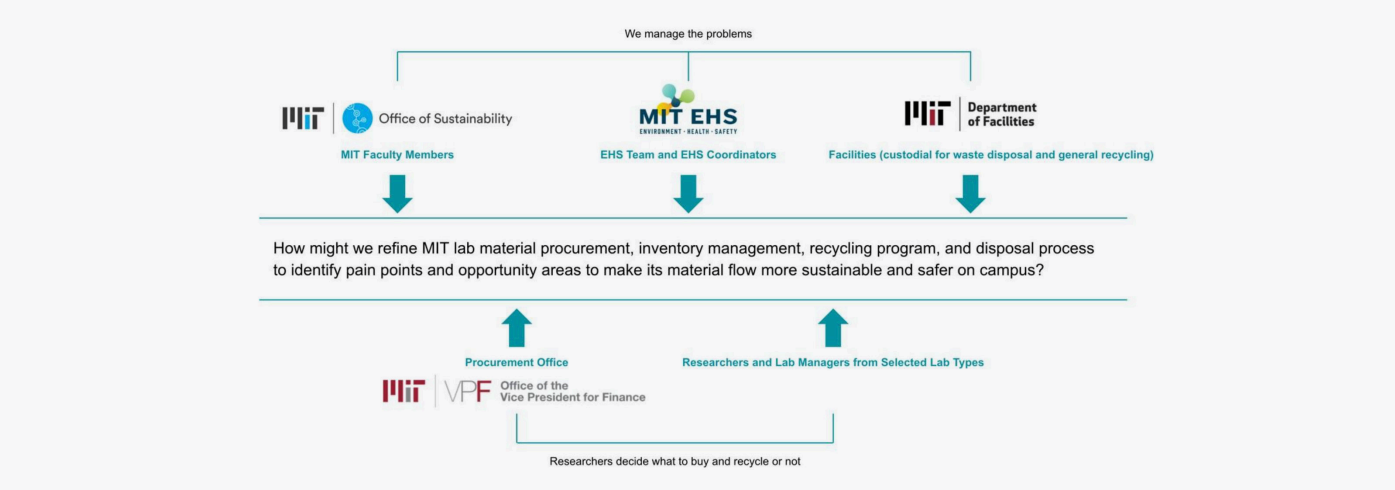

Figure 1: Key stakeholder map

2.1 Disposable laboratory material flow

We categorized a typical disposable laboratory material flow into four phases: procurement, inventory management, recycling and disposal [1]. According to the literature and interviews, we summarized the top five common disposable laboratory items at MIT: nitrile gloves, pipette tips, pipette boxes, centrifuge tubes, and conical test tubes. We used field research and a survey to analyze the disposable material flow of these items from procurement, inventory management, and recycling, to disposal [5]. In the study, we used pipette tip boxes as an experimental case study to demonstrate people's consideration and behavior in relationship with material flow in laboratories. The concept of a circular makerspace [6], a space with a shared sustainable vision by applying circular design methodologies and human-centered design to achieve carbon neutrality in the environment and system, can also tie to the disposable material flow in laboratories. The ultimate goal is to reduce the carbon footprint both in laboratories and makerspaces on campus.

2.2 Human-centred system design (HCSD)

HCSD is a modified research process curated with IDEO's version of design thinking [7] and system engineering [5, 6, 8, 9] to analyze its model. We visualize the journey of disposable laboratory material paired with people's behaviour with these materials to discuss the pros and cons among sustainable laboratory material, procurement cost, recycling process, and decision making [10, 11] (Figure 2.). We used HCSD to analyze the disposable laboratory material flow, which is an innovative approach to the study and helped us identify pain points across the design journey [12]. HCSD not only provides us a holistic view of the challenges, but also allows us to change the fidelity and zoom into the target [13, 14].

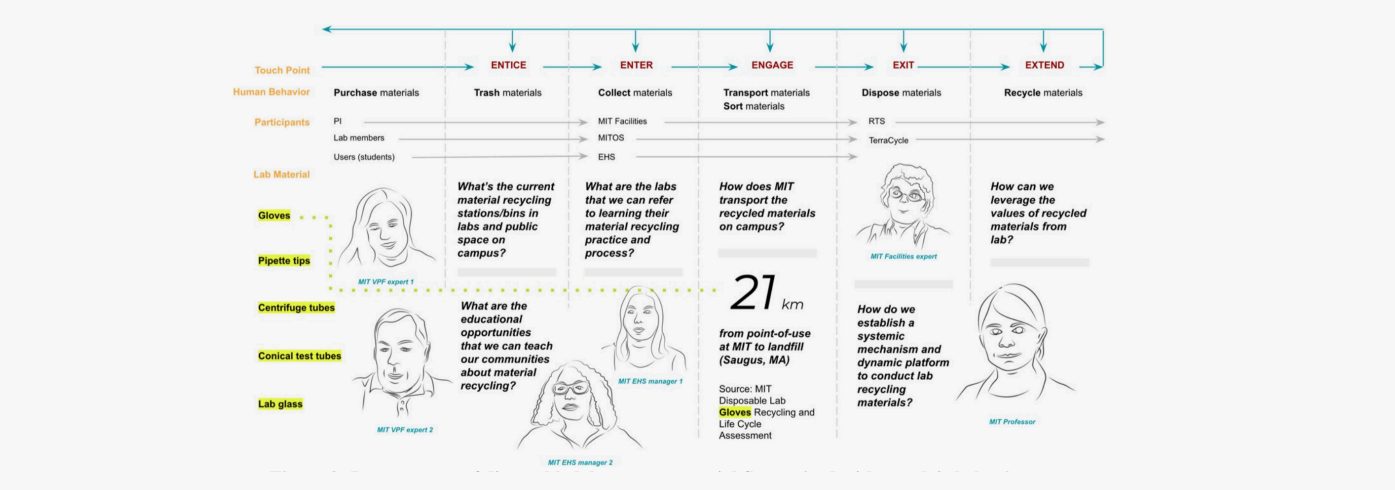

Figure 2: Journey map of disposable laboratory material flow paired with people's behaviour and interviewee's questions.

2.3 Reduce plastic waste of pipette tip boxes

In laboratories, we found that pipette tips and boxes make up approximately 80% of laboratory plastic waste from MIT waste audit [15]. Pipette tip boxes are definitely one of the largest sources of laboratory plastic waste (Figure 3). Therefore, we wanted to investigate potential area of opportunity for recycling pipette tip boxes in laboratories. Research indicated that to reduce this waste, we had three strategies to consider: 1) plastic reduction strategies 2) choosing recyclable plastics and 3) selecting components that use less disposable material [16].

Tiffany Fierros wrote in her research article that the first point, plastic reduction strategies, could mean using stackable racks since their modular design makes them more flexible for laboratories based on people's needs in terms of volume. Also, one stackable tower of racks needs only one plastic cover. People needed to leverage the rack refill systems to refill pipette tips without accumulating tips boxes in laboratories and purchase bagged tips to reduce the accumulation of plastic containers.

Figure 3: Conducted field research at MIT Building 66 (Landau Building) to observe the large volume of wasted pipette tip boxes from laboratories.

Regarding the second point, choosing recyclable plastic, Fierros suggested we need to be mindful of the type of plastic being purchased. For plastic recycling in the United States, only a few are acceptable: polyethylene (PET, plastic #1), polyethylene terephthalate (PETE, plastic #1), or high- density polyethylene (HDPE, plastic #2).

The last point, selecting components that are made of less disposable material, might mean finding laboratory supply companies that design pipette tip boxes packaging or construction with thinner walls of plastic containers, not only reducing plastic waste, but also saving significant costs in the manufacturing process. In summary, these three strategies can effectively reduce the plastic used manufactured for pipette tip boxes, so that laboratories can have more space to use for other valuable experiments.

We also found that other campus initiatives repurposed their pipette tip boxes as a plant pots giving them a second life with educational reason and emotional attachment [17]. Due to the scope of this research and the limitation of the cost and time, we won't discuss the detailed design the product of the pipette tip box. Instead, we emphasized on service models of the pipette tip box recycling programme in laboratories provided by MIT EHS.

3. Experimental research approaches and results

3.1 Field research—Visit laboratories and makerspaces on campus

To get the first-hand information on campus, we selected three laboratories and two makerspaces out of MIT research units/ departments to help us capture survey data, listen to people's stories, and document their pain points. The field research of laboratories and makerspaces was conducted in three-week period during summer vacation in 2021, following the MIT pandemic protocol.

When we visited four types of laboratories (biological, chemical, material, and mechanical engineering), it was critical to observe some common problems between the four types of laboratories and two makerspaces. For example, over-purchasing disposable materials, the lack of an organized laboratory procurement and material tracking system, the incentives of using sustainable products versus the ratio of cost and value, and the communication between laboratories and institutions needs to be more transparent considering the efficiency of decentralized institute's system. We summarized these common problems to make a hypothetical assumption: these common problems might originate from people's behaviour (e.g., laboratory culture and life ritual), the institute's environment (e.g., physical and policy), and the tradeoff of using sustainable products (e.g., product cost and time cost).

One professor from the department of civil engineering shared how her laboratory re- designed the flow of a pipette tip box recycling to optimize the life cycle of the disposable product in general (Figure 4). What impressed us was how her laboratory built a flexible-yet-rigorous recycling system based on their previous experimental experience and knowledge to make scientists or graduate students who just join the laboratory understand clear principles to follow and double check the system if anything goes wrong.

At another two laboratories, we visited the professors who focused on the material-and- mechanical-engineering-related research. They also set up their own 'laboratory ritual' such as using different colors of tapes as a name tag for each lab member to make a clear responsibility for who owns which equipment. They've also created an internal 'student on duty' system, which allocated laboratory members to each have a set time to maintain laboratories facilities and manage any emergency situations.

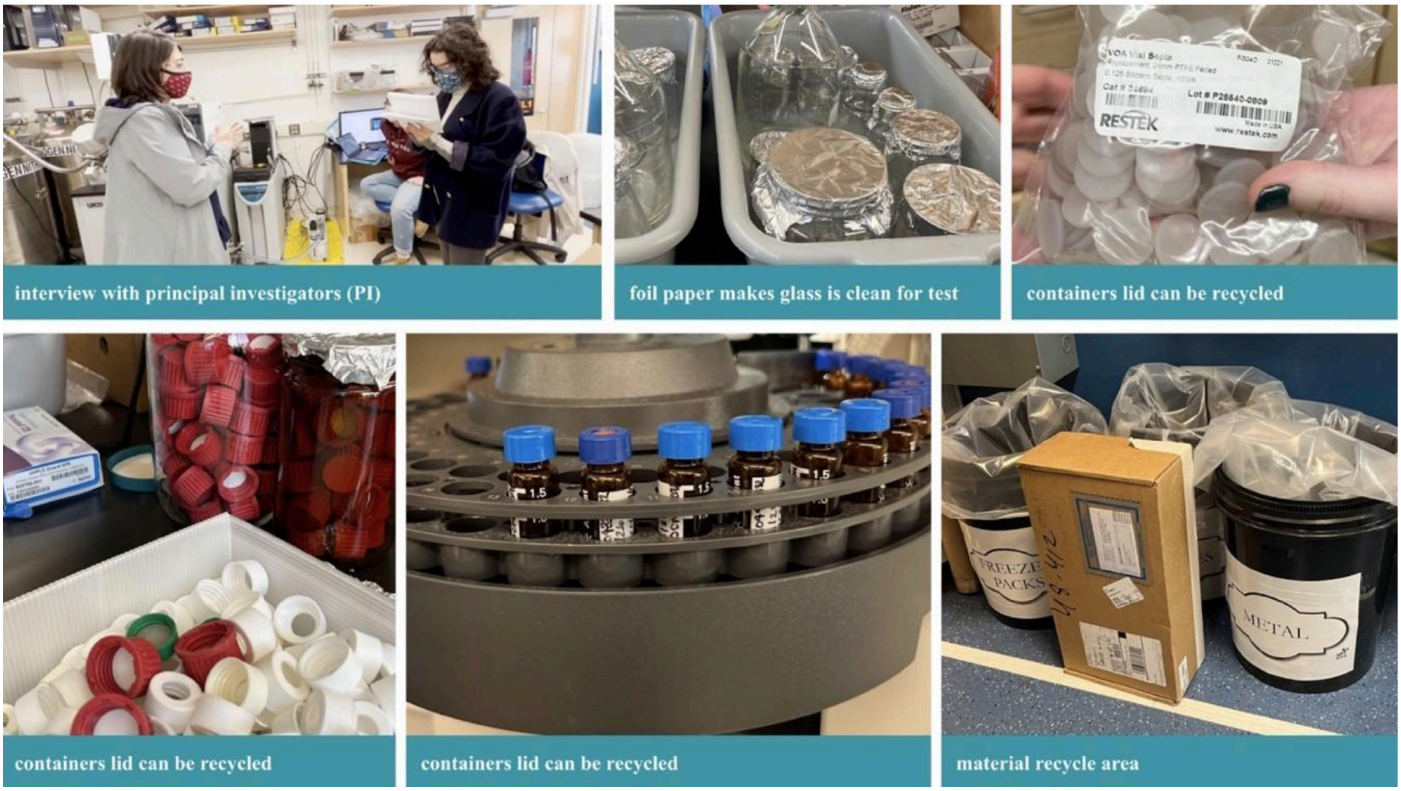

Figure 4: Field research at MIT civil and environmental engineering laboratory during interview of principal investigators.

Besides the laboratories, we also collaborated with the leadership team from MIT Project Manus, MIT's effort and investment to upgrade makerspaces and cultivate stronger maker communities on campus [18]. The Deep makerspace offers milling, turning, SLA 3D printing, mold making, and small screen printing, whereas Metropolis makerspace contains welding, laser cutting, FDM 3D printing, basic electronics, sewing, and waterjet (Figure 5).

The makerspace manager gave us a three-hour tour and explained how they organized their waste material paired with the recycling programme following the regulation from the institute. Both makerspaces are designed with great way-finding systems, allowing for great navigation of the space, but also creating signage for each piece of equipment/machine, so that makerspace members or first-time users can easily know how to use or even master the machines quickly.

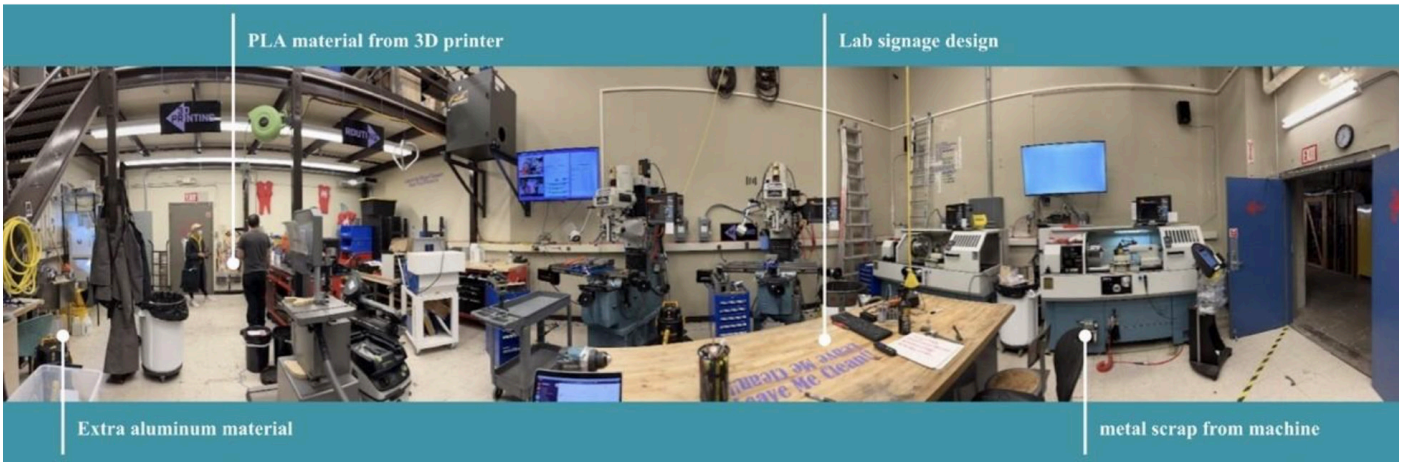

Figure 5: Field research at MIT The Deep makerspace

During the tour, we specifically focused on questions around the disposable material flow. The makerspace managers showed us where they stored metal scrap (e.g., aluminum), built an area for material recycling (e.g., acrylic, cardboard, wood), and designated a place for trash (Figure 6). They also mentioned that 3D printing is a very popular prototyping method among students, but the waste of PLA filament generated by 3D printers is difficult to recycle or is non-recyclable. Some 3D printing companies provide filament recycling services, but most don't have the awareness or service/business model to support the concept of sustainable printing.

During our visit, one shop manager said, "I want to know how the institute or MIT EHS team recycles the disposable material such as cardboard, acrylic, and wood, because I am curious to know where the material goes? If I know the recycling process or at least the next step, I can have a better sense of how I can improve the recycle protocol of [the] makerspace [making it] more efficient." It informed us of the importance of transparency of the material flow on campus both in laboratories and makerspaces. Thus, it has become one of our focuses within our scope of research.

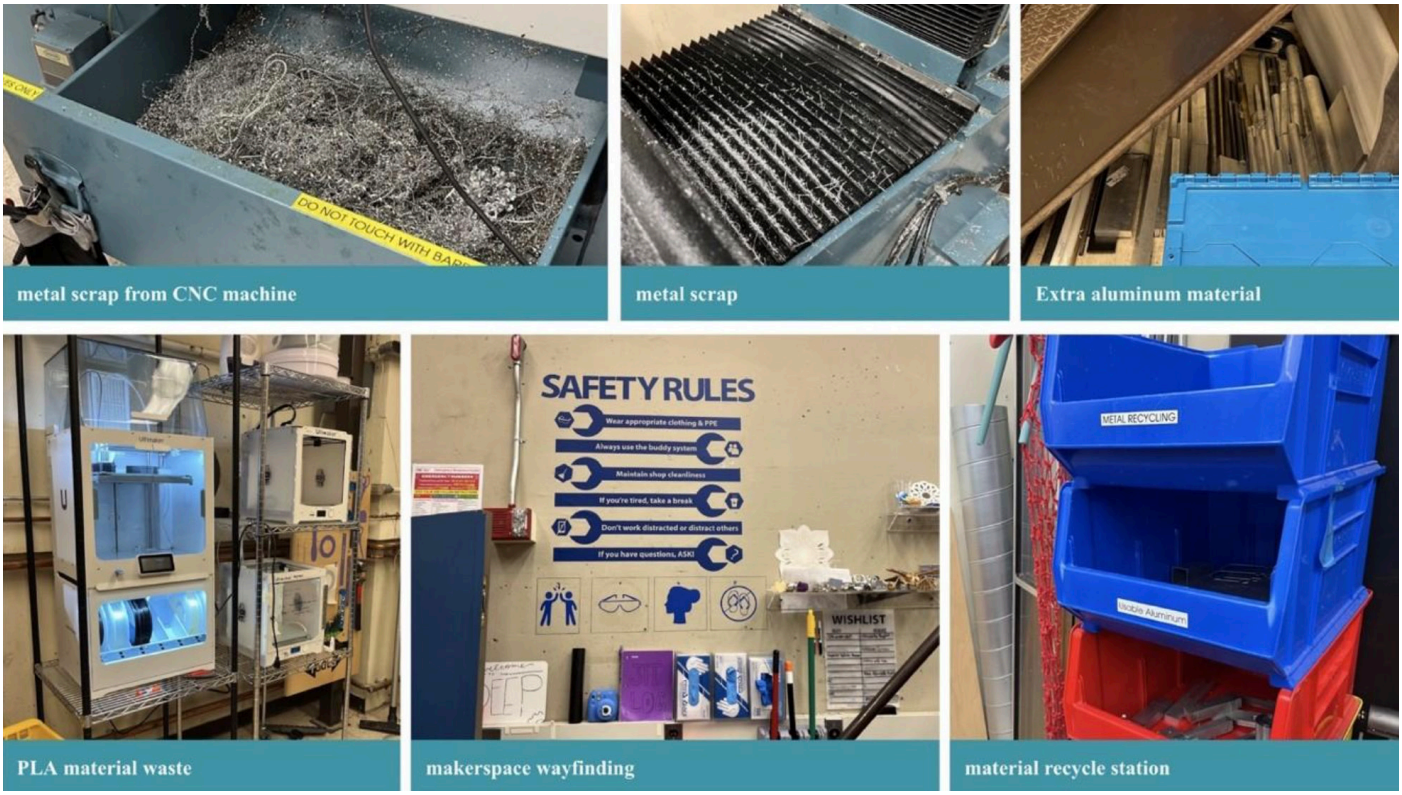

Figure 6: Field research at MIT The Deep makerspace

3.2 Survey design—Using pipette tip boxes in laboratories as a case study

The goal of this case study is to 1) improve the current MIT EHS pipette tip box recycling programme and user experience, 2) consider how to scale the initial solutions, starting with specific laboratories to the entire campus at multiple types of laboratories, and 3) learn how the MIT initiative to build a safe and sustainable laboratory project can impact our collaborative venders and business strategies.

In our survey, besides covering the sustainable design of pipette tip boxes, including using recycled content, consuming less plastic content, using less packaging, and consuming renewable energy during manufacturing, we specifically focused the questions on two sections: 1) purchasing and 2) recycling, with yes/no questions, multiple choices, and open-ended questions so that we can capture the responses both qualitatively and quantitively. The intention of this survey was to help us understand comprehensively the key touch points across the disposable material flow on campus.

For the first section, purchasing, we were curious about the input of the disposable material flow system. Before discussing the disposal and recycling stage, we need to consider the procurement stage of the system. In the study, MIT VPF played an important role in procurement. They've started to plan criteria of 'sustainable' purchasing from the institution's perspective: examining how to build the criteria and who is responsibile at the levels of individual, laboratories, and institutions collectively.

Based on the material from MIT VPF and our research, we listed the questions emphasizing not only people's purchasing behaviours, sustainable product design (e.g., reusable, refillable, and recyclable), but also brands/vendors with sustainability awareness.

For example, do participants know the brand of the pipette tip box or plastic conical tube racks that their laboratory uses? Does the brand provide any pipette tip box or plastic conical tube rack recycling service? How frequently does the laboratory order pipette tip boxes or plastic conical tube racks? Do they or their laboratory choose to buy racked tips or bagged tips? Why do they choose to buy racked tips? Could they use bagged tips instead? Are they aware of sustainable options for pipette tip products? Are they willing to pay more for sustainable pipette tip products? And, if so, how much more (1%, 5%, 10%)?

For the second section, recycling, we want to use the participants' feedback to improve the current MIT EHS pipette tip box recycling programme. 88% of the survey participants/laboratories have collaborated with MIT EHS box recycling programme. Major pain points when people/laboratories engage in pipette tip box or plastic conical tube rack recycling, include it's time-consuming, lack of clear instructions, cost of recycling, no incentives/motivation to recycle, and no one to manage the recycling in laboratories.

Some questions we added to the survey incude, does your laboratory recycle pipette tip boxes or plastic conical tube racks by participating in the EHS managed recycling programme or by a direct return to the supplier? If the brand of the pipette tip box or plastic conical tube racks provides recycling services, can you share with us the cost of this service? How many boxes (waste) are being generated per month? We were also curious to know whether laboratory participants were interested in expanding their recycling efforts to additional forms of non-contaminated laboratory plastic such as buffer bottles.

In summary, we expected that the survey results hypothetically can help MIT to improve pipette tip box or plastic conical tube rack recycling through setting up a complete recycling programme, partnering with sustainable vendors/agencies, enhancing people's recycling awareness through education, redesigning the recycling flow across the campus, and making the rental service of pipette tip box or plastic conical tube rack instead of purchasing a one-off experience.

3.3 Survey result and discussion

We've distilled selected interesting insights after the pipette tip box survey analysis covering two sections: purchasing and recycling. In two-weeks, we launched the pipette tip box survey and documented the result from 31 participants ranging from graduate students (18%), MIT EHS representatives (18%), lab managers (36%), and scientists (27%). Since we considered people's attention span within a short amount of time, the survey was made so participants could fill it out within 10 to 15 minutes (Table 1).

Background	Gender
• Graduate Student (18%) • MIT EHS Representative (18%) • Lab Manager (36%) • Lab Scientist (27%)	Male (31%) • Female (62%) • Prefer not to say (8%)

Table 1. The demography of survey participants (n=31)

3.3.1 The information of pipette tip box

67% of participants knew the brand of the pipette tip box or plastic conical tube racks, whereas 24% did not know. About 10% were not sure about their pipette tip box brands. The brands that participants did remember were: VWR, Genesee, USA Scientific, Sorenson, Neptune, Integra, Rainin, and ART. The majority of the brands (80%) did not provide any pipette tip box or plastic conical tube racks recycling service according to participants' experience. Only 20% of the companies were associated with the product recycling service.

Regarding the frequency of ordering of pipette tip boxes or plastic conical tube racks, 30% of the participants said that they purchased once per month. Only 4% ordered once per week. Some mentioned that the laboratory normally purchased multiple times per month or every other month or even once a quarter. Others said that they had a huge demand for pipette tip boxes, and therefore they order in bulk which is less correlated with the frequency of purchasing.

3.3.2 The cost of time and usability from sustainable pipette tip product

Interestingly, 82% of participants and laboratories choose to buy racked tips and none of them wanted to purchase bagged tips. The remaining 18% didn't know how to decide. Even though bagged tips were relatively sustainable compared with the racked ones, participants said ease of use, convenience, safety, cleanliness, speed were more critical to them.

One participant said, "Sometimes I buy bagged tips and then put them into racks. However, most people prefer racked tips because they get less easily contaminated.

If we buy bagged tips, we would put them into racks ourselves to keep them clean, which can be time-consuming. Also, it is harder to find bagged tips from our suppliers." This was echoed in another response: "Bagged tips are too time-consuming to place in racks one by one. I do buy reloads that are already in the wafer saving waste." For most participants, the bagged tip design was not ideal, since they did not have time to stack the tips into racks themselves, and the cost of their time was not worth the money they might have saved.

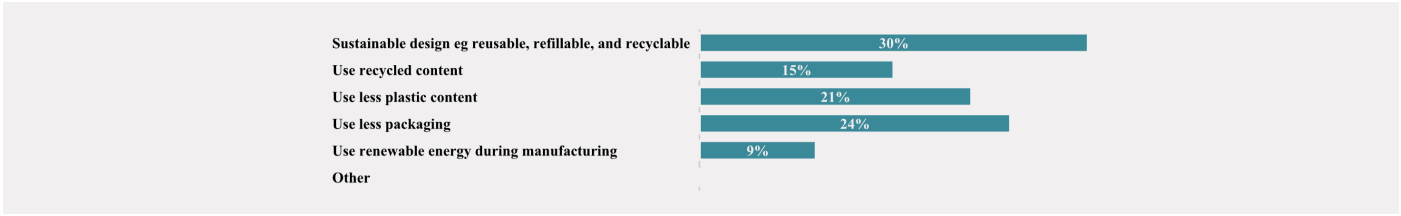

Figure 7: The survey result shows how participants are aware of sustainable options for pipette tip products.

Meanwhile, we were also curious to know if they were aware of sustainable options of pipette tip products exclusive brands and types of tips that we discussed (Figure 7) and how willing they were to put them on their shopping list (Figure 8); 50% of the participants said yes, because it can diminish resources used and improve environmental stewardship, reduce waste to save energy, and it is a 'green' action for them.

One participant identified the potential problem that "I do think that it can be a small effort for a good cause. However, it would be helpful to have a guide of sustainable pipette tips suppliers and catalogue numbers for example. Usually, the issue is the seal or release from the pipettor."

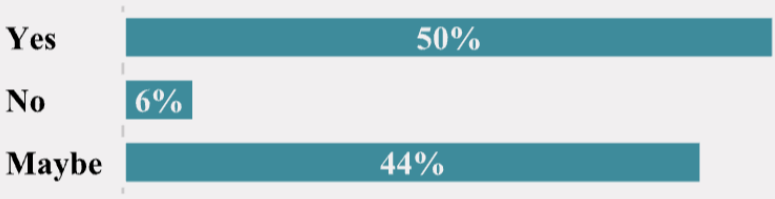

Figure 8: The survey result show how willing participants are to use sustainable pipette tip products.

Since 44% of the participants replied "maybe," which was close to half of the percentage, we wanted to discuss their intention to better understand. These quotes captured their reasons:

- *"Sustainable pipette tip product needs to be sustainable within reason. However, convenience and ease of use is far more important."*
- *"We would need to ensure that functionally sustainable pipette tip product works as well as what we use."*
- *"The sustainable pipette tip option has to be compatible with our automation equipment. We are happy to aim to be sustainable as long as it's amenable to our needs."*

In short, people considered sustainable options based on the quality and usability of the product. At the very least, it needs to have the same function and fit the laboratory's current pipette system with appropriate pricing.

3.3.3 The relationship between value and volume

We also discussed the percentage range of pricing that participants or laboratories were willing to pay for sustainable pipette tip products.

In Figure 9, we can tell that 5% more significantly stood out among other options.

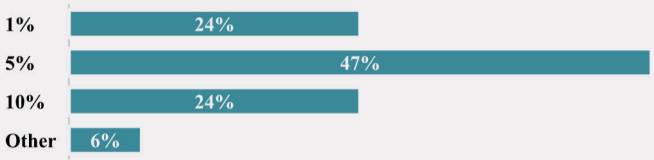

Figure 9: The survey result shows the percentage increase participants are willing to pay for sustainable pipette tip products.

A total of 70% of the participants thought the brand of the pipette tip box or plastic conical tube racks recycling services should be free, whereas the rest (30%) were unsure how much they should charge for these recycling services, which has a correlation with the volume of the wasted boxes generated from laboratory per month.

60% of laboratories generated less than 25 units per month, while 20% of laboratories between 76 units to 100 units per month. But this also depends on the types of laboratories and experiments (Figure 10).

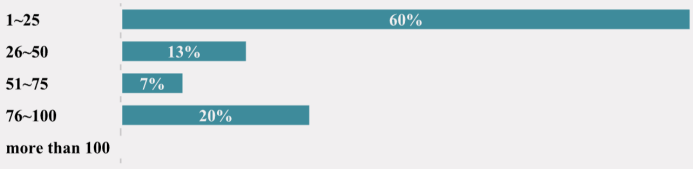

Figure 10: The survey result show how many boxes (waste) are generated from laboratories per month.

3.3.4 The challenges for individual and institution

A total of 60% of the participants felt good when they/ laboratory did pipette tip box or plastic conical tube rack recycling; 10% felt they were lacking clear instructions, or no one actually completed the recycling in laboratories; 5% considered the cost of recycling and there was no incentives/ motivation to do so (Figure 11).

But, if we viewed the pain points through the lens of the institute, how would the participants/laboratories help MIT to improve pipette tip box or plastic conical tube rack recycling or how could MIT help the participants/laboratories to do this? (Figure 12).

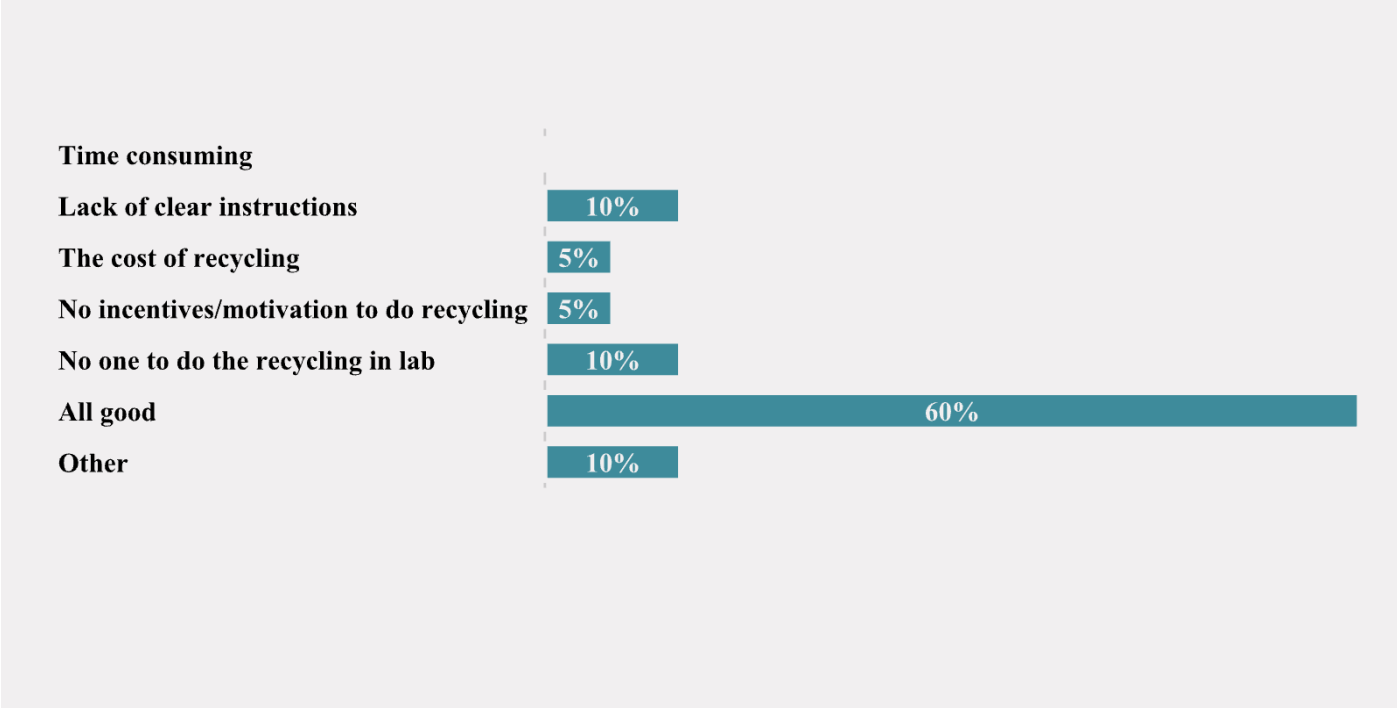

Figure 11: The survey result shows the current pain points when participants/laboratories did pipette tip box or plastic conical tube rack recycling.

Figure 12 reveals that besides the current MIT EHS recycling programme, 42% of the participants pointed out that MIT should set up a complete recycling programme from procurement to disposal and consider people's behavioural change, policy from the government, technology implication, and culture cultivation.

Besides the pipette tip box recycling programme, 92% of the participants showed their laboratories were interested in expanding their recycling efforts to additional forms of non-contaminated lab plastic such as buffer bottles.

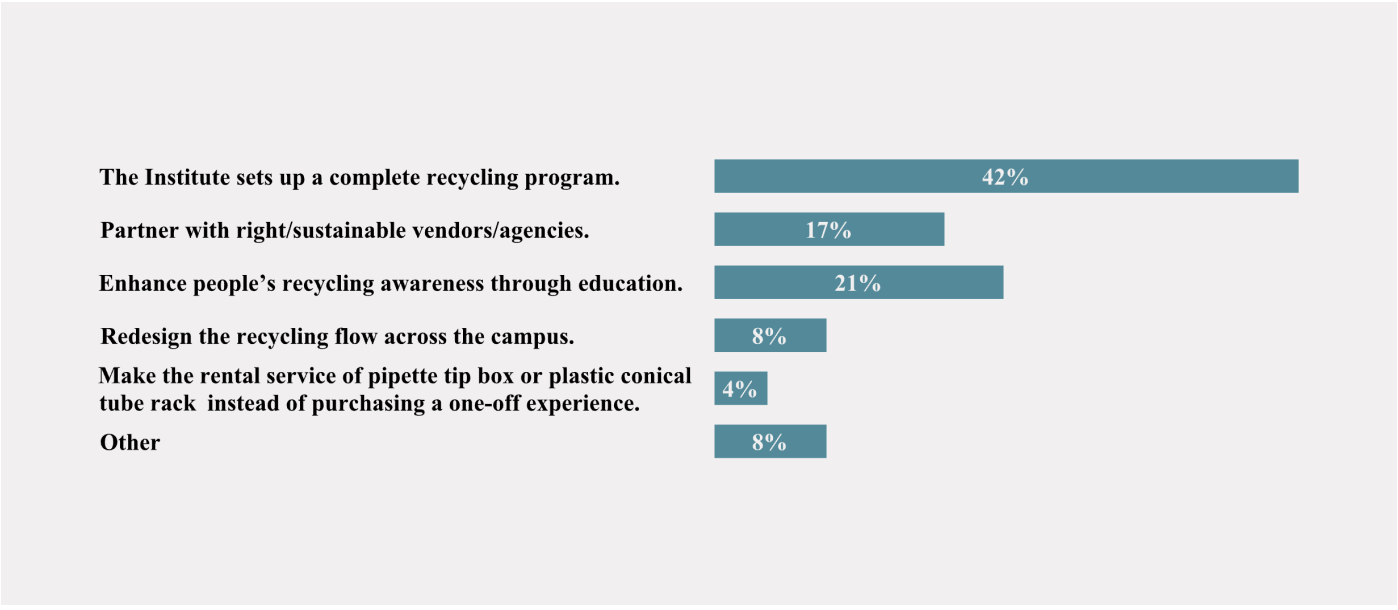

Figure 12: The survey result show how participants/laboratories would help MIT to improve pipette tip box or plastic conical tube rack recycling.

4. Summary and further study

4.1 Inventory management

"Reuse material, know your inventory, and mindful purchasing are easy concepts, but hard to do," said an expert from MIT VPF. Over-purchasing is a common behavior caused by a lack of material tracking [19]. In our pipette tip box case study, even though 60% of laboratories generated boxes (waste) under 25 units per month, which the waste was relatively little and easy to track, they were still unsure of the number of exact orders being made (Figure 10).

According to the field research, interviews and survey results, most people naturally have a mindset towards purchasing more rather than facing less material during their experiment. In conclusion, we observed that improving the laboratory inventory system is a critical step to enable PIs to make smarter material purchases, which also helps laboratory members sort in an ordered way before sending them for recycling or disposal.[20]

4.2 Human behaviour

In our interviews, people said selecting sustainable products is important, but when they make decisions about laboratory material procurement, people naturally consider an item's value per cost first before they think of sustainable impact. Take pipette tip box as an example, 44% of the survey participants replied "maybe" they are willing to use sustainable pipette tip products (Figure 8). It clearly indicated that close to half of the survey participants considered sustainable options in terms of the quality and usability of the product, and the functionality and the compatibility to fit their laboratory current pipettes system with appropriate pricing.

In response to the problem at the institute level, MIT VPF has created a Green Purchasing contract by coining specific terms to make sure vendors not only provide sustainable products with competitive prices but also minimize the carbon footprint of laboratory materials. However, we should carefully take human behavior into consideration when planning sustainable initiatives.

4.3 Safe and sustainable laboratory model

Researching disposable laboratory material flow is the tip of the iceberg of building safe, sustainable laboratories. We need to examine this complex and systemic problem in a comprehensive way to build an ideal model of safe, sustainable laboratories on campus for the future. How do we scale learning from the study? When we consider four phases of material flow analysis, how do we evaluate each phase on the institutional level and individual level?

For further study, we aim to research areas of sustainability practice in laboratories and makerspaces from the perspective of individuals and institutes, identify key touchpoints of disposable material waste with the product and service model, and consider the connection between sustainability actions and people's behavior.

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Title:

Fostering creativity methodology applied in the Ecuadorian Industrial Design Academy (case study on undergraduate students at Universidad Central del Ecuador)

Authors:
Roberto Carlos Moya
Andrea Paola Calle
Jonathan Morales

Institution:
Industrial Design Engineering, Universidad Central del Ecuador
(Ecuador)

Abstract

This research project reflects the results of a case study conducted in undergraduate students of the Industrial Design Engineering department at the Universidad del Central del Ecuador where, through varied work environments (classrooms, workshops and prototyping laboratory), different influential factors related to form studies are determined based on the Bauhaus and Ulm Schools' methodology for the design of products. The present project is developed through qualitative research of the basic principles of form and function studies of the objects and its applicability in rapid prototyping to solve problems. In this project, the problem is related to Chronic Rheumatoid Arthritis (RA) disease, forcing the students to analyze, think and improve the hand movements and its functions. Also, the project allows the identification of viable factors in the creative processes included in the student's proposal in relation to design and innovation of this case. The parameters to measure the results are based on the particularities of the problem and established in relation to the qualitative terms of design products: shape, quality, function, finishes and efficient use of the material for the final design proposal.

Keywords: Industrial design, product design, form and shape, design technology, creativity, Bauhaus, Ulm, rapid prototyping.

Purposes:

- Analyze the current technological and manufacturing context for product design in Ecuador.
- Develop objects through the application of the form studies from a traditional and technological lens through rapid prototyping.
- Determine influential agents in the development of a young design student's creativity in order to understand the context between the handmade and technological design.
- Identify the creative factors that may intervene in the creative processes before, during and after manufacturing a rapid prototype.

Introduction

The promotion of creativity and the development of intuition are tools for the experimentation of basic forms and their different interrelations. Creativity is one the main components of a design processes used to solve problems and improve innovation. The learning environment also develops different kinds of creative and work types. The practical exercises related to the study of the shape of basic design methodologies allow young students to master their diverse applications, providing them security and freedom when experimenting with all possible materials for the execution of products with high aesthetic and functional quality.

Argument

Design to create knowledge

One of the fundamental principles of design is the application and use of the form in all aspects of the designing process. The visual and relationship elements of the forms and shapes govern the spaces through their size, direction or position (Wong, W. Principles of form and design, John Wiley & Sons, INC. 1993). The designer must be capable of understanding and applying all these relationships, in order to get closer to the user's needs and keep their own creative process during the development of their project. This knowledge becomes indispensable at the moment of the creation of products but most importantly, becomes indispensable in different ways when solving the processes through rapid prototyping technologies (Zemva, A., Trost, A., & Zajc, B. 1998). A rapid prototyping environment for teaching digital logic design (IEEE Transactions on Education). Through the parameters related to this knowledge, the quality of the products is analyzed and compared based on the innovation and creativity of each project and an establishment of measurements is made in qualitative terms in order to measure these morphological results. The creative, intuitive and human motor development of the Bauhaus method is an example of this type of method, which allows it to go from handmade and artistic design to a technological model through the critical reflection of how forms are made.

As a place of experimentation, the prototyping laboratory allows the academia to develop a more complex and technological system based on design thinking and related to the user needs and human experiences. The project research "Design and Prototyping of a rehabilitation device for hand rheumatoid arthritis" (MOYA R. 2018) constitutes a practical theoretical example of a process based on the academy as an exercise in design to transmit and create knowledge.

The project describes the advances made in the application of rapid prototyping technologies (RP) in the development of personalized prostheses for the physical rehabilitation of the hand in patients with Chronic Rheumatoid Arthritis (RA). The methodology applied explores different aspects related to the physiology of the movement of the hand and the mobility problems suffered by chronic sufferers, analyzing them from the natural morphological build, the movement of the hand and the relationships of fit, flexion and deformation on mobility caused by the disease.

The educational projection leads to a project methodology that seeks design students to reach contextualized solutions in a spatial, temporal, environmental and social way with interference from the user for whom it is designed. The projects within the classroom develop an argumentative capacity and critical reflection on the mind of the student that is undertaken through the act of design itself, which is eminently intellectual. The academic design projects seek to generate an integration of knowledge that shows real development through prototyping with the confluence of multidisciplinary work that allows the exchange of knowledge and positions around a design issue, collecting the most useful information for both the project and the future performance of the designer on technological applications.

The value of creativity in education

The concept of creativity in education can be seen as complex and multifaceted considering that it defines the ways through which the student is able to create solutions for problems or innovate on existing solutions.

Creativity is also a concept that depends on culture. It is an activity that is defined through each of the personal relationships and work teams. Since each person has different experiences that allow us to gather information and create with it different realities, creativity is a space where all information, which is varied, is compounded for more innovative creations.

Although there are several models of creativity and many studies devoted to them, all start from a first initial model. Indeed, one of the first and best-known models of creativity proposed is Graham Wallas' Creative Process (1926). The basis of this model holds that the human being goes through some steps for the resolution of problems in which possibilities are analyzed in order to find them. Analyzing human psychology, the influence of feelings and behaviors, Wallas proposes a model that reflects the natural process of thinking. In this sense, the creative process developed for the research of this article corresponds to the four phases of the model:

- **Preparation:** stage in which the problem is analyzed and investigated in all possible directions.
- **Incubation:** stage in which the person unconsciously thinks about the problem and approaches viable solutions.
- **Illumination:** stage in which, through all the information collected, a possible solution is chosen with which the individual is satisfied.
- **Verification:** stage in which that enlightenment idea is tested to verify its functionality.

The value of creativity in this research is based on implementing the initial premise of the Bauhaus, which, as mentioned by Perelló (1990), focuses on providing students with spontaneous creativity. This premise is stated in the manifesto of the Bauhaus Design School, in which it was expected that the student would be able to know his creative capacity through the exploration of forms, artistic and technical practice and the intuitive exercise of his senses. In this way and through this process, the student should be able to acquire intellectual and emotional knowledge through material experimentation and not only from the theoretical.

Following the same scheme of initial learning to professional Walter Gropius' Bauhaus detailed by Argan (2006), it is proposed to students who are in a stage of professionalization, the technological experimentation of modulation and simulation programmes in industrial design. Through this process, students are expected to develop intuitively, based on intellectual and technological knowledge, a functional solution to the natural movements of the hand.

Methodology

The study takes as a research sample, a group of undergraduate students whose internship projects are in the Prototyping and Design Laboratory of the Engineering in Industrial Design School, located in the Central University of Ecuador. Through a qualitative investigation based on the different application of design elements related to forms, their results were contrasted with the results of groups of students who worked on their projects in spaces without technological tools, in order to determine influential agents in the creative processes of product and industrial design.

With the objective of generating an orderly process that allows reviewing the results of creativity in the technological application, a series of steps are established and followed by the student

In the first instance, the available information regarding the problem faced by people with reduced mobility in their hands due to RA is analyzed.

The data is analyzed in relation to measurement parameters that are described later in the references on hand mobility. This information allows the students to analyze materials conducive to achieve the highest possible functionality approaching hand movements. At this stage, students analyze the data provoking the first creative phenomenon of Graham Wallas' process: incubation.

In this research, we intend to prove that the relationship between data analysis and the beginning of the creative process is parallel, since the student acquires more ideas to solve the problem the more information they receive. Similarly, the methodology involves dabbling in Bauhaus methods, allowing students to experiment with materials.

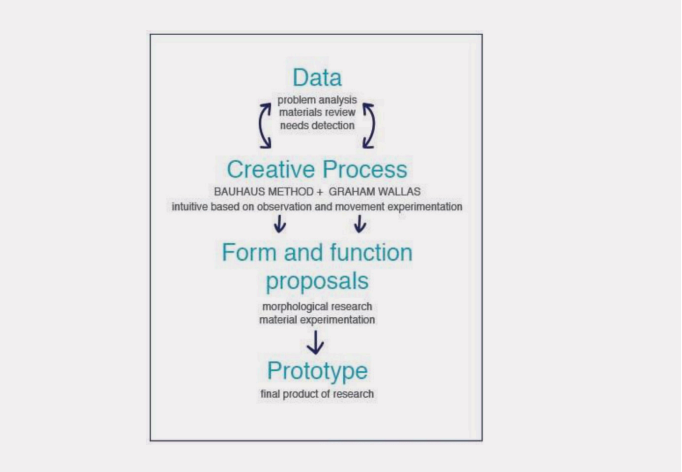

Figure 1: Methodology on fostering creativity

After analyzing the materiality and its properties in terms of form and function attributes, students experiment with their proposals through simulation systems (CAD-CAM). This stage makes it possible to establish the advantages and disadvantages of the proposed solutions to the problem of hand mobility.

The problem is analyzed from the morphology of the hand in terms of its movements, with the aim of replicating those that have been lost due to RA at the level of the fingers. As a result of this analysis, the students proceed to make the first prototyped morphological proposals. In the last stage, a table of results is established to test the proposals from the perspectives of form and function.

References on hand movements

As explained above, the data analyzed by the students corresponds to previous research that allows the understanding and can replicate the movements of the fingers of the hand. As an example, information about exoskeletons were shared and explained to students before the experiment. The data includes the results of thirty-six hand exoskeletons reviewed according to the criteria described above in previous research on this topic. The devices were organized in chronological order and classified according to their attributes of mechanism, control and unit of action, described in Table 1.

Year	Actuation	Force of Output (N)	Dégrees Freedom	Finger movvements	Range Movement	Weight	Functionality	References
2015	Hybrid Tire	1.3	3	Flex	150	-	Rehab	[8,9,10,11]
	Hydraulic	8	15	Flex and Ext	250	<500g	Rehab	[1]
	Pulley Cable	680	15	Flex and Ext	-	711g	Rehab	[5]
	Tire	29,5	99	Flex and Ext	112	194g	Rehab	[17]
	Tire	13	3	Flex	149	-	Rehab	[30]
	Tire	10,35	15	Flex	141,2	200g	Rehab	[34,35]
	Tire	9,25	12	Flex	191,2	180g	Rehab	[36]
	Tire	2N	3	Flex and Ext	143,5	25g	Rehab	[19]
	Tire	-	3	Flex	165	-	Rehab	[40]
	Tire	-	-	Flex	99,7	200g	Rehab	[33]
2016	Linear actuator	3,125N	1	Flex	-	-	Rehab	[30]
	Tire	-	15	Flex and Ext	-	-	Rehab	[24,25,26]
	Tire	35N	15	Flex	105,9	-	Rehab	[41]
	Tire	17N	3	Flex and Ext	93	-	Rehab	[28]
	Tire	10N	12	Flex and Ext	-	<100g	Rehab	[38]
	Tire	5N	3	Flex	-	-	Rehab	[37]
	Tire	2N	3	Flex	40	-	Rehab	[4]
	Tire	2,2N	4	Flex	-	-	Rehab	[31]
2017	Pulley cable	10N	2	Flex	-	-	Rehab	[6]
	Pulley cable	16N	15	Flex	141,2	300g	Rehab	[22]
	Tire	11N	14	Flex and Ext	96	85,03g	Rehab	[32]
	Tire	35N	44	Flex and Ext	90	-	Rehab	[16]
	Tire	-	15	Flex	-	-	Rehab	[18]
	Pulley cable	-	2	Flex and Ext	120	90g	Rehab	[2]
	Tire	5N	-	Flex and Ext	110	285g	Rehab	[27]
2018	Tire	4N	3	Flex and Ext	-	-	Rehab	[39]
	Tire	-	-	Flex and Ext	-	<150g	Rehab	[23]
	Tire	>10N	6	Flex and Ext	106	-	Rehab	[12]
2019	Tire	4N	-	Flex	-	75g	Rehab	[7]
	Neumatic	-	4	Flex and Ext	106	156g	Rehab	[14]

Moya-Jiménez, R., Magal-Royo, T., Ponce, D., Flores, M., & Caiza, M. (2020, November). Hand Exoskeleton Design for the Rehabilitation of Patients with Rheumatoid Arthritis. In Conference on Information and Communication Technologies of Ecuador (pp. 12-21). Springer, Cham. DOI: https://link.springer.com/chapter/10.1007/978-3-030-62833-8_2

Table 1: Summary of the mechanical, electrical and functional attributes of robotic hand exoskeletons since 2015 (Source: Moya-Jiménez R., et al, 2020)

These references were considered in the testing table shown in the results, where we intend to prove that the design of exoskeletons as a solution to hand movement is one of the most intuitive forms of creativity.

Educational spaces demand additional approaches to the use of technology as a source of inspiration and creation. The intended product of this research aims to understand the direct relationship between human beings, their mobility and industrial design. Design can be understood as a discipline that seeks to generate new products to solve needs, however, the existing technology today allows the establishment of creative processes to improve the lives of human beings.

The use of new materials, simulation and prototyping systems make it possible to think of design as an immediate means to develop biomechanical technologies, for example. The study of form and function can be an opportunity to understand the mechanics of the limbs of the human body, creating from design, a new era of symbiosis between the human and the technological. This symbiosis may be the use of exoskeletons in increasingly usual and common ways.

It is therefore possible that, in the near future, there will be products available that can replace human extremities at an affordable cost and in a very short time. These products will undoubtedly be the result of the creative process developed through intuition and intellectual knowledge, which when combined with material experimentation, would generate a new perspective on the health and welfare of people with mobility disabilities.

Likewise, simulation systems are bringing us even closer to new virtual environments that have been proposed as ways of educating and interacting in the aftermath of the COVID-19 pandemic. Facebook's business turnaround to META enterprise in 2021 (Wakefield J., 2022) is a clear example of how we are moving even closer to virtual reality experiences that require simulation tools. The Reality Labs proposed by META are potential education labs where students will be able to experience the specific mobility of their body limbs to perform their tasks. This research also implies thinking that simulation systems will be, in the future, complements for the development of avatars that will allow us to coexist in the metaverse. In this sense, current technology applied to creative and intellectual processes in industrial design, allows a number of unimaginable scenarios related to the future of human interaction.

Results

For the test of the results obtained by the students, an evaluation rubric is developed that contains in a simplified way, the concepts expanded in the contents of this research. In this sense, three aspects of creative-technological experimentation are evaluated.

Criteria	1	2	3
Function	The functionality does not allow for grabbing objects, it is too rigid and does not allow for replicating the movements of the fingers of the hand.	The functionality allows limited grabbing of objects but does not allow replication of the movements of the fingers of the hand.	The functionality allows you to grab objects and allows you to replicate the movements of the fingers of the hand.
Morphology	The shape has no concordance with modules that would replicate the structure of the fingers of the hand.	The shape is similar to a module that replicates the structure of the fingers of the hand.	The shape contains modules that can replicate the structure of the fingers of the hand.
Technological viability	The product is not feasible to be prototyped through 3D printing.	The product could be partially prototyped through 3D printing.	The product could be fully prototyped through 3D printing.

Figure 2: Moya-Jiménez, R., Calle-Mendoza, A. Evaluation Grid Parameters Fostering creativity methodology applied in the Ecuadorian Industrial Design Academy, 2020.

Also, in the final testing table, an optional field is added that refers to the use of modules as a basis for the design of the proposal. This field has no evaluation, but it allows us to visualize that the groups that used this resource were also able to make a viable proposal in terms of form and function.

Group number	Use of module	Function	Morphology	Technological viability
1	x	2	3	3
2		2		2
3	x	3	3	2

Table 2: Group testing on product prototyping
Moya-Jiménez, R., Calle-Mendoza, A. Evaluation Results

Once the results are obtained, it can be observed that the creative experimentation method used in this research allows the groups to present viable proposals in relation to the problem. As can be expected, the greater the intellectual knowledge of the students, the level of research and their social involvement in the problem, the greater the source of creativity and innovation they can develop and achieve.

The adequate spaces for the development of successful products are enhanced through creative methods that encourage the use of material, generating constructive thinking in a logical design process. The study of design morphology based on user experiences, allows a close approach to the possibilities that technology can offer to solve design problems, especially sectors where creativity applied to design can provide solutions to improve the quality of life of people around the world and specifically in developing countries.

The factors of quality and application of the material in a creative way are applicable in the current technological methods for the design of products. The researching of technologies and processes adapted to these specific topics has opened new methodological opportunities through the use of new technologies within rapid prototyping. According to the reasoning that has been done in the present proposal, the information that has been obtained, may be used in a virtual way related to the study of applicable shapes to generate adaptable products according to the needs of a design user.

Figure 3: Moya-Jiménez, R., Calle-Mendoza, A.
3D Printing Finger Module

Current technology applied to creative and intellectual processes in industrial design, allows a number of unimaginable scenarios related to the future of human interaction.

Conclusions

The morphological study of the principles of design related to form and shapes is conserved in the current educational model as the basis of the understanding of design.

The terms of quality and application of the material in a creative way are applicable in the current technological methods for the design of products.

The application of constructive thought, economy of material, synthesis of form, colour and shape continues to be decisive in the design of products.

Design proposals need interdisciplinary work, based on three lines: the formal aspects (design processes and ergonomics), the theoretical aspects (study of design theory) and the technical aspects related to functionality (communication systems, instrumentation and tools).

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Title:

Leveraging Aspects of the Rural Everyday: A case study in addressing the information gaps in Indian maternal care

Authors:
Ekta Jafri
Priyanka Pillai
Aaina Amin
Nisha Rangdal
Ishani Sathe
Poorvi Mathur

Institution:
IBM India
(India)

Abstract

The purpose of this project is to reimagine maternal care in rural and peri-urban India amongst lower socioeconomic groups. In the rural and semi-rural regions of India, maternal deaths from preventable pregnancy complications are still widely recorded. These stem from a scarcity of accessible information, pregnancy practices that are at odds with modern medicine, and a lack of infrastructure. We used human-centred design to create 'Uma', a pregnancy service that considers the socio-demographic context of the various pregnancy stakeholders and then engages with them through organic accessible touchpoints. For the pregnant woman and her support system, the service leverages household resources and practices to inculcate medical adherence, proactive decision-making, and help-seeking behaviours. For medical personnel, Uma lessens the burden of care and smoothens doctor-patient interactions for increased productivity. Each major service touchpoint is designed with careful consideration of the user's context, with technology consciously used throughout. This paper covers our enquiry into the maternal care landscape, shares the research, and explains the design intervention.

Keywords: Maternal healthcare, pregnancy, service design, systems, agency, decision-making.

Introduction

The World Health Organisation defines maternal health as the health of the person through the course of their pregnancy, during childbirth, and the postpartum period (WHO, 2019), while antenatal care, delivery care, and postnatal care are the services that constitute maternal healthcare (WHO, 2019). Every year pregnant persons lose their lives to preventable pregnancy complications (Ambulkar, 2016) that existing healthcare services can mitigate. A 2021 study of Indian maternal mortality trends places the country's maternal mortality rate at 99/1,00,000 live births – an objective that was outlined in the 2015 Millennium Development Goal (Meh et al., 2021). Further, an estimated 1.3 million people have died from maternal causes in the last twenty years, mostly in the country's rural areas (Meh et al., 2021). While healthcare innovation and reach of technology have reduced maternal deaths, many people cannot access healthcare facilities or do not know the importance of utilizing available services. We wanted to understand the maternal care ecosystem to first identify an opportunity area within and then build a relevant and sustainable intervention.

Research

Our objective was to understand the current maternal landscape and context of the lower-income category (defined here as people with an income of $2.01 - $10 a day) in the rural and peri-urban settings. The research included contributors from eight different states, who are engaged in different professions (mostly in the unorganized labour sector) and are at various stages in their pregnancy journey and/or child-rearing.

We began our primary research with pregnant persons and women (aged 20-55 years) with children, their ancillary support systems, and a few employers. In the context of this paper, 'ancillary support system' refers to the person's partner and immediate family who inhabit the same space as them and so are affected by the pregnancy. We also engaged with medical professionals and government-appointed community healthcare workers – Accredited Social Health Activist (ASHA) and Anganwadi Workers. For more information on ASHA and Anganwadi workers, see (Closser & Shekhawat, 2021; Gulati, 2020; Jigeesh,2020; Saprii et al., 2015).

We leveraged a mix of research methods like storytelling, semi-structured interviews, subjective assessments, in-depth interviews, and observational techniques like shadowing and fly-on-the-wall to understand and map the existing ecosystem of care around a pregnant woman. Our key research areas included:

- The cultural beliefs and traditions that impact pregnancy and influences the actions and decisions of pregnant persons and their ancillary system
- The form and structure of different ancillary systems and how this impacts pregnancy and maternal health
- The prevalence and depth of pregnancy-related medical information in different communities as well as management methods they follow
- The daily routines and practices that are influenced by pregnancy
- Nutritional changes and challenges that come with pregnancy
- The barriers in accessing and utilizing maternal healthcare services
- The quality of care and current medical practices

We concluded our research stage with 79 interviews, identified four user types, and clocked 120+ interview hours.

Findings

Our research methods and design tools uncovered a dynamic complex ecosystem that is strongly influenced by information, culture, and infrastructure. Our research findings come from the qualitative data and lived-experience narratives that we collected during the interviews and interactions with various stakeholders; these were then corroborated and supplemented with secondary research. While this paper does not cover all the research findings in detail, the more relevant findings are elaborated on below.

The scarcity of information

Our primary research showed that pregnancy, as an experience, is not openly discussed by pregnant people and their ancillary ecosystem. This means that the circulation of pregnancy-based information within communities is low. Mothers and grandmothers pass on their experiences and customs to their daughters only when the latter becomes pregnant. There is little to no planning or birth preparedness that comes before onset of pregnancy.

During pregnancy, the women come to rely on an 'older trusted female relative' who guides them on daily practices, nutrition, and physically helps them with household chores and daily activities. The pieces of advice they receive mostly concern the child's conformity to cultural notions of perfection, i.e., strength for boys or petiteness for girls (based on prevalent binary ideas of gender) and fairness in complexion. The socio-economic class of this group limits their ability to purchase and consume a variety of healthy foods (Mukherjee, 2019). They usually make do with their region's staple grain and dairy-based supplements. Even with the food that they can access, cultural notions dictate the consumption – they are often scared to eat too much or are afraid of how certain foods will affect the child. They are commonly given homemade preparations for the pregnancy made from local ingredients and are instructed to consume them; they are rarely given a reason and are often forced into consuming these preparations through fear.

Most women make sporadic visits to their healthcare centres through the course of their pregnancy and are prescribed supplements like iron, calcium, and folic acid. Unfortunately, they do not consistently take the supplements. They sometimes experience side-effects that they do not know how to manage, hear stories of how supplements affect the foetus and then get scared, or are simply ambivalent because they do not understand why they should be taking the medicines. Their only source of medical information is from hurried interactions with overworked medical staff or underpaid community health workers. During the limited time of the monthly appointments, the staff is barely able to brush through essential pregnancy-related information owing to the high volume of patients. We also found that for most patients, voicing their doubts or asking for clarification is a struggle; they are shy/uncertain in doing so or do not feel comfortable enough with their healthcare provider. The disconnect between doctors and patients in language and culture only adds to this communication gap. The medical pamphlets that are given out at healthcare centres are extremely text-heavy and difficult to understand. They are unable to connect to the content or ascertain its relevance to their lives. This lack of knowledge and adherence regarding supplements is one of the reasons for the high prevalence of anaemia-inflicted maternal deaths.

We also discovered that for most of the women we spoke to, going to the hospital was perceived as the last resort. In addition to financial constraints and the general notion of "waiting to get better" (more on that below), we found that neither the pregnant women nor their ecosystem is aware of danger signs. Through the pregnancy, there are certain signs that signify something is amiss. The pregnancy stakeholders need to look out for these signs and are generally required to get immediate medical help or mention it to the doctor at the next appointment. Since they are unaware of the need for vigilance or the protocol on experiencing the signs, most women delay seeking medical help and this leads to complications in the pregnancy.

There are multiple government schemes and policies by the central and state governments (Government of India, 2021; Government of Haryana, 2021; Government of Maharashtra, 2021) that provide subsidized and free services, and food and transport facilities, but the utilization remains low.

Many women are unaware of these services while others are unable to access them due to bureaucratic barriers like ID and registration.

We have identified low rates of literacy and prevailing poverty as major barriers in the accessibility to medically verified information, which further influences help-seeking and decision-making behaviours of the entire pregnancy ecosystem (Hamal et al., 2020). Further, it is not only the lack of accessible information that is concerning, but also the prevalent misinformation that is spread that causes fear and paranoia, and impacts decision-making.

The barriers of culture

In the absence of medically verified and accessible information, people widely follow their cultural beliefs and traditional customs. Most of the people we interviewed belong to patriarchal communities and their pregnancy practices are influenced by the inherent power structures and religious orientation (Hamal et al., 2020).

Pregnancy is viewed as the woman's domain, one where the man's involvement is minimal. The 'older trusted female relative,' usually the mother or mother-in-law, is by the pregnant woman's side to help and guide her. However, the responsibility of care is also placed on the woman, even for things out of her control. If the delivered child does not meet the family's expectations – in terms of gender, skin colour, features, and ability – the woman is held accountable. These accusations tend to be based on superstition and we found that a lot of women have been conditioned to self-blame. While pregnancy is perceived as a "gift" in most cultures, many people, especially younger women, feel as though it is something that is happening to them. In such a situation, they feel unbalanced and powerless.

While the pregnant woman gets help with housework and taking care of the other children (if any), the presence of the 'older trusted female relative' does not necessarily mean the woman has a friend and ally for her emotional needs. Denial of mental health needs as well as oppressive gender roles has in some ways affected the way women present themselves, especially in pregnancy.

We see an extension of the gendered denomination of pregnancy in hospitals as well where men are 'not allowed' inside the maternity wards and delivery rooms. In fact, we observed that even while accompanying their wives to the antenatal care appointments, most men preferred waiting outside the doctor's room. We noticed that most men knew little about pregnancy, its danger signs, delivery, or post-delivery health requirements and were minimally involved in the preparatory steps of their child's birth, as supported by Mersha (2018). The only protocol that necessitates the man's involvement is during a crisis where decisions regarding care of the mother and child need to be made.

The lack of infrastructure

As mentioned above, seeking care at a hospital or health centre is often the last resort. In the socio-economic context that we are investigating, poverty plays a huge role in accessing care. Many women find that they, despite knowing the need for antenatal care and having the desire to go to the appointments, cannot take the time off from work to go to the hospital. Missed work is missed pay, which has numerous repercussions in their respective households. In some places, health facilities are open only during specific time periods and so patients are forced to wait, unsure if they will even get to meet their doctor. We discovered that most women in this group continue working well into their third trimester and are often engaged in strenuous physical labour as domestic, field, construction, and daily-wage workers (Mukherjee, 2019).

Our research uncovered the inadequate quality of medical infrastructure at the rural level. There seem to be insufficient medical facilities and resources (like blood banks, syringes, medical bandages etc.).

The percentage of skilled staff is too low to meet the medical needs of the region and doctor-to-patient ratios are skewed. When compared to the WHO recommended ratio of 1:1000, India has a total doctor-population ratio of 1:404 (Parliament of India, 2020) and 1:34 000 in the public health sector (Thayyil & Jeeja, 2013). We heard accounts of abuse and poor treatment of patients by the medical staff particularly in the maternity ward, which is supported by documentation (Jungari et al., 2021). Negative experiences like this stop women from utilizing healthcare services for their next pregnancy. These factors contribute to a hesitancy in utilizing healthcare services, especially in rural areas (Yadav et al., 2020) even for delivery, leading to adverse pregnancy outcomes.

Thus, the scarcity of information, barriers of culture, and dearth of infrastructure lead to delayed responses in seeking and accessing medical care, as also found by Sheik et al (2019). They also contribute to a lack of agency as experience by the pregnant person.

Our findings corroborate the framework laid out in the three-delay model, which identifies three groups of factors that impede maternal care (Pacagnella et al., 2012) – delay one is the delay in deciding to seek care, delay two is the delay in reaching a healthcare facility, and delay three is the delay in receiving adequate care at the facility. Sheik et al (2019) identify the first delay as the most greatest contributor to maternal deaths. As per our research and resources, the first delay also stands out as a potential area for intervention.

There have been previous attempts at leveraging mobile health interventions that seek to transfer medical knowledge, create a network for emergencies, and encourage soon-to-be-mothers in the same geography to connect. However, these interventions fail to sufficiently account for the illiteracy, gender gap in mobile usage and ownership (Chari et al., 2020), and localized socio-demographics (Tambotoh et al., 2015), thus leading to low levels of user adoption and higher percentages of user attrition.

Analysis

Design tools helped reveal underlying patterns, map the system's interconnectedness, and identify core gaps that may lead to adverse pregnancy outcomes.

We used system maps to explore cognitive and behavioural patterns, and interdependencies, deconstructing the involvement of the ecosystem and the factors that influence their actions.

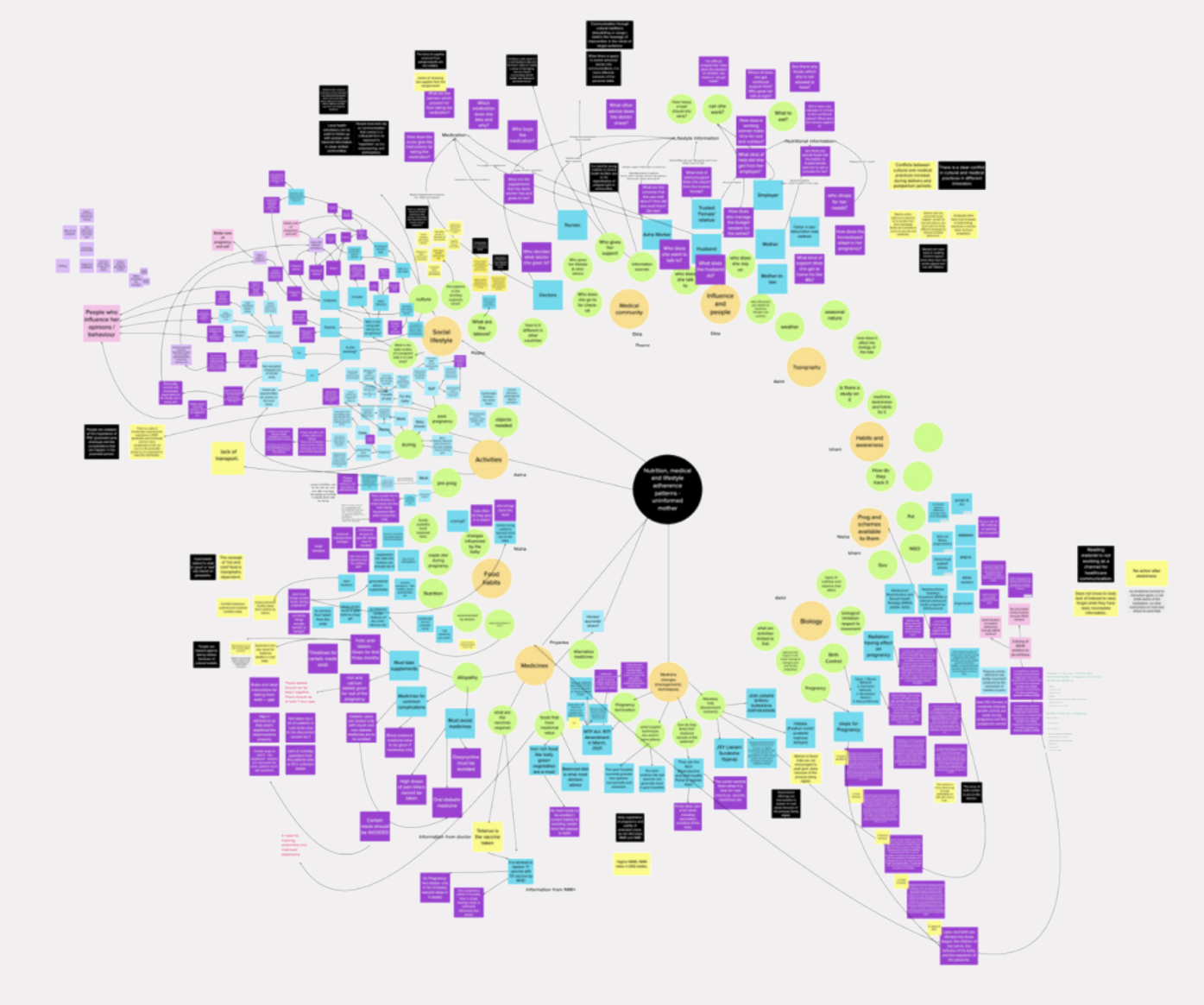

Figure 1: System Map

Through persona mapping and contextual enquiry, we unpacked mental models about pregnancy and ascertained their goals within the complex ecosystem.

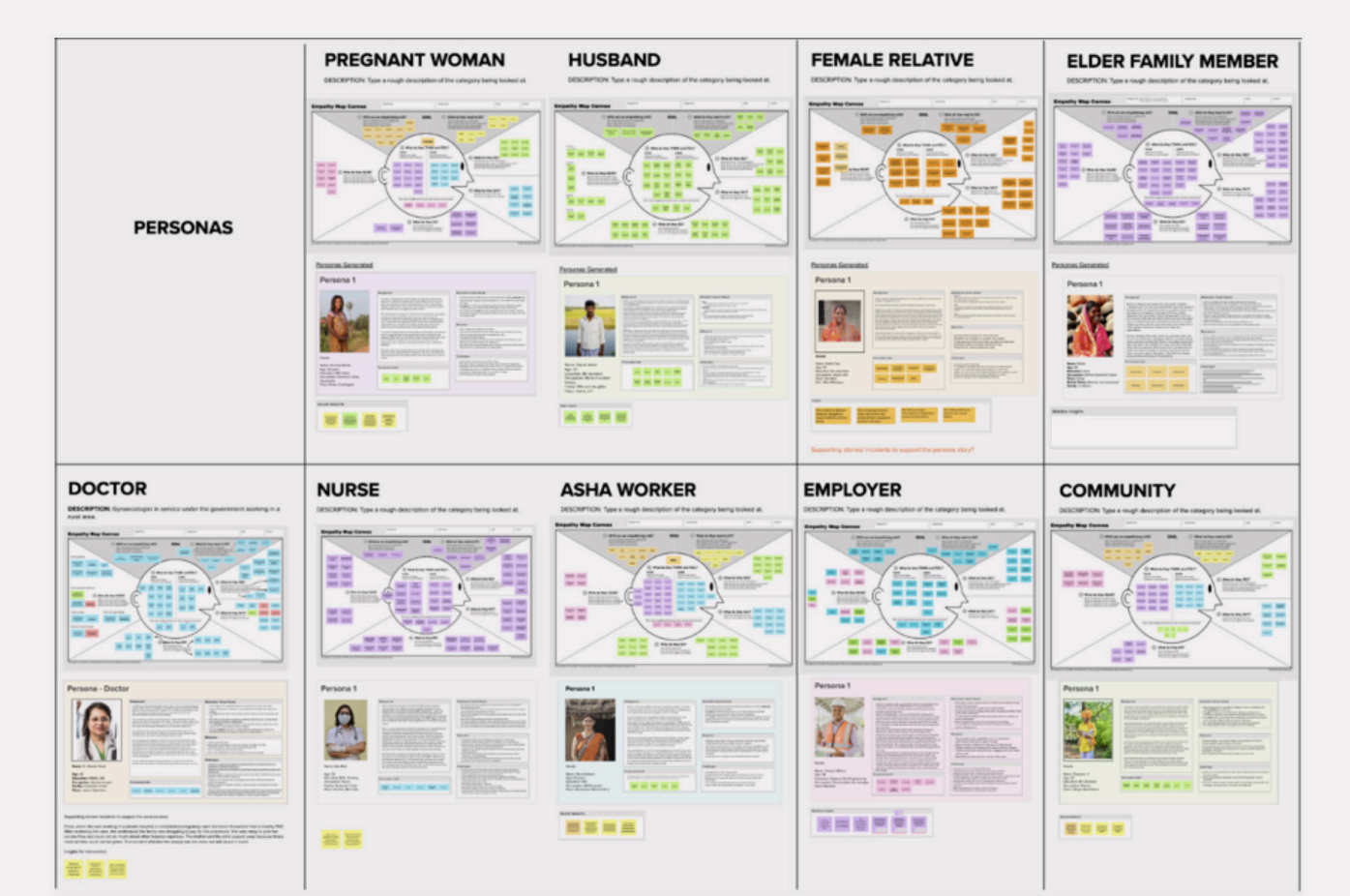

Figure 2: Persona mapping

We created causal loops to understand the behavioural triggers of our users. For example, the decision to go to the hospital was influenced by stories heard from people in the ecosystem. Stories of successful deliveries had a positive impact, while stories of unsuccessful deliveries had a negative influence, resulting in the patient delaying the decision to go to the hospital.

This in turn resulted in an unsuccessful delivery at the hospital, thereby reinforcing the loop. Similarly, stories about pills having a 'detrimental' effect on the pregnancy discouraged users from taking the supplements.

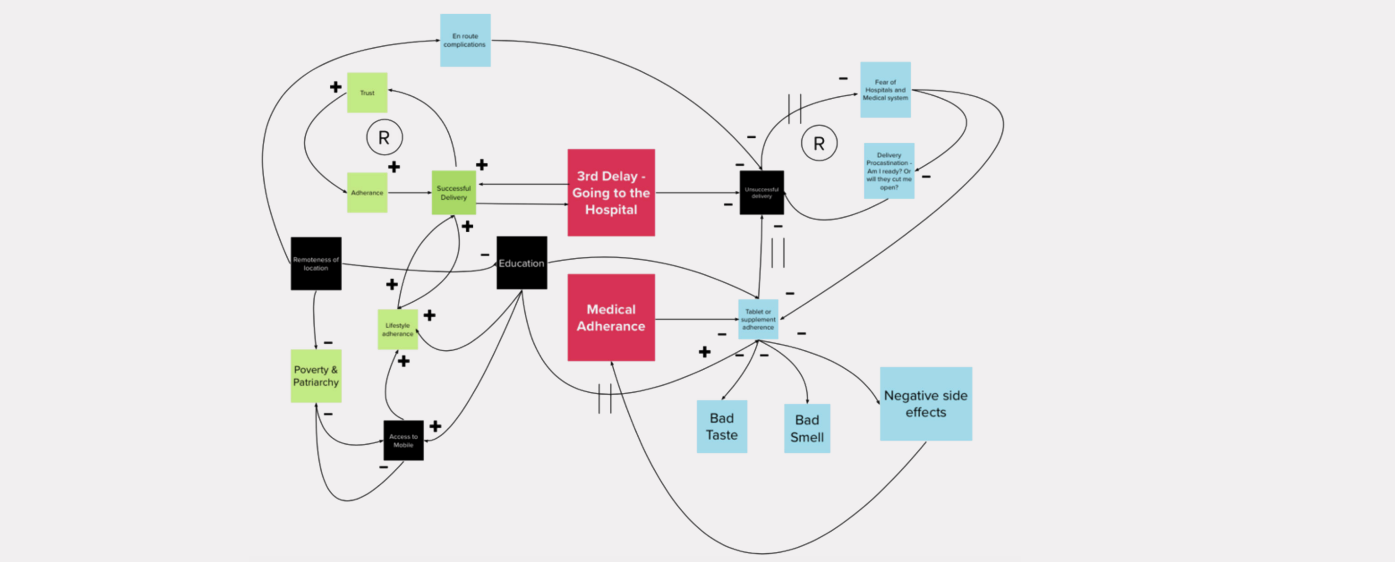

Figure 3: Causal map with feedback loop

We did a causal layered analysis of the maternal landscape to examine its social, medical, and cultural paradigms. We particularly delved into the decision-making abilities of the pregnant woman, sexism within maternal care, and medical adherence to identify opportunities for intervention.

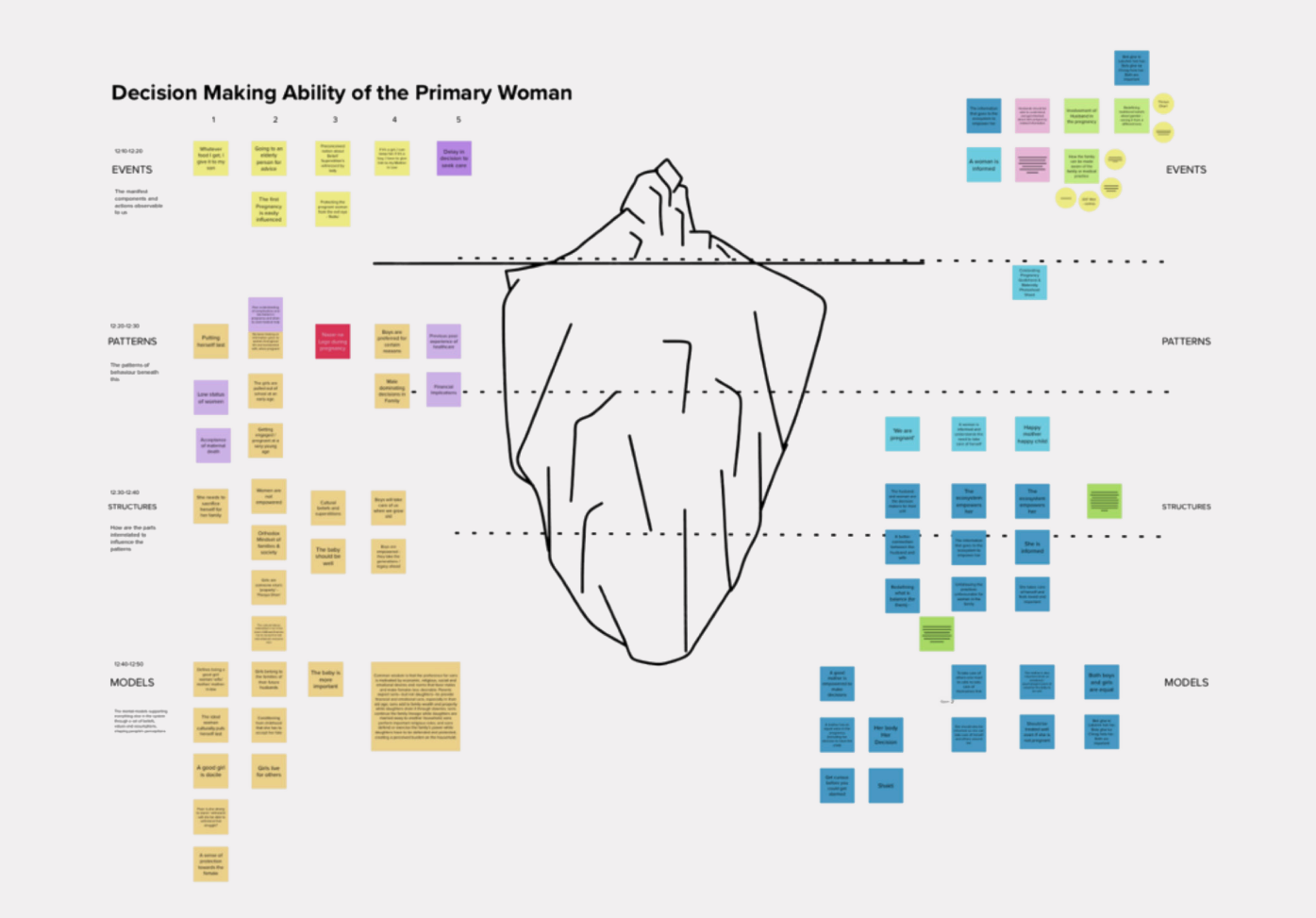

Figure 4: Layered causal analysis – decision-making paradigm

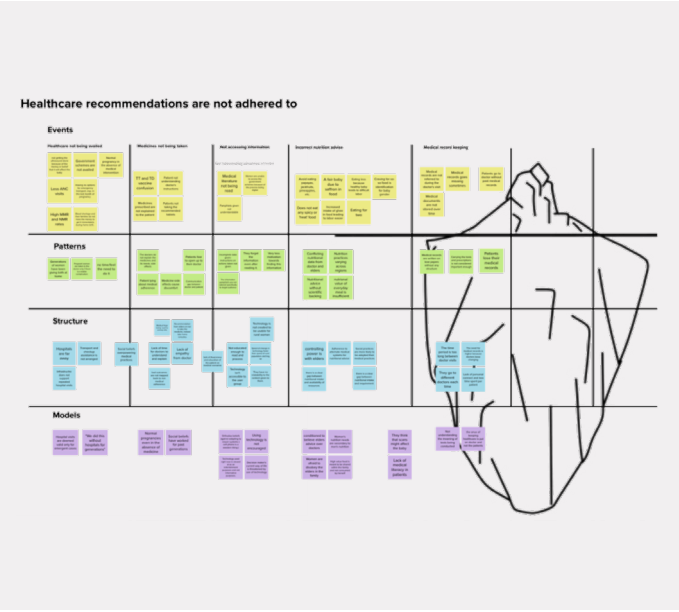

Figure 5: Layered causal analysis – adherence paradigm

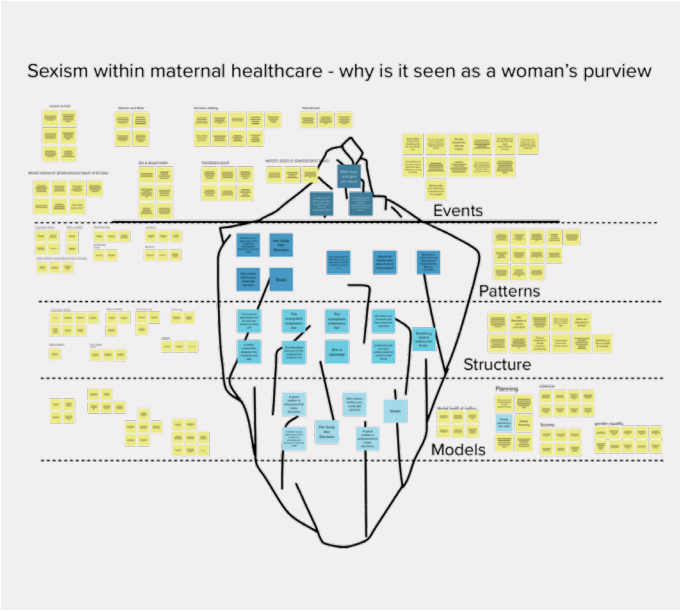

Figure 6: Layered causal analysis – gender paradigm

These tools not only allowed us to hone in on our area of focus, but they also supported a similar deduction: there is a need for effective information dissemination and healthcare tracking methods that proactively engage all the stakeholders for overall improvement in care. Such an intervention must not alienate the users, it must fit seamlessly into their lives, considering their socio-economic context.

Ideation

Understanding the needs of the pregnant woman and her ecosystem

Analysis of the primary and secondary research revealed several areas that could be linchpins for behavioural change. A clear pattern that emerged was that of information availability and communication, and medical advice adherence. A need for reliable, relatable information that was hyper localized and medically verified was apparent.

An extension of having reliable information was to ensure adherence to this information to not only empower the women, but also give them the tools to implement it with their choices.

Rapid ideation sessions

Using the research analysis to point us towards potential interventions, we conducted several rounds of converge – diverge ideation sessions where the team members would come up with various areas / methods of interventions, channels of communication and other tools with the aim of targeted behavioural change.

The ideas were generated in diverge modes that allowed the designers to ensure its validity and some benchmarking.

After some initial research, each idea was presented to the group and those with similar intent and themes were then grouped together.

Idea evaluation metrics

The evaluation metric is a method to align ideas with the intent uncovered in the research and analysis phases. This metric defined areas of success measurement, known roadblocks, and mental models of the existing ecosystem, as listed below:

- Technical Feasibility
- Content Feasibility
- Learning Curve
- Engagement (Stickiness of the product)
- Ability to test
- Ability to track success
- Error Handling
- Adoption Inertia
- Decentralisation
- Organic Fitment
- Effective Channels/Leverage Points
- Change Resiliency
- Touchpoints Availability
- Cultural Sensitivity
- Adaptability

An exercise conducted on Mural allowed the team to assess each idea against the identified metrics and arrive at the top three ideas that met the projected requirements of our intervention based on the above metric.

Hills

Using the Enterprise Design Thinking tool of hill statements (IBM, 2022), we set clear goals for each member of the pregnant woman and her ecosystem

- The pregnant person will be able to document and communicate her symptoms to the doctors without hesitation.
- The partner will be empowered with the right information on the pregnant person's condition to talk about the pregnancy with them.
- The doctor will quickly comprehend the patient's health through the calendar and so has more time to impart relevant information.
- The pregnant person will gain access to accurate pregnancy-related information.
- The pregnant person will come to rely on the service with the same comfort and trust that they feel with the older confidante.

Design intervention

Uma: Every Expecting Mother's Friend

A pregnancy service co-created with medical personnel

Vision: Uma aims to help pregnant persons from the rural poor, and their support systems, have a better-informed pregnancy journey and develop a proactive doctor-patient rapport.

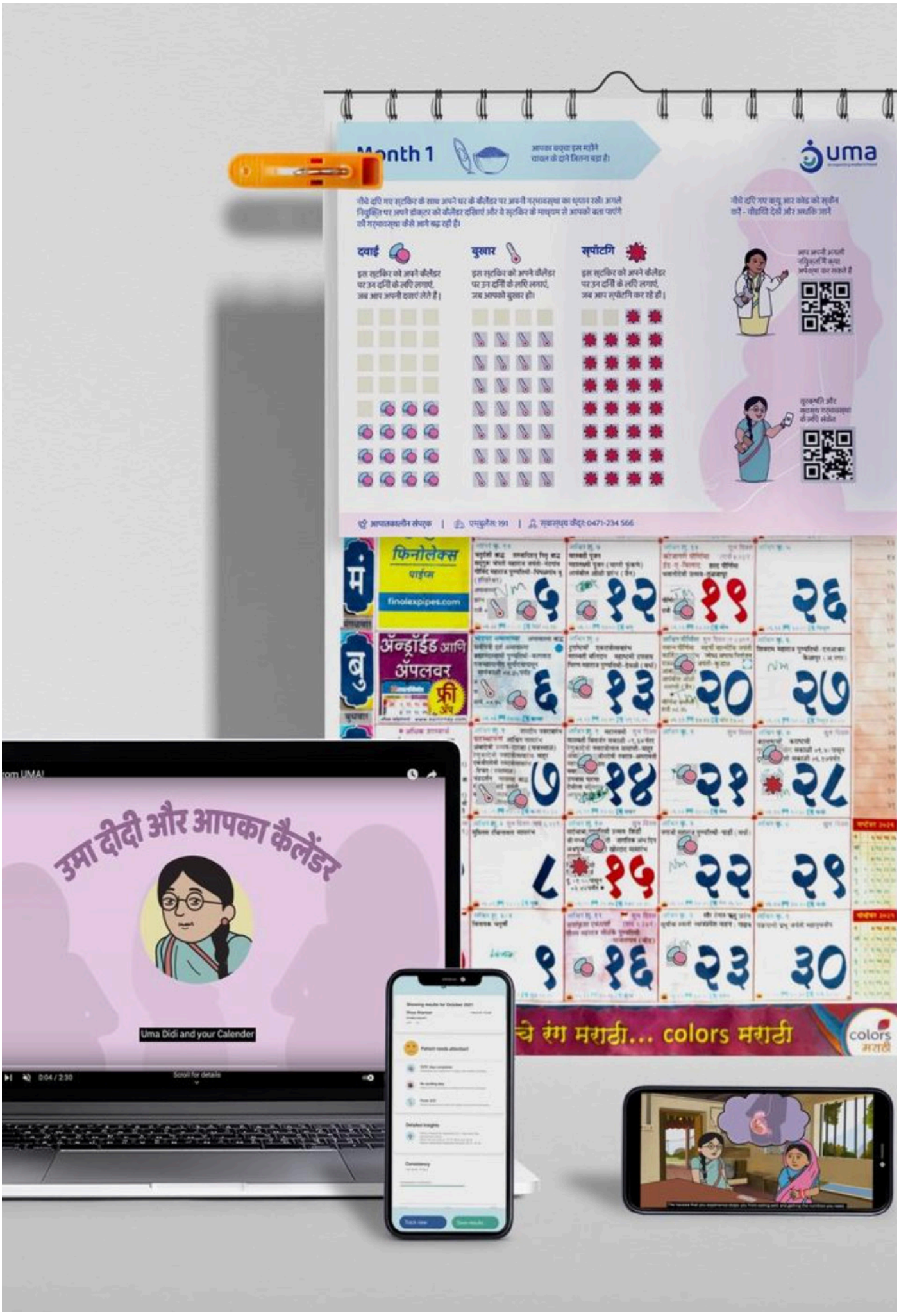

Figure 7: Uma - Every Pregnant Person's Friend

In our service, pregnant persons receive a sticker sheet at their doctor's appointment that is relevant to their trimester. These include stickers for supplements, stickers for month-specific danger signs, scannable appointment stickers, and scannable information stickers. The pregnant persons put these stickers on their calendars for the days that they take their supplements or experience those symptoms. At their next appointment, the doctors scan these stickers to get insights into pregnancy pains and medical adherence, which would help the doctor devise a treatment strategy.

The scannable stickers lead to a curated playlist of informational videos that cover topics like nutrition, health and hygiene, preparedness etc. The first video that the pregnant person and their support system watch is an introduction to the Uma service and how to use it.

Service touchpoints

Calendar

Calendars were discovered to be one of the most common artifacts available in every household, irrespective of geography and socio-economic statuses. They are low cost and families typically use them to track festivals and holy days, lunar, and solar cycles, and make notes for groceries, payments, and family activities.

Users track their pregnancy on their own calendars at home – with trimester specific stickers that are provided by our service. They can remember to go for check-up and scans by associating them with culturally significant dates that may be highly personal to them and involve the ancillary system in tracking the pregnancy journey.

Since users are already familiar with the form and usage of calendars, there is minimal disruption to their daily lives. With this relatability comes greater user adoption, making the calendar an artefact with which our users will readily interact. As the Uma sticker sheet is an add-on to the calendars, it is highly scalable and has higher reach. The calendars and sticker sheets – our physical interfaces – are very visual and do not have a large learning curve. Thus, their usage is not bound by the availability of technology and literacy.

Figure 8: Calendar and sticker sheet

Sticker sheet

The trimester-specific sheet will hold stickers pertaining to nutrition and supplements, pregnancy danger signs, doctor's appointments, and the informative videos. By integrating itself into the everyday of the pregnant woman and her family through daily tracking and visibility on the cultural calendar, this sheet is a point of physical intervention that promotes healthy behavioural change.

In addition to the stickers, it contains information on the baby's growth as well. This feature is drawn from the insight of the pregnant person being initially disconnected from the pregnancy. The bottom of the sheet contains the contact numbers for health services, as a way of normalising and promoting help-seeking behaviours.

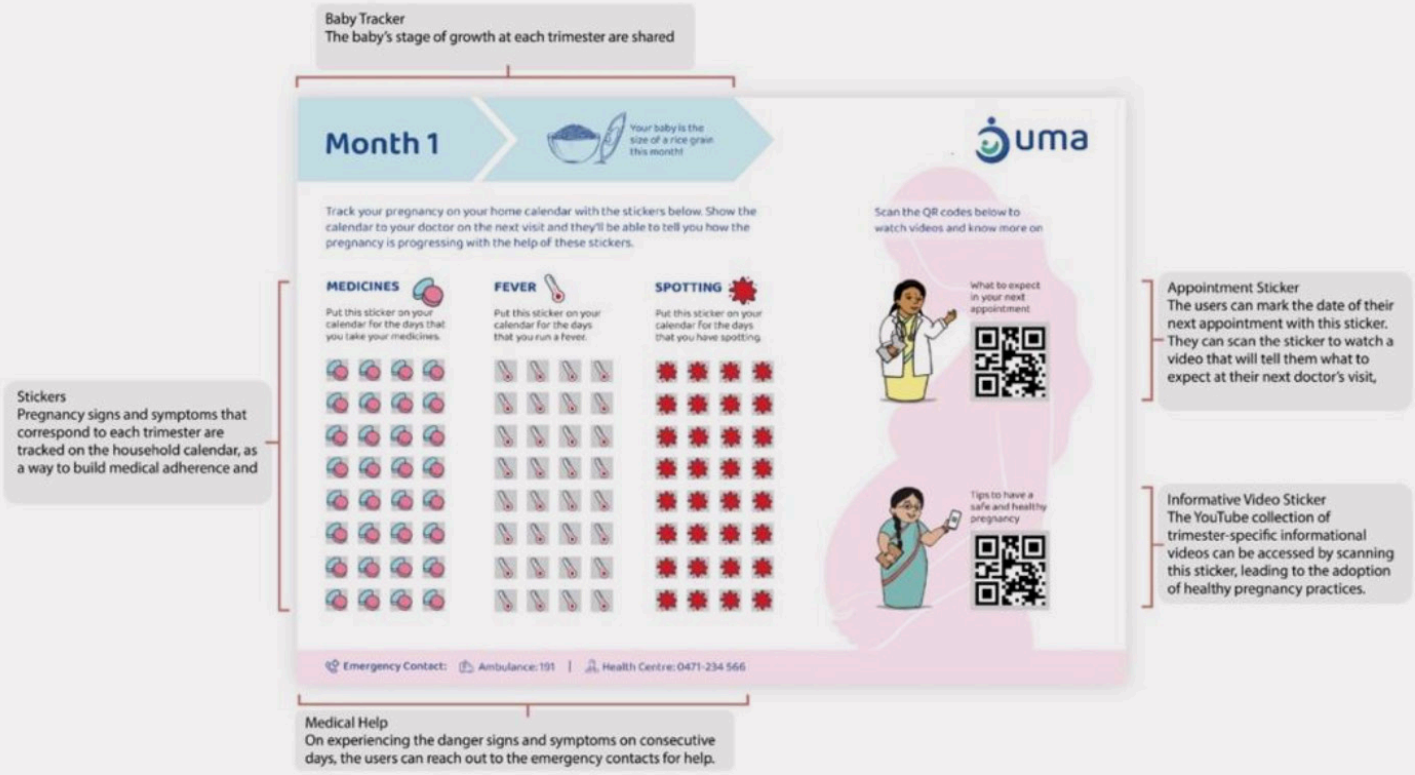

Figure 9: Uma sticker sheet

The QR codes are one of two technological artifacts in the service. Mobile penetration in rural and peri-urban India is increasing at a rapid rate. QR codes have a small learning curve, are accessible through almost every smartphone device, and are a good means to spread relevant information to many users.

The access to informational videos through the QR codes means more access to medically accurate information, improving pregnancy-related literacy and awareness.

Informative videos

There is a lack of authentic, contextual information around pregnancy. Owing to various cultural barriers and shyness, the education around nutrition and medicine is not carried by word of mouth. Healthcare providers need their patients to access and follow pregnancy-related information because they get limited interaction time per patient. Digital penetration has drastically increased in the rural areas since the pandemic, due to which the usage of platforms like YouTube and Instagram has increased with developed content targeted to hyperlocal consumers.

Uma leverages the increase in digital content consumption by creating engaging short videos that use local cultural contexts as vehicles to deliver information pertinent to the pregnant person at various stages in the pregnancy journey.

Figure 10: Still from the first informative video, titled ‘Episode 1: Necessary information for a healthy pregnancy - Nutrition’

In-clinic videos

The average waiting time at government healthcare centres is high. While there is some reading material like pamphlets and posters available to the pregnant women as they wait for their check-up, they have proven to have a low engagement rate. Uma allows them to better utilize this time by enabling them to access informative videos either on their own phones or on screens available in the healthcare centre.

These videos educate and encourage people to have informed pregnancy journeys, in a way where the burden of instruction is not on the medical professionals.

AI-driven insights

Doctors download the Uma app on their phones to help them assist and consult their patients better. The app provides features to create and update patient records - on every pregnant woman's first visit, a profile is created for her on the app, and insights from her appointments are saved to her profile.

At the appointment, the doctor scans the patient's sticker-marked calendar from the app. The app makes use of optical character recognition (OCR) and image processing to recognize the 'markers' i.e., the stickers. The size of the stickers and the dimensions allows the OCR to conduct an error-free reading.

Natural Language Processing enables the app's algorithm to identify the frequency and significance of the stickers, ascertains the relative position of the stickers, and converts this data into insights. These insights make the doctor aware of the occurrence and frequency of any symptoms. The generated insights are saved to the patient's profile thus helping in data management and allowing the medical staff to track a patient's progress over the duration of the pregnancy.

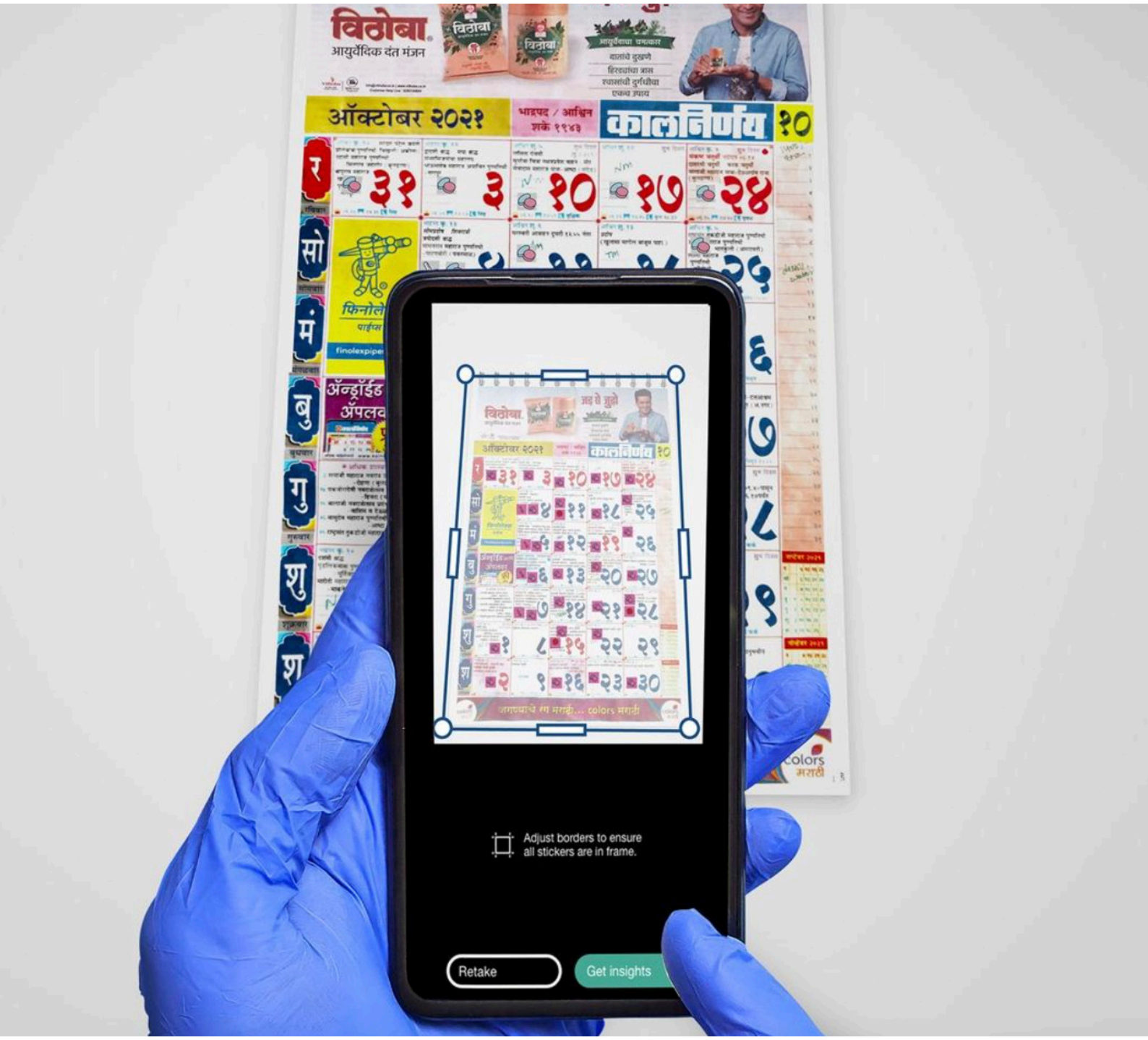

Figure 11: Scanning the sticker-filled calendar with Uma app

Figure 12: The app provides insights based on the tracked pregnancy behaviour

The Uma app is the 'high-tech' touchpoint in the service and it has been designed for the user group that is technology literate and has access to resources.

Uma Didi - Our mascot

One of the most common insights from our interviews across the states was that pregnant women have a female friend/relative that they rely upon for support, advice and often as a sounding board for the challenges and experiences of their pregnancy. These women are not only confidants but also inspire trust in the information that was shared by them. Leveraging the already existing perception of trust, we designed the Uma Didi character to tell stories that are relatable yet medically verified ('Didi' means older sister in Hindi).

Uma Didi is kind, wise, engaging, a mother, trustworthy, and has rudimentary medical knowledge. She empowers the pregnant person to make informed decisions and improve her help-seeking behaviour.

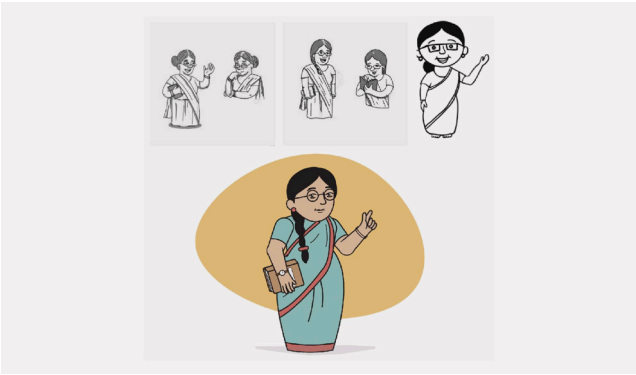

Figure 13: Uma Didi

Concept testing

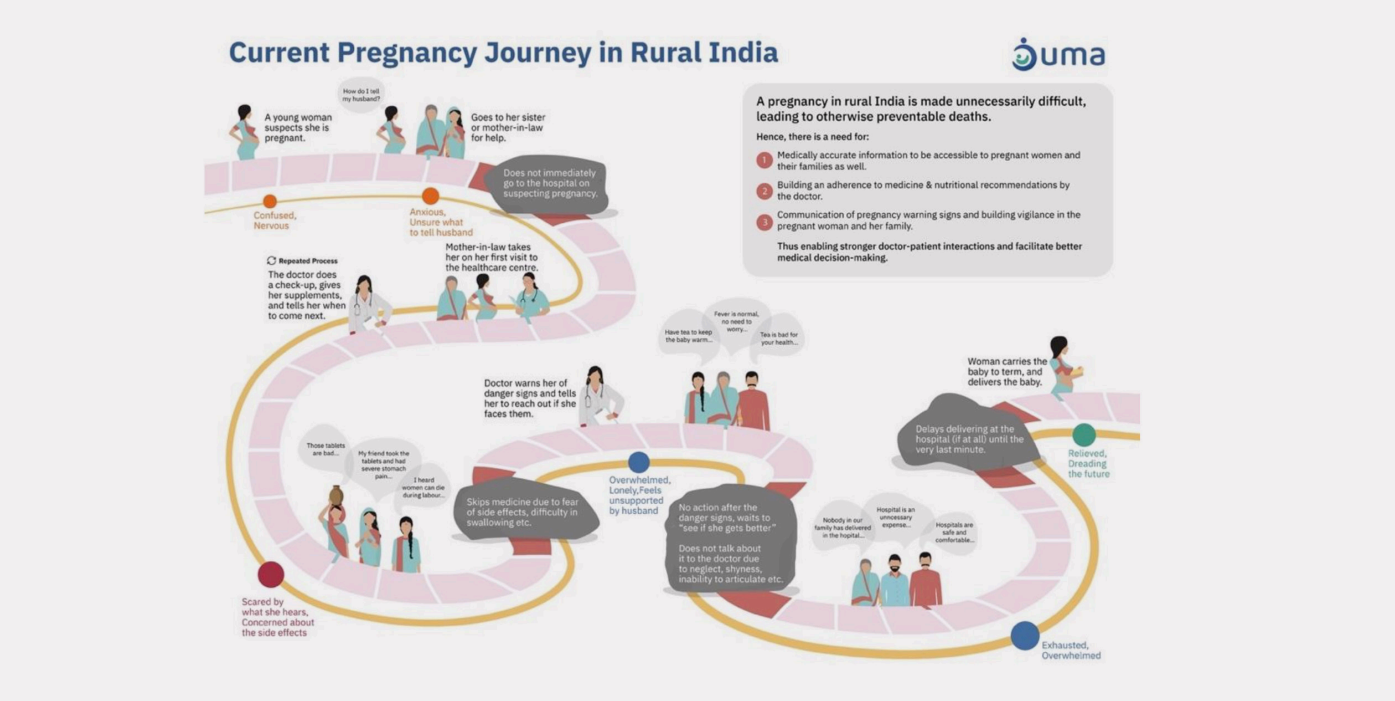

Figure 14: The current pregnancy journey

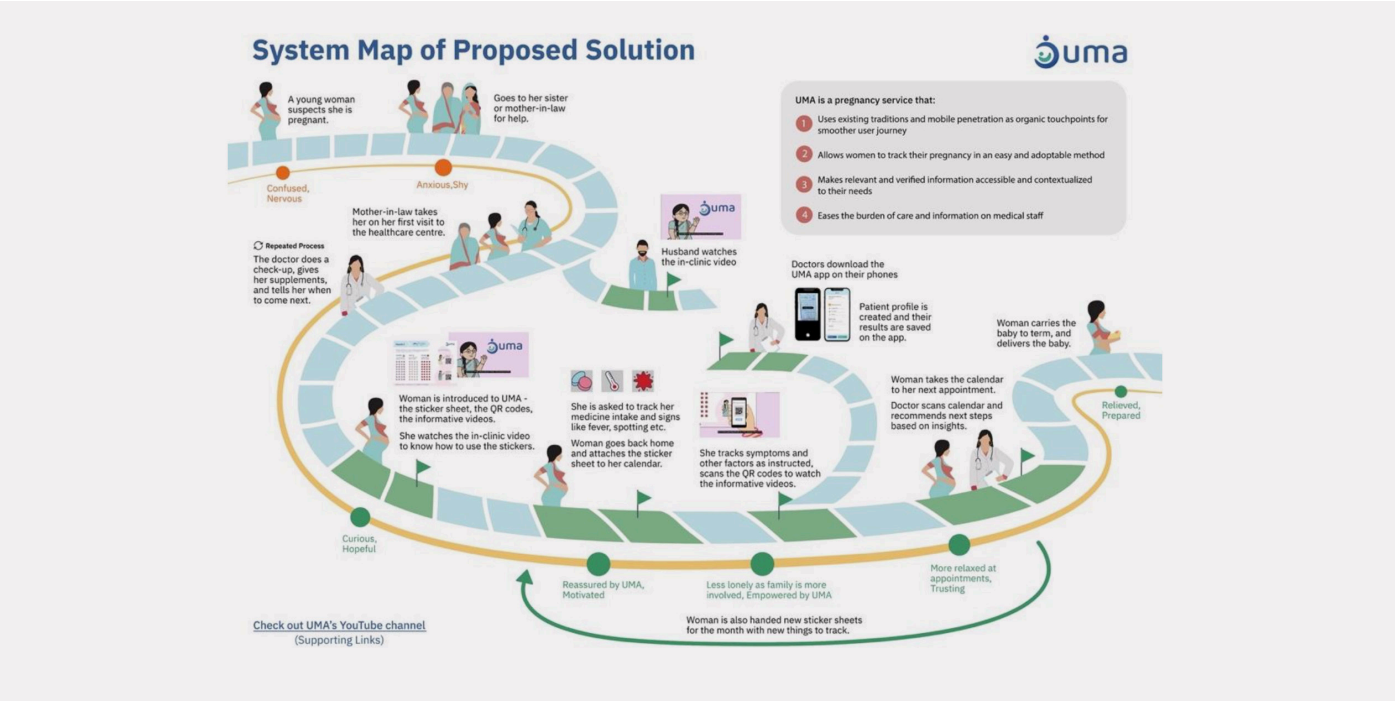

Figure 15: The improved pregnancy journey with Uma

We tested the low fidelity version of our intervention with doctors and pregnant persons from a few different cities. One doctor said, “Asking the mothers if they had fever, pains, etc. was tiring and we sometimes miss something”, and they were confident that Uma would enable them to gather all the required information. One of the pregnant persons said that some of the advice she followed during her previous pregnancy were wrong and that with Uma, she hoped for an easier pregnancy this time.

To take this service forward, we are currently in the process of identifying the right partners to conduct detailed concept testing.

This coming year will be dedicated to a hybrid diary study that will both study and iterate on the product as it is being used by the user through the 9 month pregnancy journey. We plan to field-test Uma in the state of Uttar Pradesh in India. The maternal mortality rate here is 197 (2016-2018) and the sex ratio at birth is lower than the national average, which is indicative of prevailing gender bias. Uttar Pradesh is also the state with the largest rural population, housing around 20% of the country’s total rural population.

Expected outcomes

Increased agency of the pregnant woman	With access to information that is medically verified and relevant to her context, she is adherent to the doctor's recommendations and medical practices. She is vigilant and knows when and how to ask for help, should she need it. She is also more in control of her body and pregnancy as she is now a decision-maker.
Increased stakeholder activity	The calendar is usually in a visible space in the household and so by using it to track the pregnancy journey, the stakeholders are involved. Partners are more active in tracking while older relatives are more open to following medical advice. The pregnant person is now able to discuss her experiences with the other stakeholders.
Increased productivity of ANC appointments	The wait-time for pregnancy stakeholders is less frustrating as they interact with the service in the time before their appointment. During the check-ups, doctors can glean health updates from the patient's calendar without having to ask too many questions. This results in more time for the doctor to share instructions and listen to patient concerns.

Discussion

Our aim at the commencement of this project – to positively impact maternal healthcare – was a broad goal. In our attempt to stimulate behavioural change, we identified the latent emotions of the pregnancy stakeholders and used those as the basis for our design decisions. For example, the trimester-specific sticker sheets illustrate the growth of the foetus as many women find the pregnancy experience to be "unreal" or external to them. By connecting the development of their child with their day-to-day lives through the calendar, we tried to manifest a connection of sorts.

We found that notions of 'care' were as wide and varied as the people we spoke to, the spaces we analysed. While we did try to combat the lack of information and misinformation with relevant and verified medical advice, we need to be cognizant of the scope of our undertaking. Culture and fear are at the root of these gaps and so, for large-scale change and development, small interventions will be insufficient. There is a need for education programmes and pro-poor economic and healthcare policies.

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Theme 3

Emergence of new learning

Title:

An ‘appropriate’ education: Towards a practice based evidence approach in design education

Author:
Carlo Branzaglia

Institution:
Istituto Europeo di Design
Milano
(Italy)

The construction of educational programmes aimed at design requires special attention due to the nature of this activity, suspended between theory and practice, amongst strategy and tactics.

In fact, design has its own speculative and conceptual components. But it completes its path in a practical activity, whether it is strictly temporally linked to the theoretical one, or not. A concept can in fact be applied at a distance, or not be applied at all, but still give suggestions on the actions to be developed.

This is a historical fact, only made more complex by the acceleration of social, economic and, in recent years, health scenarios.

Despite its broad spectrum of applications (or: because of it) design remains a tool. It is not a discipline: as it is not a normative system built based on its own rules, but a particularly versatile tool (or a set of tools, or a toolkit) used to achieve specific objectives. In the current scenario, problem solving has been combined with problem setting, and problem finding. The first, to circumscribe the problem. The second, to predict it.

Hence its fortune, filtered through particularly effective keywords: design thinking, flexibility, and, in education, learning by doing, which undoubtedly represents a canonical as well as historical fact. This last definition (Dewey) was born in the same American pragmatist school that generated the idea of abduction (Peirce), so precious to design scholars. Abduction is placed outside the deductive and inductive logic that represent the canons of the construction of any disciplinary model, in the relationship between particular and general. This means that even the concept of transdisciplinarity, particularly crucial for scientific and humanistic disciplines, once applied to design must have a very specific interpretation.

If we want to be very synthetic (perhaps excessively), design is necessarily transdisciplinary, precisely because it is not a discipline. According to the idea of transdisciplinarity, the intersection of different disciplinary models today represents a more than fertile scientific and hermeneutical horizon. But it must be handled correctly in the choice of models, because the theme of design is not scientific evidence, but pragmatic activity. So, the reference models can hardly be epistemological, but they must be linked to areas of knowledge that show the same problem: that, of a relationship between theory and practice.

On the other hand, this also means guaranteeing a considerable variety and flexibility of approach during the training phases. And this must lead us to consider the role of designers themselves in design training. To avoid that an approach that tries to be scientific (but in fact does not have a disciplinary model to rely on) automatically becomes academic. Specifically, if training prepares the student for a profession, then the logic of the expert, who transforms experience into a norm, can lead not only to an ‘academic’ attitude, but also to a vicious self-referential circle. This is particularly dangerous in such a complex and emergency climate, in which even the multiplication of tools risks to become ineffective (or dangerous) if used improperly.

The risk is very evident in the use of the same explanatory structure that accompanies scientific communication, in the research activities about design. The search for objective conclusions in the essays asked for international conferences seems to mime the outcome drawn from the scientific experiment in the laboratory. But design does not work in vitro, as its ‘discoveries’ are always contextual.

The role of the references themselves should be subject to specific conditions. A reference is something that you can use freely, as designers do by taking advantage of everything that can allow them to pragmatically solve a problem (in terms of texts, patterns, styles, iconographies); or is it a canon to be devoutly respected? The sources are useful to build a ‘style’ of thinking (and designing), that is a way of, that is a methodology, at last; or instead abstract reference systems?

Design - as a tool - is required to transform into practice that transdisciplinarity, which is so fashionable today, because design is one of the main actors in the construction of relationships with the external environment, which characterize the identity, social and cultural dimension of man.

It is a problem that design shares with other fields: health, first of all, which needs not only to find practical solutions based on documented premises, but also to monitor the results achieved in order to develop increasingly appropriate tools.
From these specific needs, a true transdisciplinary hypothesis could arise because it is not based on certified laws and data coming from different scientific contexts, but on their possible application in hypothesis and models.

In the clinical activity (in short) the Practice-Based Evidence (PBE) model (based on the evidence of data) seeks a balance with the Evidence-Based Practice (EBP) model (where practice re-shapes the research). This means looking for a balance between what the data has shown (made available by scientific works) and the need to focus on the implications of the individual case.

It is therefore not a matter of induction or deduction, but of contextualizing in practice the data derived from research, bearing in mind the importance of the individual case, and of the hic et nunc. The problem is the cure, not the respect of the rule indicated by scientific evidence. Finally, the solution of the specific problem does not guarantee solely the availability of further data but redefines the model of acquisition and use of them. If we can exaggerate, it is a kind of theory of practical arts (De Certeau): where practical interpretation constructs models (tricks, methodologies, rituals) that build daily action related to day-to-day life.

So, can we maintain a balance between the two models, PBE and EBP? It depends, of course. But certainly, considering a design process based on an EBP model means adopting conservative solutions that repeat results already achieved. This may happen, in the professional activity of the designers: because the will of the client however prevails, when he looks for an application of his ideas; when he wants to follow a celebrated example; or when he goes in search of a designer's stylistic features. But if we view design as a tool for innovation, this model is not particularly well suited to describe its approach. Moreover, in terms of education, in a period of constant and increasingly explosive crisis, this balance can no longer be maintained, as (for instance) the two First things First manifestos of the 1960s and 2000s had already suggested (Bollini, Branzaglia, 2003).

Design - as a tool - is required to transform into practice that transdisciplinarity, which is so fashionable today, because design is one of the main actors in the construction of relationships with the external environment, which characterize the identity, social and cultural dimension of man. Building relationships means influencing behaviours and giving them (new) meanings. Whatever the object of this intervention is: products, services, communities, communicational artifacts, policies, etc.

This is a model that does not therefore foresee the adaptation of a programme, but the construction of a process always ready to model the practice of these relationships in design and training methodologies. It is the model that comes from one of the most interesting transdisciplinary approaches, which uses anthropology as a pivot between biology and psychology (Ingold); it is no coincidence that anthropology is a discipline that deals with culture and its symbolic expressions, but applied to everyday life, human behaviours, and material culture.

Design education must then be elaborated in such a way as to build a kind of 'anthropology of practice', in the physical world as well as in the virtual one (Manovich). Keeping in mind the relationship between these two aspects in the dynamics of the cultural and creative industries (CCI), of which design itself is perhaps the oldest representative.

There is an anthropological view of design and creative industries in general that sets up deep structural patterns, similarly to the approach of recent anthropologists (Friedman). These patterns can apply both to the mechanism of production, by the creative industries in particular, and to their organizational structure. From the first point of view, the process of elaboration by CCI do not change, although the range of production can be extremely large and differ greatly. These are examples given about the 'new craftsmanship', or rather the craftsmanship approach by people working in the digital world (Sennet).

On the other hand, the creative industries are characterized by an organizational model that is radically different from the one of the traditional industries. And they are also characterized by a revival of the idea of community, which features are obviously very different from the original ones, first of all in terms of temporality (Bauman).

CCIs are in fact linked to models that are completely different from traditional industries: transitional models, related to projects, rather than to organizations and networks (Agostini). We could call them cloud; or canvas (Bey). In this context, it is possible to apply a series of definitions that interact with the previously expressed concepts of PBE and EBP, to the field of design (and design education); and in turn to provide a model related to the goals that an educational action can offer.

The same terms of efficacy, effectiveness, efficiency, appropriateness used at different tilts in economic (Drucker) and clinical (Cochrane) allow us to establish a guideline, especially inherent to a situation in which the entire social context (and the educational one in it) has been displaced by the current COVID-19 pandemic situation. Efficacy and effectiveness are linked to the two models PBE and EBP mentioned above: the first involves the application of a programme (protocol) and the second the transformation of good practices into recommendations. The third involves achieving a goal with the least possible effort, the fourth involves the right intervention (at the right time, on the right user, in the right way).

During the pandemic lockdown, the Postgraduate School of IED Milano activated a series of practical hypotheses based on the contribution of its coordinators. Solutions applied in emergency, which turned out to be able to stimulate wider issues related to the very rapid evolution of CCI. Therefore, these solutions have been useful from a tactical point of view to redesign the curricula by building new workflows; and to identify from a strategic point of view solutions to face a phigital future, that was becoming normal for the project's stakeholder (private and public organizations).

This series of hypotheses have become guidelines: element of processes, not application of already given protocols. They can be summarized in a few keywords, armed with secondary keywords and (possible) relevant statements.

Adaptation has the terms strategy/tactics, resilience, and flexibility, as sub-keywords. They concern all those situations in which an adequately designed process is subject to sudden changes due to unexpected events, which re-shape the effective application of guidelines (it would be impossible in the case of protocols).

A possible motto: Design as a mix between strategy and tactics.

Workout brings together the definitions: exercise, practice, open process. Continuous training reviews design methodologies through a process of intense practice and revision to tackle complex projects. A possible motto: Design as a complex toolkit.

Self-production contains Do It Yourself (or, design it yourself?), technique, democratization of technologies.

Project phases can be developed remotely by the student and fed into the flow. A possible motto: Design it Yourself.

Cloudiness means project, elasticity, transience. In fact, classes and working groups are transient communities: they aggregate, disintegrate and reappear according to a non-definitive model. A possible motto: Cloud vs network, canvas vs network.

Ability/skills pertains to competencies, skills, alignment. In a cloud context everyone brings their own skills and contact networks, 'glocalizing' his/her/their intervention on the basis of a specific substratum of knowledge and contacts, and then realigning it. A possible motto: Anthropology of techniques.

In conclusion, the training objective becomes that of preparing the student to not only be a professional, but an activator of contexts, resources, contacts; capable of imagining, defining and setting dormant problems, as well as solving given ones.

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Title:

New learning experiences: Open challenge-based learning in online design education at IED Barcelona

Authors:
Jose Carlos Ramos
David Tinoco

Institution:
Istituto Europeo di Design (Spain)

Abstract

The COVID-19 pandemic was a disruption, in March 2020, on the way schools around the world educated (Asgari, Shadnaz, 2021; Paudel, Pitambar, 2021). At Istituto Europeo di Design (IED) Barcelona Master School, most of the programmes were fully developed and delivered in a face-to-face manner, with applied projects placed at companies and some participative experiences with other programmes or external institutions. Overnight, we had to change to remote education.

In 2020, the pandemic crisis forced a change in the way courses were delivered to the students, from face-to-face teaching to online, synchronous (streaming classes) or asynchronous (Yamagata-Lynch, Lisa C, 2014). The literature review suggests that this situation became an opportunity to boost new competences linked to the methodologies applied (Öztürk, Mücahit, 2021; Murray, Susan, 2021) as was the case for IED.

This paper aims to share the experience of using a methodology based on Challenge Based Learning, delivered online in an asynchronous way. It includes the technologies used and all the change processes involving all the stakeholders impacted: academic support staff, faculty, the IT staff and students. After deciding how to do it, the greatest difficulties at IED came from the human side: faculty and staff. Literature suggests that the inertia of a whole life educating traditionally is the highest barrier to overcome (Kotter, John P. 2012; By, Rune Todnem. 2005). Therefore, the implemented framework, tools, and process, where change was deeply managed, resulted in good practice for design education as seen in other initiatives around the world (Paudel, Pitambar, 2021).

Introduction

In 2016 IED Master School in Barcelona implemented a set of common subjects, delivered online with a Challenge Based Learning (CBL) methodology and using open access resources to support the learning process (Johnson, Laurence F. 2009; Gallagher, Silvia Elena, 2020).

These common subjects in CBL have been incorporated into the master programmes as a first step to explore a teaching model combining several learning methodologies. The aim was to promote the development of complementary skills to the design disciplines, which are eminently practical and face-to-face.

When the COVID-19 pandemic pushed the institution to deliver online education, based on former experience, new formats were created mixing synchronous and asynchronous methodology delivered face-to-face and online, enriching the students' experience. The new mixed formats kept essential elements of our design education intact (research, development and projects) as well as enhanced the teachers' expertise and tools.

Framework

As explained, IED evolved the model enriching it with other positive experiences IED has had from launching pure online education programmes prior to 2020. The framework and systems created are currently used on a regular basis, even after teaching returned to a face-to-face modality, as a lot of the programmes have adopted a new blended modality (of alternating online and in-person).

The framework integrates an adapted methodology of CBL, a set of systems to facilitate its use by faculty, tutors, students and academic coordinators; and several tools supporting the processes: content generation and follow ups (templates, guidelines); an online collaborative platform and the online campus.

The systems mainly consist of training environments and activities which are available for the academic community. There are designated experts in the community who act as referents and have specific roles such as: trainer on CBL, advisor for questions and incidents, reviewers of developed challenges and works, coordinators for planning and deploying subjects and academic supporters' experts on the online campus.

There are designated spaces (in-person facilities and virtual facilities) to promote their interaction and learning of the new framework on a regular basis (Nonaka, Takeuchi, 1996; Argyris, C. 1996; Alter, S, 2006).

Technology was key to enable collaboration when staff, faculty and students connected remotely. Several new functionalities were set up to extend the teaching possibilities. One example was video streaming capabilities and another, automatic assessment systems based on completed tasks, deliverables or feedback of teachers to students about their progress.

Figure 1 shows the different components of the framework.

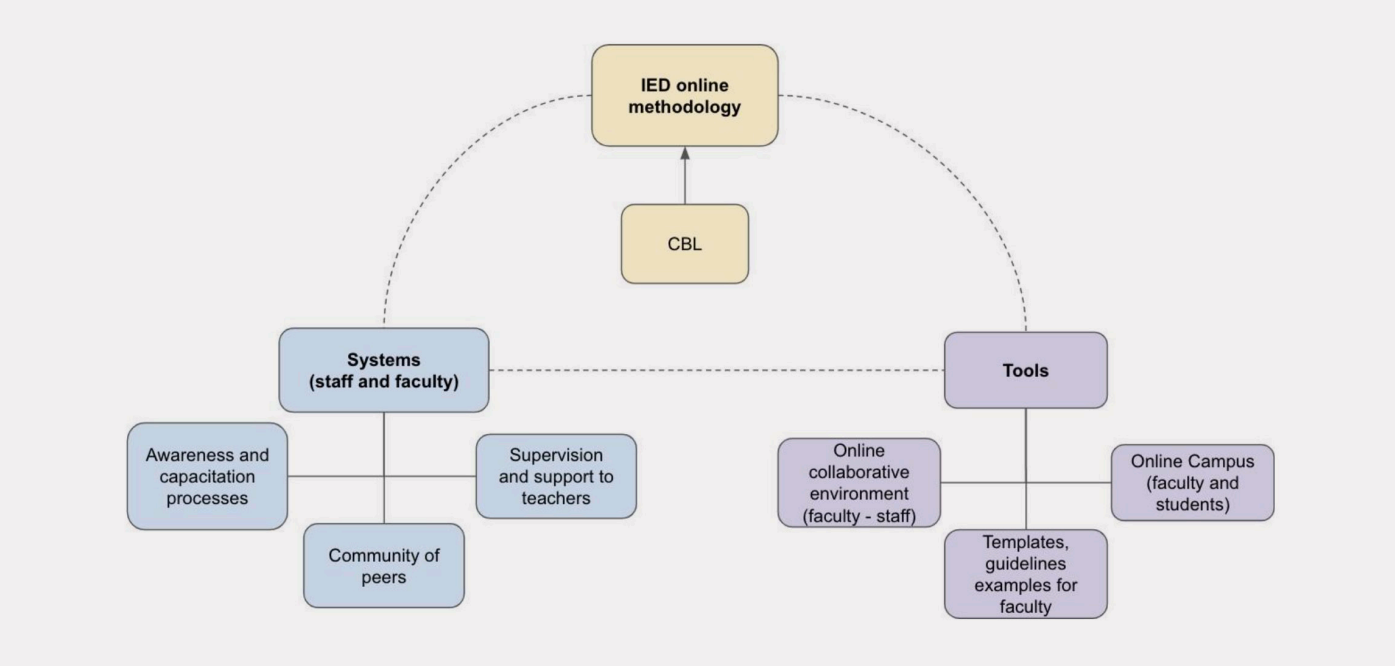

Figure 1: The IED online, challenge-based learning framework

Approach

Through analyzing the discourse, the literature and the experienced reality, the model identifies fundamental theoretical and empirical relationships among involved disciplines: online learning, CBL, supportive technologies and design education. Those identified factors will validate the new competences acquired by the students, as well as better the experience for the students and faculty.

The implemented initiatives generated open discussions about how to educate online and added new elements to the positive and negative aspects of synchronicity in online learning, which showed to be exhausting for students spending whole days in front of screens (Yamagata-Lynch, L. 2012; He, Wu, Guandong X, and S. E. Kruck, 2014). While better students' experiences were observed in asynchronous online learning (Murray, S, 2021; Paudel, P, 2021). It was especially evident in some specific design areas where discovering, testing, iterating and prototyping is essential.

The conclusion based on the experiences developed in parallel, using different methodologies, is that the applied framework based on CBL and elaboration process and teaching methodology have been revealed as optimal for remote learning in design. One important finding has to do with the adaptation process for students to the new mindset. At IED, we did not spend enough time exploring the importance of explaining and training students on this different learning paradigm. It arose later from the collected feedback. Now we are working on a new combination of methodologies to better adapt to each programme's requirements.

Method

The empirical part of this paper is based on regular surveys taken at IED. As in every year prior, at the end of the academic courses that concluded during the timeframe of the pandemic, the satisfaction of the students was evaluated through surveys, obtaining surprisingly good results, considering all the changes and inconveniences that the students had to endure.

In fact, the weighted result of overall satisfaction with respect to all the master's courses was 8.59 out of 10, which represents an overall assessment of 0.39 points more than the previous year in which the classes were not affected by the pandemic.

In the following figure, we can see the global level of satisfaction of IED Master School from students at the Barcelona campus, with their corresponding programme.

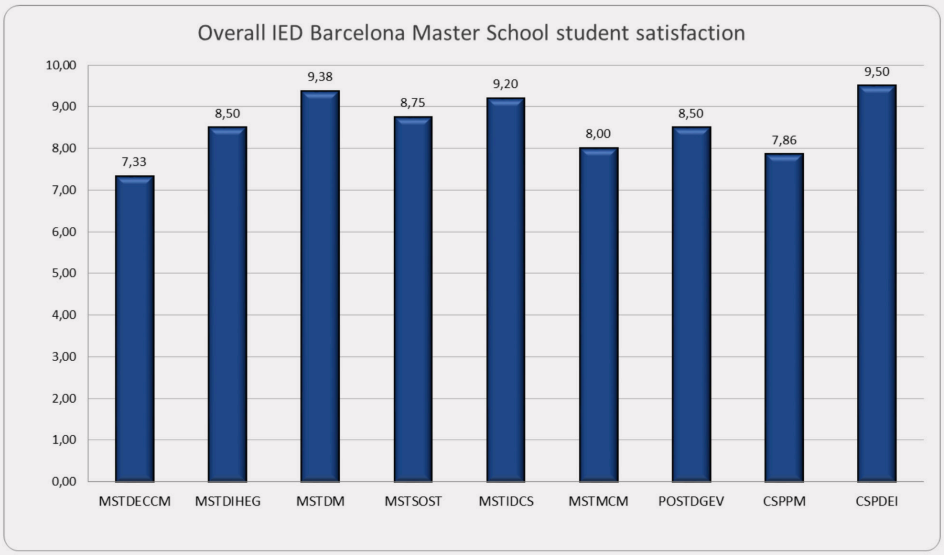

Figure 2: Satisfaction level of students. Source: annual surveys at IED

In the same way, the surveys indicated very revealing information, since 100% of the students in the academic year 2020-21 stated that they would recommend IED Barcelona Master School.

This percentage is also higher than the 93.25% obtained the previous year.

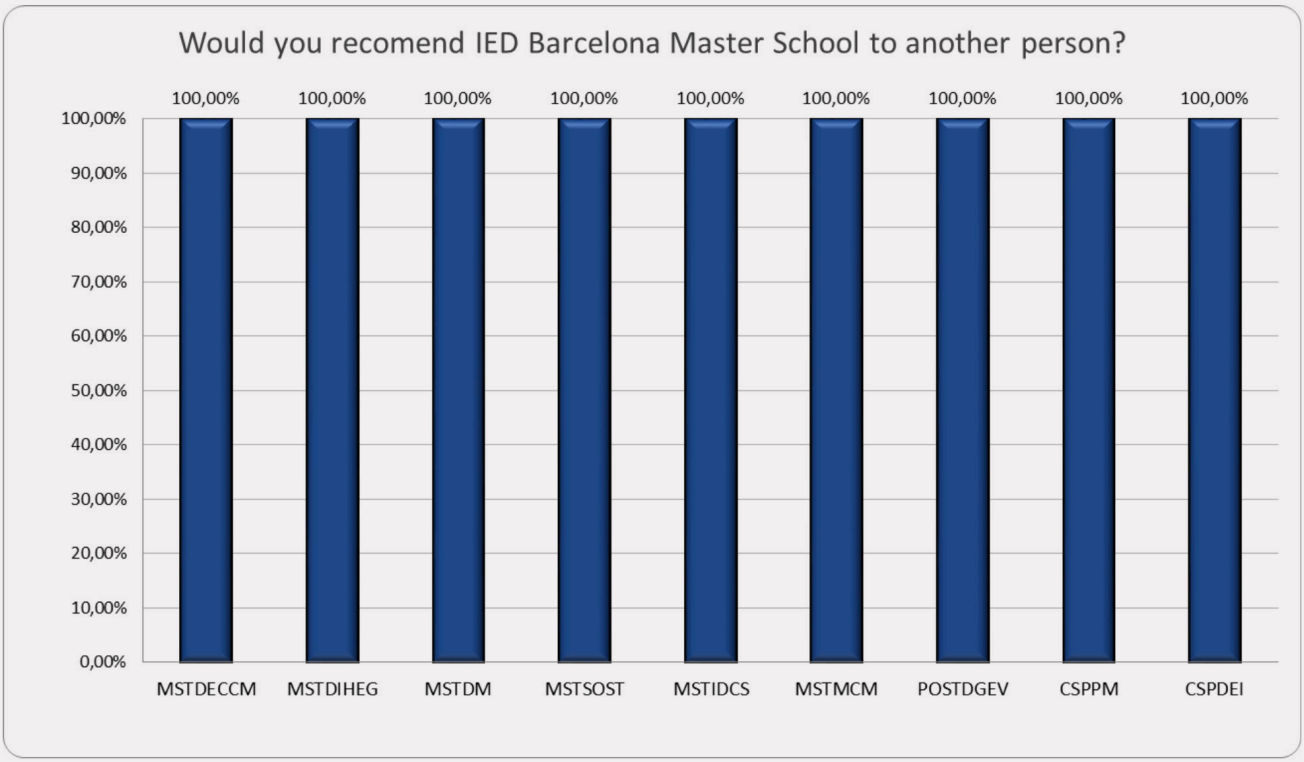

Figure 3: Specific question of the survey about willingness to recommend IED. Source: annual surveys at IED

Of course, this data, although positive, is only a small part of the analysis that must be carried out to verify the results of the implementation of new teaching methodologies, such as Challenge Based Learning within the academic model of IED Barcelona. To this end, various focus groups are conducted involving students, professors and programme leaders.

These focus groups will be held in panel model over the next few years as an observatory that will allow the analysis and optimization of the progressive use of new methodologies such as Challenge Based Learning, with the dual objective of measuring its impact on student learning and defining the structure and operational tools that are necessary for the teaching staff.

The items to be analyzed and assessed are:

- Analysis, carried out by the professors and programme leaders, regarding the development of the specific skills associated with the teaching of subjects through the Challenge Based Learning format adapted to IED Barcelona Master School based on the academic results obtained and the evaluation tests developed to this end.
- Analysis, carried out by the academic directors, regarding the complementarity and synergy of these skills developed for the desired profile for the students of the different design disciplines.
- Analysis of the capacity of teachers and programme leaders to incorporate methodologies derived from Challenge Based Learning in their programmes and definition of the necessary information and training.
- Analysis of the structure and operational tools necessary for the correct application of these methodologies in teaching practice.
- Detailed analysis of the student experience.

Conclusions

The conclusion of this experience is very positive. The objective outputs IED achieved from the experience were very revealing as presented in previous sections.

The global student assessment of the experience during the pandemic, after the rapid implementation of the CBL asynchronous e-learning was even better than the year before. Some other factors must be considered, such as the gratitude of the students towards the efforts and extra attention the staff was providing during those difficult times.

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Title:

Future-focused design learning community

Authors:
Simona Colitti
Elena Formia
Valentina Gianfrate
Laura Succini

Institution:
Department of Architecture,
University of Bologna
(Italy)

Introduction

How is design (as in designing, design thinking, and design cultures) influencing educational processes and systems? How do enabling technologies change the learning experience? How can creating a 'continuous community' in the field of knowledge innovation starts to aggregate research, experiences, practices?

These three central questions are animating the debate around design education, with the aim to discover, understand, be part of and propose contemporary and sustainable strategies to face actual, unexpected and future challenges with the optimism design offers.

There is a mounting consensus around the idea that the COVID-19 crisis will transform almost everything for the next few years or decades. The pandemic will last longer than initially expected and its behavioral and social implications could even be permanent, affecting the way we will produce and consume 'knowledge' as a direct manifestation of our culture. In the meantime, other crises are emerging, influencing the times and processes society adopts to face these emergencies, which have become an almost constant state. These boundary conditions are driving a rethinking about how learning and education frameworks, methods and tools can prepare future designers in their role to drive impact on the emerging challenges affecting organizations and society overall.

In 2016, the Advanced Design Unit (ADU) of the University of Bologna started a collaborative reflection that originated from the idea of design as a culture (not just a practice). It can, at the same time be considered an innovation driver and be used to leverage the transformation of educational systems. This led to the launch of FutureDesignEd, an international symposium and a research platform intended to understand the current situation and propose models for the future in design schools and, more generally, in organizations interested in welcoming the innovative value of design (Celaschi et al., 2021).

Through the different symposium editions, the platform activates international observers and experts, committed to reporting and sharing experiences that relate to design-driven educational processes (Fig.1). In combination with a social media platform, it allows to inform and engage students, citizens, educators, researchers, practitioners, businesses moving into a collaborative environment driven by design education, presenting significant disruptions from multiple points of view.

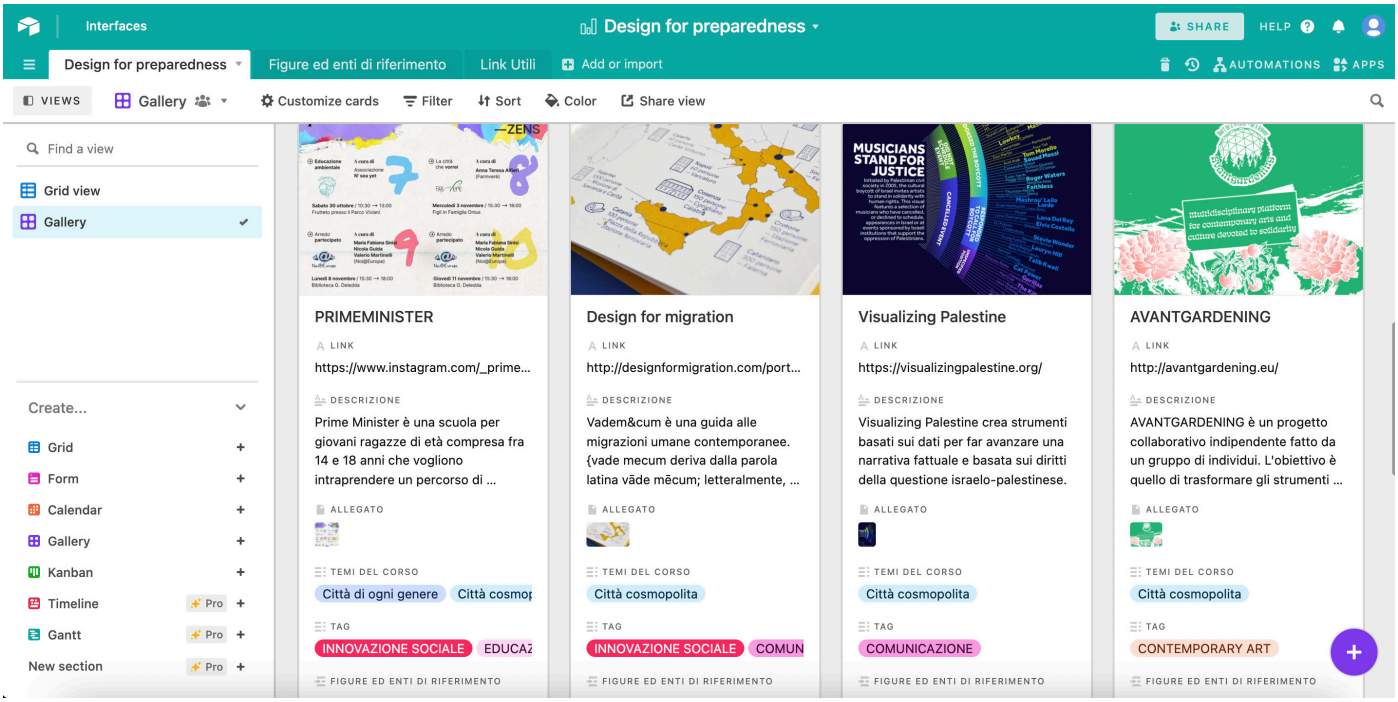

Figure 1: Example repository on Airtable on the topic “Design for preparedness”.

As discussed in the book *Updating Values: Perspectives on Design Education* (Bosco 2021), which was produced as an outcome of the symposia, the research methodology is based on a series of subsequent steps: the observation of a certain reality (where the emphasis on the word “observation” is particularly important), its synthesis through interpretative models and categories, and the proposition of actions addressed to manipulate and transform real settings with a prospective attitude, naturally oriented towards future developments.

The interpretative model implies the preliminary definition of a specific framework fed by the debate on learning and education systems, the preparation of a call as a survey tool, and the activation of a network of ‘observers’ as relevant stakeholders. In the second phase, it implies the collection of data, their analysis, systematization, mapping, and interpretation.

The organization of a symposium aims to collect all the results and to present the outputs deriving from the survey and education case histories. At the same time, it is the place to propose emerging phenomena, while allowing key figures from the research to express themselves. Finally, the creation of a digital infrastructure or archive as a permanent observatory aims, to keep the results of the research and the community of observers alive, and nurture the next editions of the symposium. This approach has been refined and improved through three editions of the Forum, held in 2017, 2020 and 2021. Maintaining the same structure, these three events explored different facets of design education, involving a huge community formed by 100 recorded ‘observers’ each time.

The 2017 edition was titled *Innovation in Design Education Innovation in Education by Design* and held in Bologna (Italy). The quantitative mapping of the information collected (based on 125 reports related to experiences in 31 countries) was accompanied by visual representations of the phenomenon; the identification of the prevalent trends.

The 2020 edition was curated by a group of professors and researchers from the University of San Marino, with the aim of investigating the values transferred through design programmes. Their mutations according to radical changes also due to the COVID-19 emergency period and how the cross-fertilization between different disciplines and actors is also a growing phenomenon in the field of education.

The 2021 edition was titled *Future Design for Knowledge Innovation* and was led by a group of young researchers from University of Bologna. This third edition focused on the role of technologies to activate a change in the access to knowledge and learning, as well as the power of systemic forms of knowledge to integrate competitive and social value within academic and corporate organizations. Five years following the inception of the project, it is possible to affirm that FutureDesignEd promotes a non-hegemonic approach to design education opening a more collaborative, inclusive, transdisciplinary and collective learning system and related impactful projects.

All three editions of the symposium focused on the importance of creating a learning community made of researchers, teachers and students to capitalize on the collective intelligence of different backgrounds and cultures, adopting and testing different tools and mixing capabilities and competences.

Design students remain at the center of this process, to nurture a non-hierarchical group of higher education institutions that will design, conduct and assess innovative ways of teaching and learning.

A new attitude is emerging to support, alongside new tools and methods, the integration of the fundamental skills and competences of future professionals in their academic pathways. This allows for open innovation, to bridge the existing gap between the theoretical dimension of learning and the real-life experience of challenges, contrasting the vision of students as 'passive consumers' of knowledge, rather than active co-producers and participants.

One of the results of this bridge (and follow-up of the overall project) is the creation of a field bottom-up experiment: the Dzain Community. It has been set up in the context of the Design courses at the University of Bologna, with the aim of encouraging communication and collaboration between design students. The main objective is to contribute to a new model of lifelong learning, which enhances individual skills and backgrounds and, at the same time, responds to the needs and requirements of the world of work, the territory and the global challenges, in a collective way.

A heterogeneous group of PhD students, young researchers and alumni from the University of Bologna design courses collected and analyzed a series of learning needs from the students, with the idea to translate them into hybrid channels of interaction (online and offline) and build a collective design intelligence which, by cultivating diversity and a critical sense, catalyzes the positive resources needed to think about and respond to future perspectives, starting with environmental, social and cultural crises.

Three macro learning needs have emerged for the students:

1. Identifying themselves through the creation of a system of research and reflection on the roles of designers.

2. Collaborating through light interaction systems to foster self-organization, flexibility and adaptability of the network.

3. Narrating themselves to enable communication with companies, educational institutions and professional bodies.

The research group has associated each macro need to a specific community tool cluster:

1. Open repository of case studies, articles and research on the Airtable platform (Fig.2), based on a crowdsourcing system, divided according to topics of interest for the community. Themes have been defined thanks to a dynamic manifesto, accessible to all, capable of guiding the evolution of the network's topics and keeping track of the guiding principles. During the preliminary phase of building the manifesto, a selection of fundamental principles was defined by the DZC Team, consisting of design professionals, researchers and PhD students and alumni of the design courses of the University of Bologna. Those principles will be extended and modified through a phase of co-design with students, designers, and other members of the community, ensuring a fair representation of all the participants.

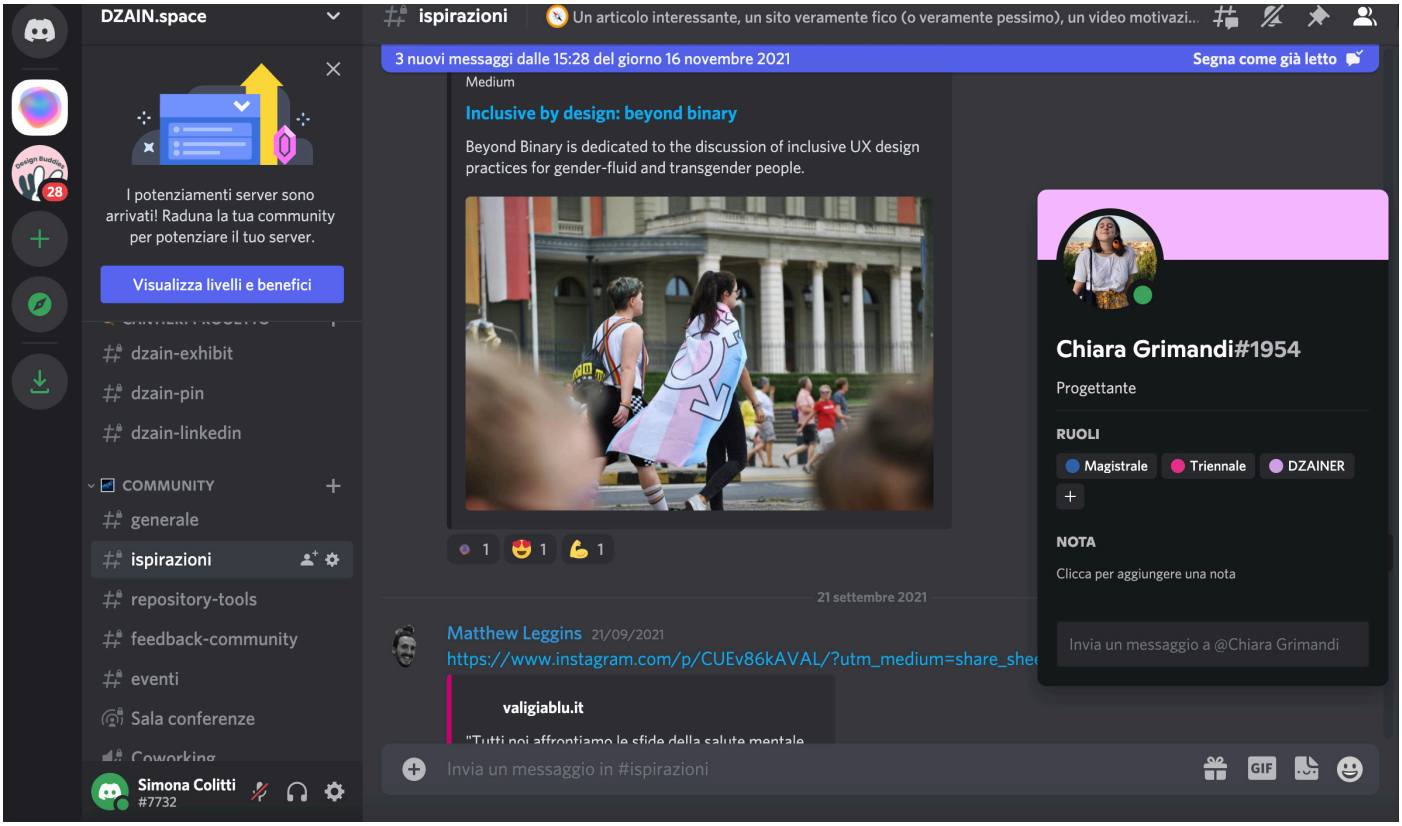

Figure 2: Example of self-profiling with dynamic tags on the Discord platform.

2. The manifesto also includes the definition of the hybrid (digital and physical) dimension of the activities organized by the community. In fact, digital spaces, due to their possibility to reach broad and diversified audiences, are used especially for networking, communication and dissemination. Digital spaces may be a space also for co-designing in case of emergencies, as happened during the COVID-19 period.

   The repository was launched during a workshop at the beginning of the 2021 and co-developed by researchers and students. It currently contains a new section with the aim of collecting companies and workplaces of interest to the students and a channel for sharing job advertisements, calls and opportunities such as competitions and open calls.

   Dzain space (currently existing on discord.com), that is accessible from any device and all the users can profile themselves autonomously through a dynamic tag system (Fig.3), useful for the creation of a peer-to-peer knowledge exchange channel (dzainskills and dzaindebate identify the specific sections of sharing in the community).

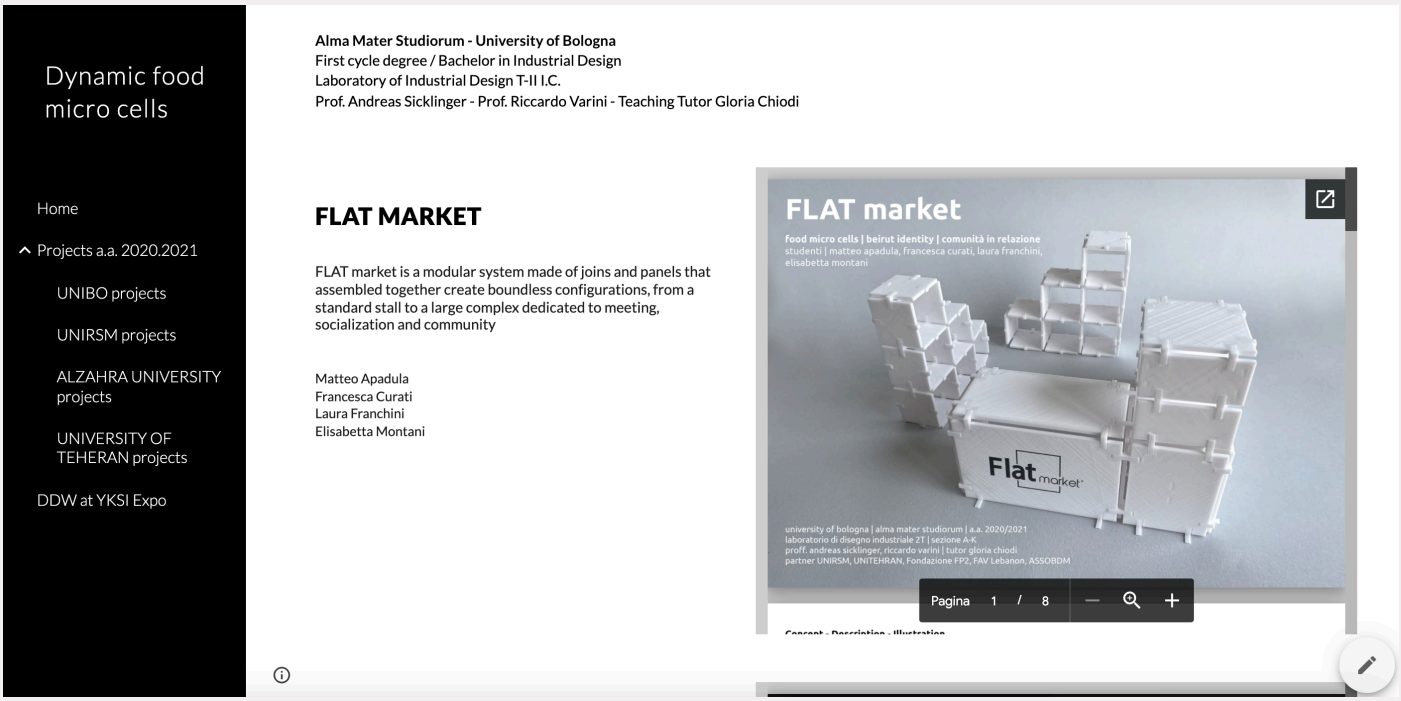

Figure 3: Example of a showcase site for the collection of projects on the theme of Dynamic food micro cells from the Industrial Design Lab.

Taking example from selected best practices related to the world of platform cooperativism (Scholz, 2015; Calleo et al., 2021), the system is based on a maximum openness of the platforms to allow the process to be effectively community-led, with open-source systems and open tools. The DZC wants to collectively approach complexity around contemporary issues, in terms of content and data with the goal of ensuring better long-term outcomes and reducing bias as much as possible.

3. Virtual Exhibit Lab is the Instagram profile used as a showcase for the design students (Fig.4). It was developed during studies and extracurricular activities promoted by the design courses and deriving from community collaborations to transfer the annual edition of the Exhibit Labs into a digital environment during the early days of the COVID-19 pandemic. The Instagram account and the showcase site has been structured by topics of interest, course of reference and community members involved.

Figure 4: A presentation during the first Edition of the International Symposium FutureDesignEd that took place at the Opificio Golinelli in Bologna (Italy) in September 2017.

The group considers the Dzain initiative as a direct result of the FutureDesignEd's experimentation: an open space of collaboration that can work as a supportive tool for students and researchers to co-develop complementary ways of knowledge creation, but also to empower open innovation practices and digital skills, through the introduction of a horizontal learning approach.

These transversal peer-to-peer tools enable the creation of open learning spaces to group projects, facilitating collaboration and exchange among students, providing showcase opportunities. And at the same time, they allow the dialogue and interaction of multi-level students (high school, bachelor, master, PhD) and cross-disciplinary target groups (from professional and business realms) on the same topics, igniting co-design an open-production in a non-hierarchical space. This peer-knowledge process is activated in the digital and physical environment.

The digital environment is crucial for the openness and inclusion of the whole community of designers and its ecosystem (at different levels from local to global), eliminating physical and social distances, geopolitical and economic boundaries, and sharing the same tools and languages (Davis et al., 2021; Ozturk, Avci & Kaya, 2021).

The physical environment activates the collective and social experiences, supporting the mutual learning and the interaction among students and other actors through nonverbal modes that can generate tacit knowledge production (Nonaka, 1994), able to build and/or consolidate the sense of community and the empathy (Murdoch-kitt, Emans & Oewel, 2020; Villari, 2021).

The Dzain experimentation and the FutureDesignED initiatives are two examples of the need to address the design students' learning process on three main levels:

- Building self-identity: the identity as a designer opens two fields, one in which design schools play a fundamental role in the construction of one's own critical thinking and how one's contribution can influence the behaviour of the entire community. The second can be activated by developing a multidimensional form of learning generated from curricular activities, interdisciplinary, multi-actor experiences and different contexts' dynamics.

- Collaborative approach in design education: this means both teaching collaboration as an approach to the design cultures and practices but also as a value to be undertaken in the construction of an educational programme. This collaboration can take place at multiple levels between curricula, disciplines, institutions, companies or other schools, operationalized through multiple formats (workshops, academic courses, extra-academic projects, personal and collective experiences).

- The design cultures' vision goes beyond the master-apprentice learning perspective (Mayer & Norman, 2019, p.23) and it is based on an advanced design approach driven by co-design as a tool to build more peer education systems.

Challenge-based learning: that prepares for socio-economic,

environmental, technological and cultural challenges, therefore not only being considered within projects but being incorporated within their own educational pathways. The creation of a metaverse system can link the physical and the virtual, the use of technology and the centrality of ethics. This system supports the generation of new open models, aware of technical and digital skills training, but also the construction of ethical and inclusive thinking, where the principles of responsible innovation - gender equity, open access, inclusion, open governance, education, public engagement (Stilgoe, Owen & Macnaghten, 2013) and social and environmental justice are pillars of the learning and design process (Costanza-Chock, 2020).

These reflections have been capitalized on by the Advanced Design Unit, with the aim to activate a follow-up of FutureDesignED, capable of meeting contemporary and future challenges, through:

- Observing: to produce an iterative mapping process, structuring continuous exchange and sharing in thematic symposia, able to connect a wider community of researchers, practitioners and institutions.

- Nurturing: to open up the community dimension, including bottom-up initiatives self-promoted by groups of students and early researchers, to embed their tools and methods also in the curricula experiences.

- Anticipating: To implement a future-focused and design driven educational model, integrating needs, expectations, competences, skills of students, professors, public and private institutions, association and business, in a horizontal learning space, which is cross-fertilized and permeable in nature.

ADU intends to support the growing of these self-innovation approaches, favouring the integration between top-down (institutional) and bottom-up initiatives that can fertilize each other, where the skills of each actor can be part of a continuous knowledge system. The connection between traditional teaching forms and innovative teaching experiments, can drive this system, by finding also in the phigital dimension, a new paradigm of development.

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Title:

Hybrid Industrial Design Education in the Pandemic World

Authors:
Wei Wang
Xinyi Gao
Roger Ball
Yijing Yang
Tie Ji

Institution:
Hunan University (China)

Introduction

Design education always thrives on global collaboration. This study shows continuing work that began before the COVID-19 pandemic between researchers at School of Design, Hunan University (China) and the School of Industrial Design, Georgia Institute of Technology (USA) about the transformation of industrial design education in the global context. Budd and Wang (2017) traced 20 years of industrial design curriculum development and argued for the inclusion of smart technology and user experience courses in industrial design education. Huang, Ball and Wang (2021) compared industrial design undergraduate education in China and USA to understand the similarities and differences in pedagogy, curriculum, and culture towards the future of global industrial design education. The COVID-19 pandemic upended the ways we live, teach and collaborate. The pandemic presents the new challenges and new opportunities for students and educators in how we learn and deliver industrial design education. What kind of designer and design educator does the world need in the future?

Literature review

During the pandemic, industrial design education shifted to online and hybrid models. With fewer opportunities for in-person learning in the classroom, online tools were essential for delivering the industrial design curriculum (White-Hancock, 2022). However, the current mode of online teaching is not as effective as in person studio teaching. Varma and Jafri (2020) surveyed the COVID-19 responsive teaching of undergraduate architecture programmes in India and found that satisfaction with the effectiveness of online studio teaching was low. The design studio is dynamic, collaborative, and creative processes (Habib and Naghshbandi, 2021). For example, non-verbal communication (such as eye contact and facial express) is vitally important in a design classroom but just half of students are willing to turn on their camera according to Peimani and Kamalipour's research (2021). Alex Wright and Robert Groverin in the UK also discovered that peer learning and support were most negatively affected (Salama and Crosbie, 2020).

Taking the lens of the pandemic as the 'new normal', Rapanta et al. (2021) found that the 'forced' experience of teaching online when combined with some in-person delivery leads to more active, flexible and meaningful learning experiences. In Australia, Melbourne School of Design also used the 'dual delivery' in 2021. Thompson (2021) combined online and in-person learning modes within an industrial design studio. Whitehead et al. (2021) found the online studio was beneficial for students to generate ideas, develop team thinking and collaboration. But the research suggested that the physical studios and workshop were essential for hands on model-making and physical prototyping. The Hyflex mode (Lederman, 2020) started in 2006 requires industrial design instructors to create both an online and face-to-face version of their studio courses with the same assignments and learning outcomes, giving students the flexibility to switch their learning mode. However, it creates an increased workload for instructors in preparing teaching materials and student supervision.

Case 1: 'Global Design Education in Post-Pandemic' seminar

In this section, we present the thoughts and reflections from the 'Global Design Education in Post-Pandemic' seminar organized in August 2021 by the authors. The six-member panel from five countries included:

- P1, the expert from the World Design Organization (WDO) and Carleton University (Canada);
- P2, the design educator from Eindhoven University of Technology (Netherlands);
- P3, the design educator from the Federal University of Pernambuco (Brazil) and Hunan University (China);
- P4, the design educator and former administrative from Rochester Institute of Technology (USA);
- P5, the design educator and former administrative from Hunan University (China);
- P6, the design educator from Tsinghua University (China).

From the conversations, all experts agreed that COVID-19 continues to change industrial design education in every programme around the world. The industrial design schools reported varying levels of success, in implementing online curriculum and maintaining online student engagement. With the remote technology platform, design education has been delivered beyond the classroom. Panel members agreed that they will continue to use some form of online platform resources despite a return to in-person teaching in the future. However, they also addressed critical issues to combine online teaching with on-campus experience. They also outlined the possible evolution of design professions and design trends in future.

Key findings

1. Design education

The panel agreed that online industrial design teaching raises new challenges as well as opportunities for the student/faculty experience, course communications, and student engagement. When examining the learning experience of students, P4 found that there was a relationship between students' personalities and their performance in the hybrid class.

For example, some of her students are shy so "they feel more comfortable behind the screen", while others prefer interaction with teachers in person.

P2 believed that face-to-face activities are essential to cultivating learning ability. Fewer in-person classes limit students' ability to learn quietly from other students through observation and live demonstration.

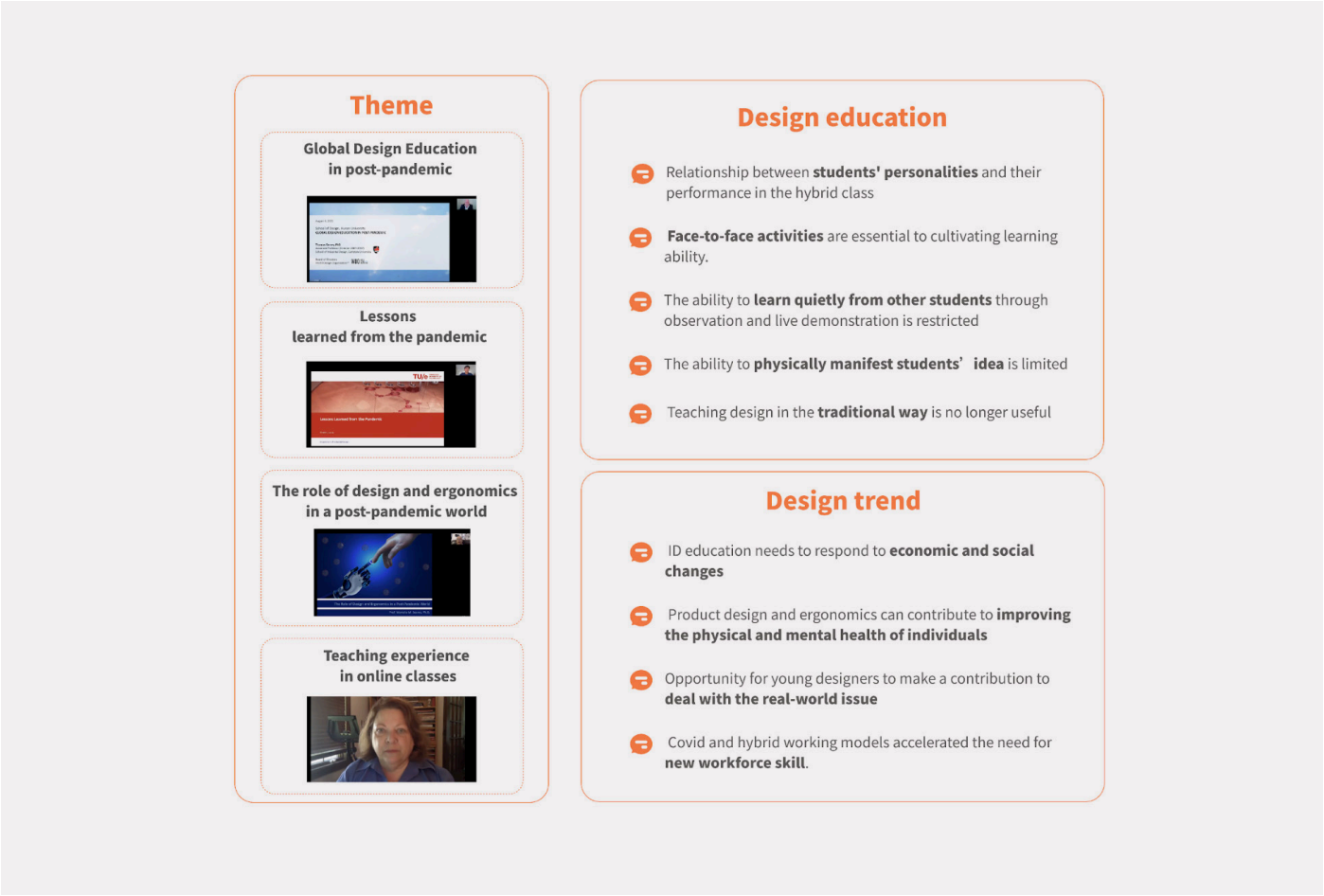

Figure 1: the seminar 'Global Design Education in Post-Pandemic'

Another problem mentioned by P1 is "the ability to physically manifest students' ideas", such as prototyping and physical modeling, because of the restrictions on physical meeting. In the hybrid activities, P2 found a clue from his creative coding class; students are always lacking new tools/platforms to collaborate with each other.

There is also some new trouble for professors. With a majority of classes taught with digital meeting technologies, P4 has to ask students to turn on their camera so that she can see their expressions and interact with them live through eye contact. But it is still difficult to know exactly "whether they are getting [the] teachers' attention".

Moreover, teaching design in the traditional way is no longer useful. The instructors tend to use the hybrid class and flipped class to adapt to the 'new normal'. Currently, students and faculty usually have weekly online meetings. Once the situation is allowed, they hold offline compact meetings to communicate with each other. At the same time, all educators in the panel were constantly reflecting and improving their educational methods in preparation for the longer post-COVID-19 period.

According to the above, the panel called for new ways to teach design pedagogy to increase the immersive and causal interaction with student peers and the clinical-based, intensive conversations between the instructor and students, which the panel believes are at the core of design education.

The panel first focused on the international connection of design. For students who desire international study and new experiences, it is challenging to face the risk and varied policies of a different country, resulting in many of them giving up further education in foreign countries. Obviously, this has a negative impact on richness of diversity. On the other hand, digital tools make a difference to international meetings.

Panel members also discussed how the future of industrial design education needs to respond to economic and social changes, that give several opportunities for designers. P3 talked about product design and how ergonomics can contribute to improving the physical and mental health of individuals in the pandemic and post-pandemic period. P2 believed that the pandemic has a huge impact on peoples' daily life, from health problems to mobility and urban planning, which is a great opportunity for young designers to contribute to and confront real-world issues.

The members debated the development of designers and students in the post-pandemic context as well. P1, P5 and P6 shared their perspectives on how the new opportunity arising from remote work will affect the design job market and the global communication among different design organizations. COVID-19 and hybrid working models accelerated the need for new workforce skills. Future designers need leadership, critical thinking, project management and continuous learning. In order to prepare for the long post-pandemic period, P1 asked for four demands of youth designers "ability to change and adapt through learning and understanding; resilience in thinking and imagining new future scenarios; skills in visualization and representation for sharing these visions; deep desire to understand people and contribute to our greater societies."

According to this, design education needs to provide our future talents more flexibility in their design career pathway.

Case 2: Learning experience in the hybrid industrial design studio

In the second section, we focus on the teaching and learning experience in the industrial design studio using a hybrid delivery mode that combines a mix of online and in-person teaching. In our case study, we compared the industrial design studio practices at Georgia Institute of Technology and Hunan University from 2020 using a mixed technology teaching platform.

We discuss the student/faculty experience in different cultural settings and the feedback from the instructors and students in the hybrid teaching mode of the industrial design studio. We analyzed the teaching outcomes, pain points, and new opportunities for teaching.

Figure 2: the comparison of industrial design studio at Georgia Tech and Hunan University

The backing campus schedules at Hunan University and Georgia Tech are not synchronized. HNU had begun to take online classes since the outbreak of COVID-19 in the March 2020. But it just lasted for one semester and went back to the face-to-face classes in August 2020. Only a few classes at Hunan remained hybrid mode in early 2021.

But most in-person courses still keep various online tools and bringing the benefit of digital technology into the classroom. On the other hand, the online classes at Georgia Tech started from March 2020 and continued to 2021. It had a hybrid term in early (spring) 2021, and continually kept hybrid and online courses in the 2021 fall semester that began in August.

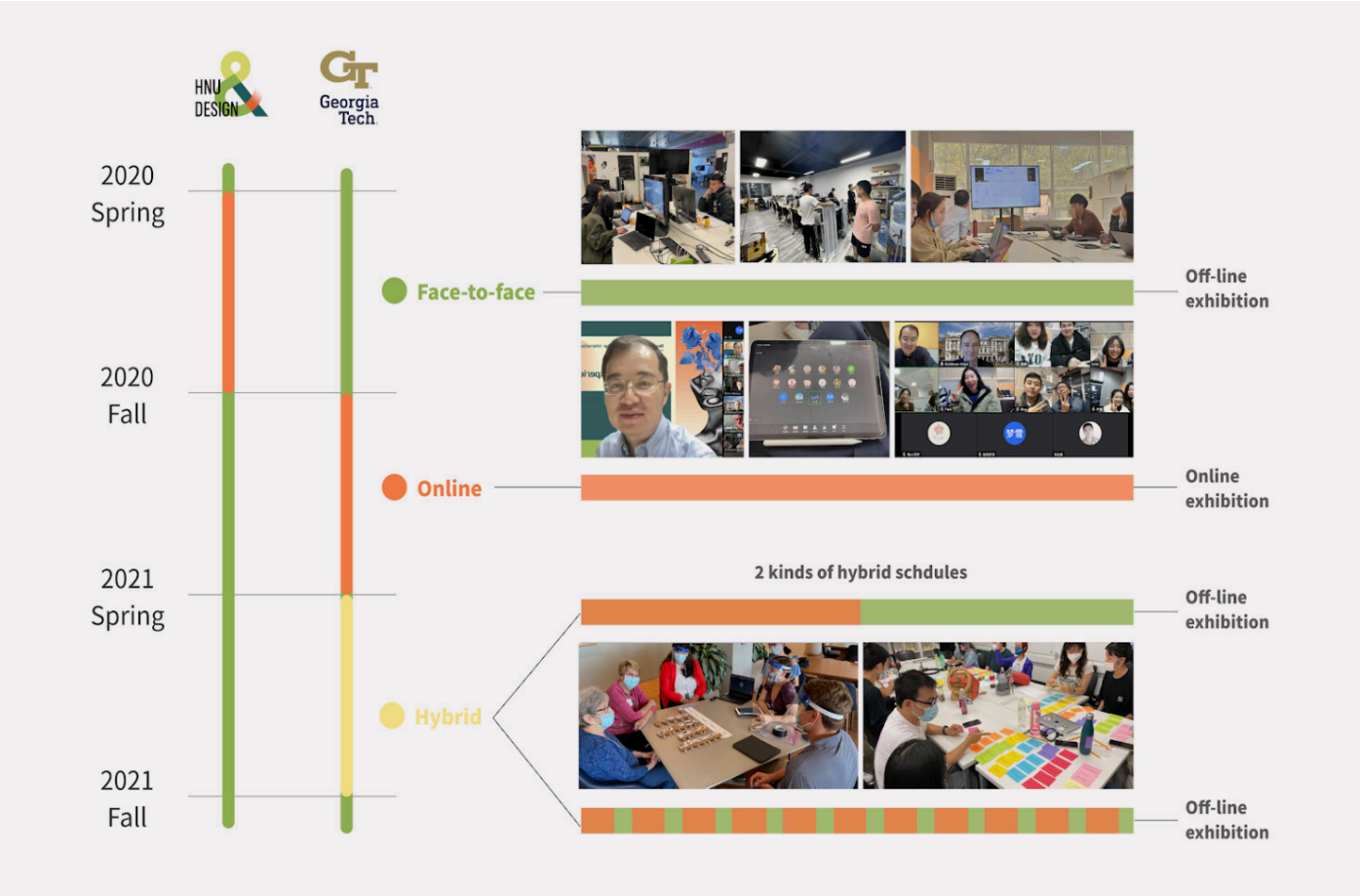

Figure 3: The timeline of online and hybrid teaching

There are several modes of hybrid courses at Georgia Tech. One type is where half of the students were online and the other half in person, and the groups would alternate each week.

The other was a flexible combination of online and in-person teaching due to the course plan, which uses online for lecturing and in-person for making. The second type schedule is widely used in the Hunan system.

Mixed technologies in hybrid teaching

From the comparison of studios at Hunan and Georgia Tech during the epidemic, it can be easily seen that China and USA have two relatively independent sets of digital tools/ platforms, both of which can, at a basic level, meet the needs of online design. Both student groups used a combination of university-based IT platforms such as Pinwall at Hunan and Canvas at Georgia Tech, with public social media and messaging tools such as WeChat in China and Slack in USA. Both student groups were able to use the platforms to take courses, communicate with others, view their design outcomes, discuss in groups and design collaboratively online.

However, the difference between Hunan and Georgia Tech in design tools and platforms also shaped their different learning experiences. For example, in comparison to Slack, WeChat is a widly-used social media platform in China, which gives students more interaction beyond the classroom, as well as distraction and privacy concerns. It also shows the technology divergence between China and USA impacts design areas.

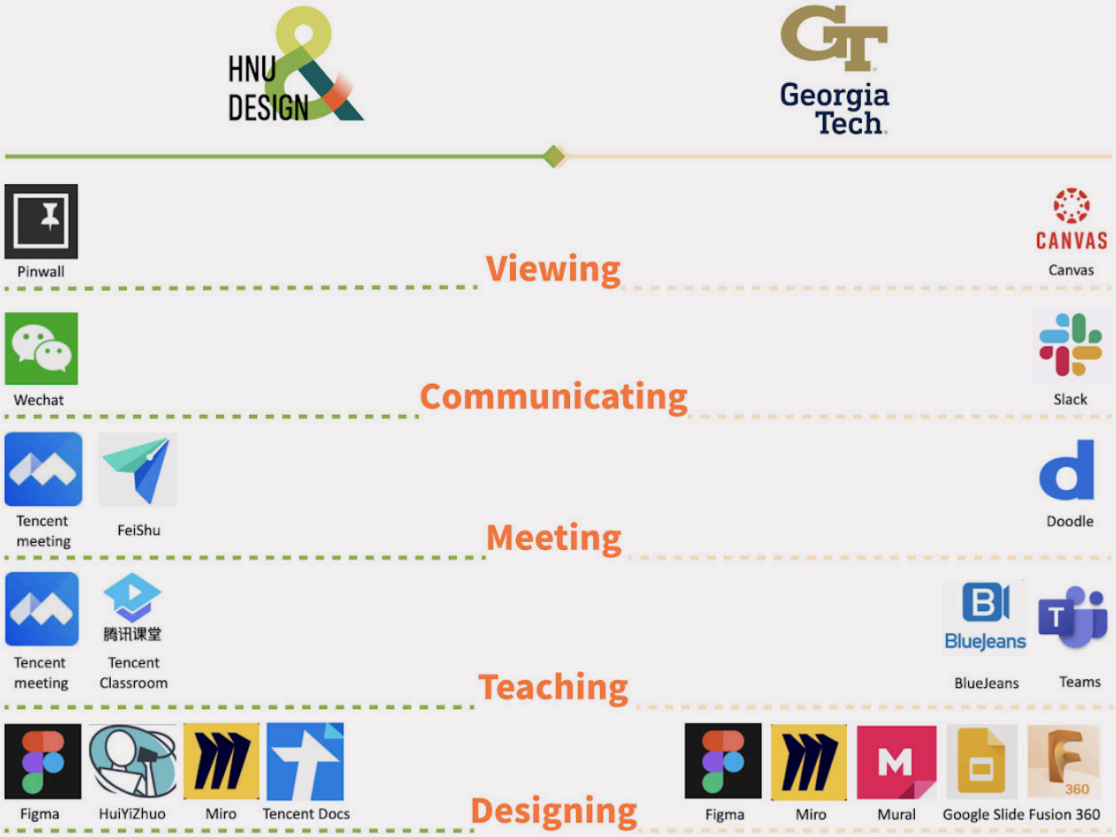

Figure 4: The comparison of technologies in hybrid classroom

Learning experience

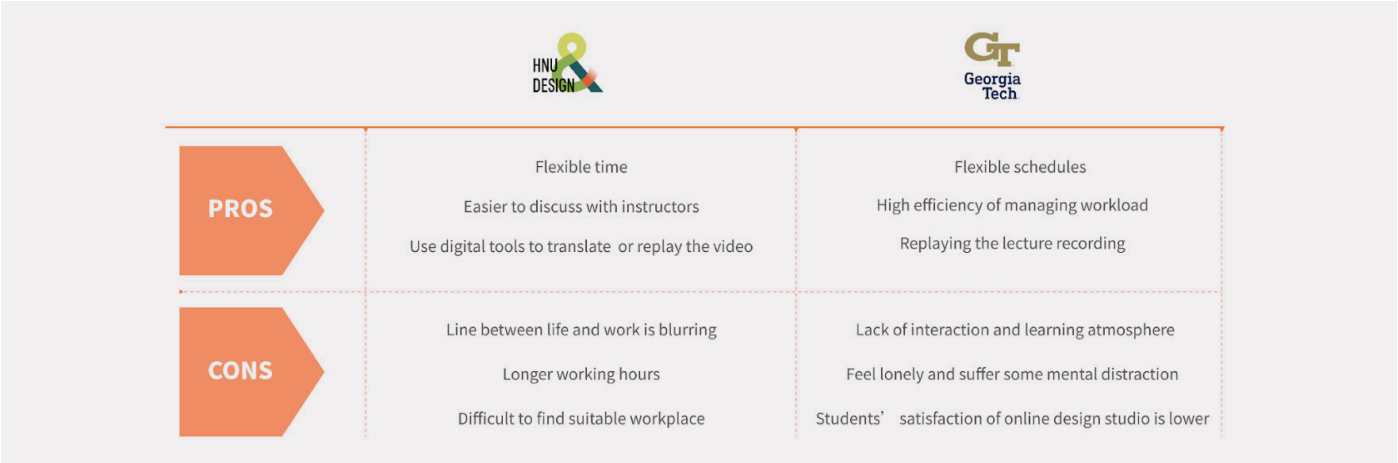

Figure 5: The pros and cons of hybrid studio from students' feedback in each school

Students at Hunan reported that online meeting tools make discussions easier with instructors anywhere and anytime. They feel they have more flexibility with online scheduling. Also, some students recognized the class recordings can help students with English language barriers because they can use digital tools to translate the sentences or replay the video. However, it is worth noting that it also means the line between life and work is blurring and less attention is paid in class hours. They may unconsciously spend longer time working behind the screen because of the uncertain timetable. Another drawback is the difficulty of finding a suitable and concentrated workplace, where a stable network and conversational environment are needed.

Students at Georgia Tech shared similar views. Hybrid education gives them flexible classes and high efficiency of managing workload and completing assignments. Replaying the lecture recording helped maximize this flexibility. On the other hand, the most severe problem is the lack of interaction with classmates and learning atmosphere. It is quite easy to feel lonely and suffer some mental distraction while studying from home. Compared with Hunan, students' satisfaction of online design studio at Georgia Tech was lower.

Discussion

In the post-pandemic period, design education has turned to hybrid education, and it is predictable that this situation will last for a longer period. But it is also an opportunity for faculty and students to rethink and reform the design education in respond to the 'new normal'.

Firstly, the complete upgrade of the curriculum system with hybrid modes needs to be established. We can find that both online and in-person classes have their pros and cons, which can be fully used to customize every curriculum according to the content. For example, digital tools can be more helpful and efficient if the course is lecture-based, such as design history or theory. But in-person sessions become essential when students need to prototype during design studios. In addition, it is necessary for teachers to take students' cultural background, character and workplace into consideration. The curriculum system needs to be flexible enough to adapt to the pandemic and changes in local guidelines and regulations.

Secondly, new tools and platforms are continually mixing and evolving. Online collaboration highly improves the efficiency in both online and hybrid context. But the current online collaborative design software is still limited to the 2D. There are not enough tools to support collaborative 3D representation and communication.

Under these circumstances, instructors find it difficult to teach and share the prototyping process through the Internet. It calls for more dedicated online platform for design education.

Thirdly, the goals of the design education should keep up with the changes and needs of society. The changes in society and people's habits caused by epidemics will generate an impact on future design trends, such as developing sustainable products, improving workspaces and providing digital and physical lives, which also affects the career development of students. We can see the trends and key themes for future industrial design education are interlacing, which needs to be considered in curriculum design, academic management, and global education collaboration.

Fourthly, global industrial design education will shift from a small-scale offline mode to a large-scale online mode. The restrictions on international students will not be completely lifted in the short term The communication will turn to international connections that are easily accessible to a wider range of students from both developed and developing countries, which lead the faculties all over the world to intentionally use digital tools to facilitate academic exchanges. We suggested a leadership role for World Design Organization in the global design education community.

Conclusion

In summary, hybrid design education demonstrates the world-wide change of our life and work, which raises a range of problems and opportunities from the individual to society at large. As a unique teaching mode for the design discipline, design studios have also turned to hybrid education. By sharing ideas between six educators from different countries and comparing the design studio at Hunan and Georgia Tech, there is still room for development on collaborative platforms and tools to achieve a better learning experience. In the next few years, despite inter-country policies having a negative impact on international students, we believe that various organized forms of online connections allow for a better knowledge sharing. We argue that a long-term exploration is required to establish a teaching system with technology-compliant methods and design goals that keep up with the changes of the times.

This paper is valuable to registrars, international affairs administrators, exchange programme staff, deans, school chairs, industrial design professors, professors of practice, industrial design educators, design researchers, staff, and industrial design students to understand the challenges and opportunities for industrial design education in a hybrid studio environment.

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Title:

The Design Neo-workshop: A Teaching proposal in the Face of Uncertainty

Authors:
Eska Elena Solano Meneses
Marco Antonio Luna Pichardo
Jaime Guadarrama

Institution:
Faculty of Architecture and Design, UAEMEX (Mexico)

Design, both in its academic and professional fields is currently facing a serious crisis derived from diverse factors from the serious economic situation recently hit harder by the effects of the COVID-19 pandemic, constant social changes, low labor demand and degree of recruitment, lack of collaboration between companies and educational institutions, distance between the methods used in teaching and those applied professionally, and the generation of curricula focused on academic objectives instead of disciplinary objectives, among many others.

In this regard, Antonio Toca (2014) in his article Teaching Resists Change, points out that there are many schools that offer content that does not correspond to the real needs of the country, that teaching is stagnant as it has not been able to advance with the same speed as technology and globalization, and that finally, it has not been able to propose real innovation of knowledge or its products, adopting a comfortable but mute posture, in the face of social demands. Institutions in charge of design education must offer students enough flexibility to learn outside the classroom and live professional experiences that connect them with reality.

The current context makes the scenario of this discipline more complex, emerging in the midst of economic, social and recently health crises, due to the COVID-19 pandemic that has transformed the world panorama, characterized by great uncertainty. Since this reality is the only certainty that students will face when they graduate from universities, it is essential to teach students to make decisions under conditions of uncertainty (Schön, 1998), focusing on the development of skills and competencies, and not focusing on sharing information that is not very relevant and applicable. In teaching, it is necessary to focus on developing thinking strategies, through cognitive tools and fostering self-management processes. And this is especially important in design education; in this regard Irigoyen (2008) states that design must be taught through “a dialectical pedagogical process in which teaching-learning occurs simultaneously” and not through academic processes that propose well-defined problems and determined, quasi-scientific methodological processes, which are not very close to the uncertainty of reality.

Unfortunately, within the classroom, there is an overvaluation of the theoretical and aesthetic discourse by teachers (Ocampo, 2010), leaving behind the utilitarian and practical value of the projects, which is where the insertion with the reality of work lies.

It is for this reason that this work aims to rethink the teaching of design with a ‘Neo-Workshop’ that:

- establishes a balance between teaching programmes
- redefines the teaching processes - the teaching profile and teaching spaces
- promotes an approach to the disciplinary contexts that brings them closer to the problems and real uncertainty.

This proposal is based on the need to recognize that the social demand and expectation of professional performance is very difficult to satisfy, since society is in constant change, evolution and growth, thus leaving professional development and practice in the constant state of moving away from the scope of professional competence, which must be reduced by addressing the three axes indicated in this work.

The Neo-Workshop proposal is synthetically supported by 15 basic arguments.

Each of these arguments has implications that must be considered in teaching, from the conception to the practice of design, in order to provide a pertinent response to the uncertainty that weighs on this practice.

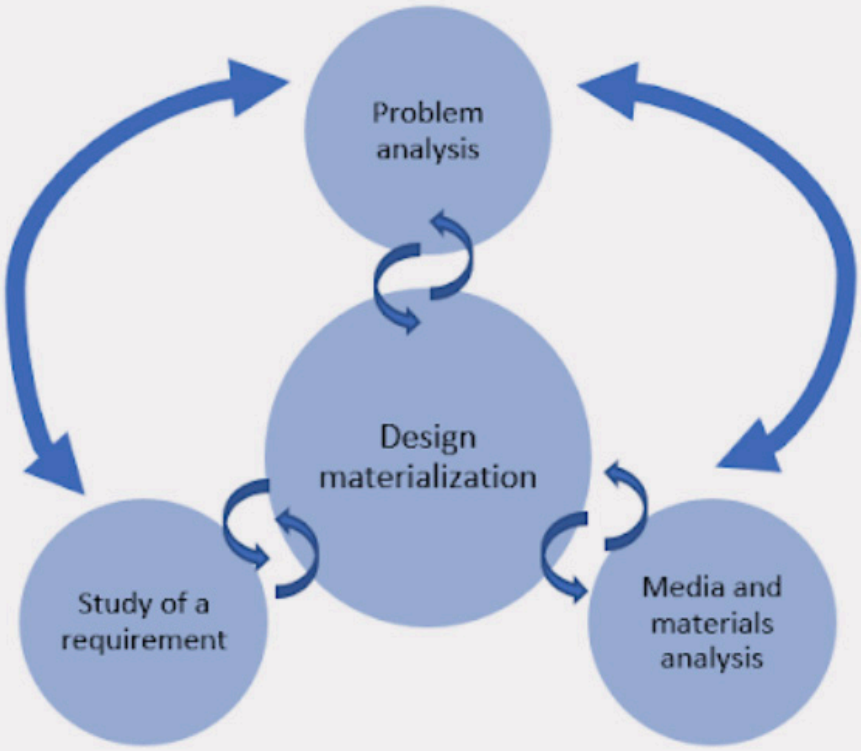

Figure 1: Diagram representing traditional design education (Solano, 2022)

Recognize the existing crisis between the academy and the work context.

It is undeniable that there is a gap between the way in which design is perceived in the academy and what happens in the market. One of the characteristics of the academy is its decontextualization in the field of production, distribution, and commercialization. This is because universities focus on the conceptual processes of design and only superficially on the elaboration of the object, which they conceive from an artisanal perspective; considering the beginning of the process with the study of a need, the analysis of a problem, the analysis of means and materials to focus on the materialization, leaving aside pragmatic processes of production and distribution. In academia, the generation of ideas is privileged over their elaboration, and a cyclical concept that goes as far as evaluation, redesign and life cycles is still scarce.

Eliminate lines of accentuation in teaching, seeking a balance between theory and practice.

In a need highly promoted by modernity, design education has been governed by strict specialization criteria that have inhibited the designer's proactivity and distanced theory and practice. According to Rodriguez (2014), the formation of an integral designer, without specialization, although it leaves some aspects vulnerable, points towards a change in the designer's paradigm, where the designer moves away from the concept of "solver" of a user's need, to that of an entity with initiative that can question, build problems, and contribute innovative proposals.

Strengthen strategic, practical, and applied research.

Research in design, as in all disciplinary fields, is the foundation of innovation and development; however, research is defined by intentionality, which for the purposes of design is disjointed. Herrera (2010) argues that there are basically three sectors that drive the development of current research in design: industrial, social, and academic; and that each sector has different interests such as economic or market factors, the quality of life of society and the promotion or reflection on design by the scientific community, respectively. This divides efforts, which makes strategic, practical, and applied research necessary.

Develop relevant and flexible methodologies for design, focused on research processes, practical learning, and production close to reality.

The origin of the first design methodologies were given within schools such as the Bauhaus and the Ulm School, more than 100 years ago, these methodologies sought the systematization of the designer's work in an objective manner, derived from the influence they received from the scientific method (Herrera Batista, 2010). These methodologies are based on phases such as: case study, problem statement, hypothesis proposal, project development and project materialization, which demonstrate a quasi-scientific inclination. However, today it is necessary to bring these proposals closer to reality, with a pragmatic approach and in line with current production processes.

Promote disciplinary innovation with a social character.

According to Norberto Chaves (2014), the social character of design is attributed to a committed and humanistic look with little presence in real and current practice. It can be affirmed that this approach is only marginally fulfilled, given that the economy and the neoliberal market are predominant in the practice of design. Therefore, it is necessary to promote innovation with a social approach.

Strengthen self-management in teaching, with greater flexibility and a wide range of selected topics and optional subjects.

The teaching of design must seek to train the designer in a panorama of great openness and possibilities. Understanding learning as a multifactorial, intra - and interpersonal process leads irremediably to the idea of self-regulated learning in which the design student possesses great autonomy and independence (Crispin Bernardo & Caudillo, 2011). To this end, it is necessary for design education programmes to present the student with a wide range of options and openness to take electives even in other institutions.

Social, inclusive, technological and sustainable emphasis as core elements of the design process, not as an isolated unit of knowledge.

The different discourses that design has had to incorporate into its teaching strategies aim to meet the emergencies that the current context demands. In response to a commercial design, social design is developed, in response to a predatory design, sustainable design appears, in response to a standardized design, emerges accessible design proposals. Unfortunately, the emergence of these discourses is due to the commitment of universities, as trainers of designers, without being promoted from a global and inclusive platform. It is imperative that these discourses become the main principle of design, overcoming the criteria of functionality and aesthetics inherited from the first design schools (Solano Meneses, 2021).

Transcend to the conceptual phases renewing the theoretical-practical balance, as well as the theoretical-technological.

As mentioned in argument one, the current design teaching discourse pays special attention to the conceptual and creative phases but neglects the consolidation of theory with practice, as well as theory with technology. Contrary to traditional forms of teaching, theory should not be developed as a disassociated unit, but within the practice: in the workshop or in the laboratory, so that its contents acquire meaning in practice.

Strengthen professional practices with shared responsibility.

It is essential to establish links between the academy and the various bodies that accompany the training of designers (private companies, public institutions, civil associations) under the triple helix criterion. The triple helix model promotes teamwork, the participation of different sectors and the exchange of ideas and projects. In other words, the presence of the different sectors fosters the relevance of innovative projects and thus consolidates their efficiency and co-responsibility.

Promote interdisciplinary development as the central focus of the design workshop.

The interdisciplinary nature of design has been much discussed, since design is nourished by other disciplines, while at the same time it borrows and reinterprets methodologies and tools from these different disciplines. Due to its interdisciplinary essence, it is pertinent to rethink the design workshops, as well as the actors that participate in it, allowing this scenario to bring together experts from different areas, i.e.: designers, anthropologists, sociologists, economists, engineers, psychologists, etc. that promote the interdisciplinary character within the classrooms and in the training process of the designer.

Propose a curricular structure in which the design workshop serves as the axis of the teaching and practice of design.

Due to the eminently pragmatic nature of design education, it is recommended that the design workshop or design studio be the scenario that brings together the knowledge and provides the most meaning. This will strengthen the pertinence of each discipline in the field of design, as well as allow the designer in training a tacit approach to their work in the professional field, where interdisciplinary is naturally experienced and the materialization of design becomes the axis of all activities.

To value the processes of design, not only its products.

The fundamental principle of the university as a training entity is to value the development of student competencies, and therein lies the essence of its teaching. This essence is diluted in the labor field, where what is privileged is the developed product, without applauding the design processes on which the product was built. It is therefore important that these processes are vindicated, and that, although they are systematized during the teaching process, we do not lose sight of the fact that they constitute the DNA of every design product.

Encourage the 'sudden' exercise of design as teaching to systematize students' responses to uncertain situations.

Due to the great demands of the labour field of design, it is essential to develop the necessary skills of designers in training, to be able to respond efficiently to the demands of users or employers, approaching emerging and uncertainty scenarios within their daily practice.

Propose exercises where the solution is applied to specific and complex problems to generate relevant, innovative, and divergent solutions.

This as a result of an adequate linkage as described in argument nine of the triple helix, presenting students with real cases to put their knowledge and skills into practice. This strengthens meaningful learning, by supporting their academic efforts in needs and products based in reality and cultivates the concept of utility and service engrained in design.

Promote the integral development of multi- and interdisciplinary projects.

In accordance with reality, the projects to be developed in the formative processes should promote the view of diverse disciplines, combining not only the formation but also the experience of other perspectives, strengthening a global and phenomenological view of design. It should eliminate a univocal view and replace it with an integral perspective, in which the designer is an agent of change, interacting with other professionals to join efforts and diverse disciplinary views in projects, and whose complexity challenges the designer to develop his competencies to the maximum.

As can be seen, these 15 arguments promote a change of paradigms in the teaching of design. The results allow a reconsideration of the way design and its teaching are currently conceived, which have distanced designers from a labor reality that demands professionals capable of facing uncertainty.

The proposed Neo-Workshop aims to offer a panorama to designers in training aligned with the professional scenarios they will face upon exiting design school and provide them with the necessary tools to develop with a high sense of commitment and relevance.

It is concluded that a reform in the current teaching models and paradigms can contribute to improving the way of learning by turning learning into a creative, socially and sustainably committed, interdisciplinary process that promotes self-management and autonomy.

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Title:

The Learning Mela: A Fun and Meaningful Gathering Focused Upon Learning

Author:
Lavanya Sahi

Institution:
Faculty at Srishti Manipal Institute of Art, Design and Technology
(India)

Abstract

In this article, I will look at an educational community that has worked on the concept of learning as a design exploration: undergraduate facilitators creating and leading learning experiences for children. This learning community of undergraduate facilitators and learners, in the 8-to-16 age group, is named The Learning Mela, an apprenticeship model initiated by a team of faculty at Srishti Manipal Institute of Art, Design and Technology, located in Bangalore (India). Here, learners of different ages gather to create and share learning experiences in the spirit of what Seymour Papert called constructionism – a learning model wherein the learner drives the learning with the project as the pivot. In this way, learners learn by creating, and while creating, the learners build connections and increase their understanding and knowledge. In turn, The Learning Mela undergraduate facilitators learn by designing experiences and engaging with young learners. As a result, The Learning Mela becomes a community context wherein all members–facilitators, as well as participants–discover and create.

Thinking Hands — A way of learning

At Srishti Manipal there is a small group of people who have been exploring alternative ways of teaching and learning that encourage students to make and experiment with their hands; this approach is known as Thinking Hands, a process of learning through making. Thinking Hands learning experiences are immersive and, as described later in this essay, are often in the form of a mela or a camp.

Thinking Hands is a term coined by us to describe a type of learning experience that involves materials (physical and/or digital), documentation, and conversations. Since 2006, we have run camps and courses with school children and undergraduate students. The concepts in the Thinking Hands approach have been reflected and explored by an educational community of adults and young adults at Srishti Manipal, as well as by colleagues from other institutions.

In Thinking Hands, the hand is wise, but the activities of the hands are not always craft related. Here, learning experiences promote ideas and concepts that are then explored and given fruition. Thinking Hands learning experiences are designed to involve the learners' manual dexterity, visual skills, and creative insights about phenomena. In doing so, this triad of skills places emphasis on the conversations learners have with each other and the facilitators.

There are no textbooks in Thinking Hands. Learners learn by making and doing. The learners use various materials and tools to create. In doing so, they learn about ideas, concepts, materials, and themselves. Learners are encouraged to reflect upon and document what they are doing and thinking. The documentation is often a combination of written passages, drawings, diagrams, and even photographs. Learners are encouraged to explore, experiment, and develop hypotheses. They often make annotated drawings to understand and explain their observations and their ideas to themselves and to others. Learners may also research from the Internet and from books, but the desire to make, forms the basis of the research.

Thinking Hands has taken inspiration from South African-born educator Seymour Papert. Papert worked with the Swiss psychologist Jean Piaget from 1958 to 1963, and developed a theory on learning called constructionism. Edith Ackermann writes in her paper "Piaget's Constructivism, Papert's Constructionism: What's the difference?"

Papert's constructionism, in contrast, focuses more on the art of learning, or 'learning to learn', and on the significance of making things in learning. Papert is interested in how learners engage in a conversation with [their own or other people's] artifacts, and how these conversations boost self-directed learning, and ultimately facilitate the construction of new knowledge. He stresses the importance of tools, media, and context in human development. Integrating both perspectives illuminates the processes by which individuals come to make sense of their experience, gradually optimizing their interactions with the world. (Ackermann 2001,1)

Seymour Papert was a learner all his life and was constantly learning and engaging in self-reflection. Papert lamented the fact that there was no word for the art of learning (Papert 1993, 82-105). In his article "Teaching Children Thinking" (Papert), Papert talks about the importance of addressing the ideas of thinking and learning, and describes how Logo, a programming language he invented, explores this idea of thinking and learning.

Over the past 15 years, we have been exploring and experimenting with the idea of creating and facilitating activities that involve learners, materials and ideas. Sometimes we have worked with found materials, and sometimes with specially selected items such as mirrors or the MakeyMakey. Regardless of material, a key objective during an activity is to make learners curious and excited in the process of making and learning.

We create and facilitate activities in contexts that seem befitting and natural to understand or explore ideas or phenomena. Learners create, and while doing so, they think, and in turn they reflect on their thinking so they can make and learn more!

While thinking about and exploring ways in creating meaningful learning experiences for different learners, we have come up with three types of approaches. The three different approaches will be described to give a better understanding of how Thinking Hands learning experiences work. Often, a learning experience may be a combination of these different approaches.

An object-led approach

In this approach, learners have a clear visualized goal, but to achieve that goal, the learner must explore ideas and work with tools and materials. Learners may be given a finished object, as well as the materials and tools used to make the object. Each learner must identify the different parts of the object and develop the steps to make it. Here, the materials give specificity to the project's learning objectives, and the object is a prompt to start the learner off as well as to sustain focus and curiosity. Drawing and annotating the different parts of the objects enables the facilitator to see what the learner is observing. The step-by-step plan made by the learner helps the facilitators understand what the learner is planning and thinking. Drawings help the learner see and think, and they help the facilitator understand details and thought processes of individual learners and can augment meaningful and contextual discussions.

A hypothesis-led approach

This approach encourages learners to observe a phenomenon and then reflect upon it by writing or drawing. Then, through the act of making and testing their hypotheses, learners achieve understanding. Making annotated drawings of objects helps learners decode what is happening. It also helps facilitators understand what each learner is thinking, and this can trigger meaningful discussions. Drawings can be part of the hypothesis and learners are encouraged to use drawings while imagining, creating, observing, and verifying what they are investigating.

An experiment-led approach

Here, learners have a clear goal, but there are several variables. These variables are understood in the process of making the object, and each learner can identify the variables while experimenting with the object. Learners are encouraged to be systematic and to change the variables one at a time, keeping all the other variables the same. This process is repeated with different variables that are identified by the group of learners as possible variables for experimentation. Some of these variables may or may not change the readings, but they are still investigated in serious and systematic ways, and the results are shared and discussed. Here, learners engage with the idea that testing needs to be done multiple times to ensure the reading is authentic or true. They figure out the variables and document and organize all the information collected by the individual members.

Thinking Hands is different from the DIY movement and the maker movement. While all three involve making and creating with materials, Thinking Hands is a way of facilitating learning through the process of making and documenting. It may be in a classroom setting or in an informal setting such as a park. In Thinking Hands, conversation is important. Learners often use drawings and other forms of documentation to be able to have meaningful conversations with each other as well as with the facilitator. These drawings enable people to understand one another.

Documentation includes learners' observations, thoughts and ideas. Documentation and conversations about the documentation is the cognitive process wherein learners develop understanding of processes, ideas, and concepts along with materials. They also learn about themselves through reflection of what they know, what they have learned, and what is happening in their heads!

The Learning Mela: An apprenticeship model for facilitating

The Learning Mela is an informal, open-ended project open to all Srishti students regardless of academic major or year of study. The Learning Mela was launched in 2016 for several different reasons. One particularly important incentive for The Learning Mela is that it creates a context wherein Srishti Manipal faculty and students can interact with others who are not formally part of the college. Community participants consist of residents from Yelahanka, including children from different social backgrounds, some of whom attend nearby government schools, and with people from other places in the city of Bangalore.

Srishti Manipal students are creative, but they are often absorbed by their own creative interests and specializations. The Learning Mela was conceived as a platform where Srishti students could share their creativity and experiences in "design learning" with young learners, who most likely were exposed only to rote learning, the prevalent mode of teaching in local government schools and in general throughout India's education institutions.

The Learning Mela offers an apprenticeship model into the educational world to create experiences with materials and ideas. Here, Srishti Manipal students would engage in creating learning experiences for children under the mentorship of faculty. The Learning Mela gives design students the confidence and expertise to work with children in the Thinking Hands model of learning and facilitating.

While running The Learning Mela, we have used two design approaches:

1. Conglomeration, mixture, and combination

Here, The Learning Mela has different activities, with very different materials and ideas happening at the same time. Srishti Manipal undergraduate students have different ideas and interests and are given the freedom to choose activities they want to facilitate. The experience for the children is fun, and the challenge for the Srishti Manipal students is to keep them engaged enough that they will not wander off to another activity. This approach works well when facilitators are excited and invested in what they are facilitating.

2. Concept base

In this approach, a concept – such as the movement of spinning or the idea of symmetry – is decided upon. Choosing a broad topic as a base for a learning mela works well. Here, the learning experience is not competing with the neighbouring activity. The materials are similar for all the children but allow for variations. Initially, we felt this would be limiting for the Srishti Manipal student facilitators, but we later found that it made the students more creative and thoughtful. The concept of how to create the movement of spinning was explored and unpacked to create many different forms. The variations were similar but used different design ideas. To make an object spin, the movement can be created using a straw and blowing, or using a string and pulling, or using two cans. The object that spins can also have huge variations in form, shape, and detail. The facilitators spend time before the children arrive making examples and talking between themselves about mechanisms. They make simple basic structures – and sometimes complex challenging ones – as examples which can be used to explain as well as inspire the learners. These discussions and experimentations enable facilitators later to have conversations with the children.

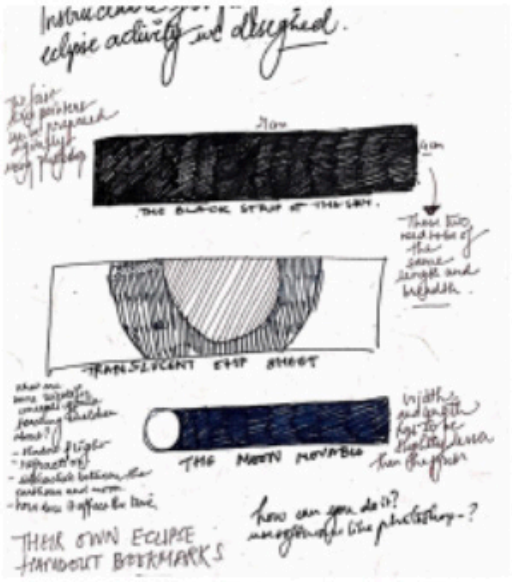
The Learning Mela has been set up with very different groups of children

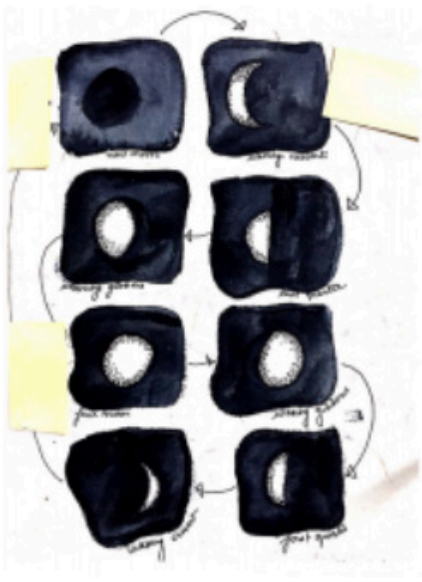
Photos are included at the end of the article showing examples of our students working with children in formal and informal settings.

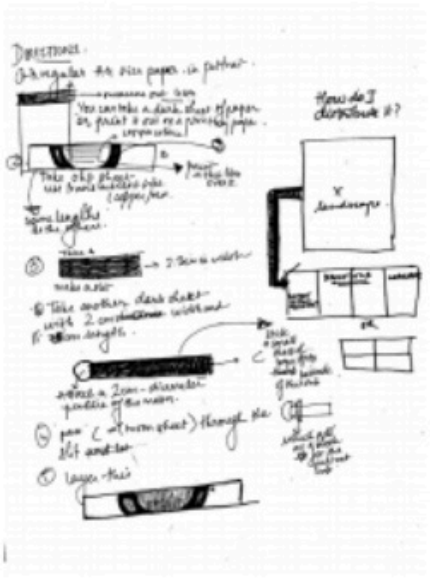
1. In public/semi-public settings such as a park or the common area of an apartment complex. In some contexts, the prospective audience needs to be curious so as to engage. In such places, Srishti students plan activities, and in pairs they go to the park to engage with the public, particularly children.

   Often, during the evenings or weekends, students take their class projects and engage with children to see if what they planned actually worked, and they learn how to iterate and change their ideas in order to create more engaging activities.

Apartment complexes in Yelahanka



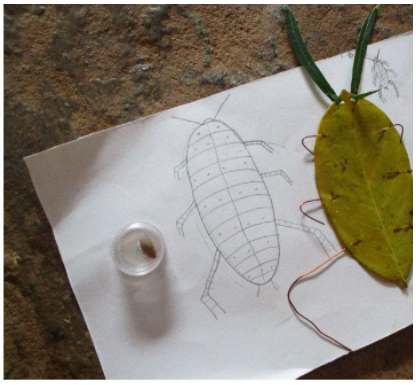




Here, Srishti students took advantage of the Blood Moon event in 2016, to create several activities that explored the idea of the solar system. Some topics included: the idea of distance and scale in relation to the fact that the moon looks larger than the sun; the idea of the solar system and planets orbiting around the sun; the idea of an elliptical orbit and the blood moon; and the idea of an eclipse.

2. In Institutional settings where there is a captive audience: Srishti Manipal student facilitators have worked in classroom contexts, but often in informal and explorative ways. Here, Srishti students have designed activities that relate to the work the teacher has done or needs to do in the syllabus. The activities are for a short duration and take an idea or concept and explore it by making and creating.





Village school, near Yelahanka

Sometimes a learning experience can use the surroundings as the starting point. In this school, children were studying insects. The Srishti students designed a complimentary hands-on learning experience. Learners were given small plastic boxes to collect insects and other creatures. They had magnifying lenses and were asked to make drawings of the creatures they had collected. At this stage there were many observations, and questions were addressed by consulting books and the Internet. One student found a scorpion with its young, and discussion of the fact that the mother scorpion carries its young on its back and that it eats many of them were interesting pieces of information for both the learners, as well as the facilitators who used their phones to rsearch more information about scorpions.

The next part of the activity was to create insects with natural material and wire. The insect was made larger than life, but they had to adhere to the ideas of shape and proportion. The learners were asked to make these insects from natural material they could find on the school grounds. Learners could modify the materials they found by cutting and manipulating the material. The learners were also given thread, wire, scissors and cutting pliers to aid in this process. This activity resulted in interesting conversations with peers, as well as facilitators.

3. Srishti Manipal Campuses: Children come after school on Saturday afternoons for two hours to discover what Srishti Manipal students have planned. This mode of engagement with students on campus has been running as The Learning Mela for the past four years. Sometimes the children come from the surrounding neighborhood, and on some occasions visits by school children have been coordinated with institutions working with government schools. Children from other parts of Bangalore have also attended.



Srishti Manipal N3 Campus

In this activity learners explored circuits, conduction, batteries, and LED lights. The children from the Yelahanka neighbourhood came to Srishti N3 campus on a Saturday for two hours. On the table LEDs, wire, batteries and tape were placed. The facilitators introduced the idea of a circuit by holding hands and passing messages from hand to hand.

The learners explored the idea of conductors and nonconductors. Finally, learners made circuits with wires, LEDs and switches by breaking the circuit physically. Making pop-up cards with a circuit could have been introduced if this activity had extended into the next phase.

Srishti Manipal N6 Campus

This is an example of a few hands-on activities that were designed for a group of students from local government schools. In this activity, learners explore air pressure, friction and balance. Facilitators introduced challenges without giving a solution or talking about potential problems. Materials were arranged on the table. These included laser-cut circles and ovals with holes, cardboard, tape, straws, scissors, and balloons.

The learners explored creating movement as well as introducing stability. Learners combined different materials to create wheels that moved and a structure that remained stable while in motion, and to which a balloon could be attached. Here, the idea of an axel needed to be used. Learners also figured out how the balloons could be placed so as to enable easy access to blow but also the correct angle to make the car move forward.

Srishti Manipal N6 Campus

Here, an NGO-bussed government school children from a hostel campus near Srishti Manipal so that the children could learn and engage with code. The same children came multiple times in order to expand on the learnings of past Learning Melas. The NGO provided laptops, and Srishti Manipal student facilitators worked with small groups of children. Each week, the group of facilitators agreed on a topic such as using the pen tool or using if-then statements, and the learners created programmes of their own with the Srishti Manipal student facilitators serving as mentors and sounding boards. Here, it was important that children had individual laptops, but they sometimes worked in pairs or simply next to one another. Facilitators also tended to work on student laptops but deleted the additions they made. Using the Scratch ‘remix’ option enabled the facilitators to work and demonstrate possible additions or modifications of the learners’ programmes on their own computers without interfering with the learners’ work.

Undergraduate design students: Learning and facilitating

Undergraduate design students are an exciting group to work with when creating and facilitating learning experiences. They prove to be interesting and enthusiastic hands-on facilitators. There are some aspects of creating and facilitating a constructionism type of learning experience that come naturally to design students. Repeated trials and reflections lead to creating and facilitating even more thoughtful and interesting learning experiences. Being designers, they bring their varied skills to interactions with the young learners.

The experience of creating and facilitating gives the design students an insight into children and their interests and enables them to think of possible ways to interact with young learners in the future. During the academic semester, the design students worked with different materials and children. At the end of each session, facilitators pause to think about what worked and what needed to change. We, faculty and student facilitators also plan for the next session.

Srishti Manipal students are encouraged to plan activities. These activities should not have a single outcome but should allow for different abilities and diverse personal expressions. The activities need to have many learning goals identified, and often some learnings may be common for a group of children; but different children may have different learnings depending on their interests and abilities. The activities need to be broken into sub-activities that involve the cyclic process of making, reflecting and making. Short concise instructions explaining goals for exploration need to be made and articulated, and the possible variations and explorations should be unpacked and encouraged.

During the facilitation, students first test their activities on one another. Here, their peers are given a ladder of feedback to critique the experience for aspects that worked smoothly as well as areas for improvement. The setup in terms of space, materials, and instructions are tested and modified.

Aspects, features and characteristics that are important to incorporate while working with children

We provide feedback sessions for undergraduate students who work as facilitators. This feedback emerges from our personal experience in facilitation as well as from observing the unique circumstances of each Mela.

Facilitators should not face the class but should try and be part of the circle of learners. Facilitators should never sit with or stand next to each other; instead, standing opposite one another is a more appropriate arrangement. While interacting with children, facilitators should try to be at the same eye level as the learners. Facilitators should be conscious of their eyes and their hands. Facilitators need to use their eyes to show interest, patience, and engagement in what the learners are focusing on. While working with learners, facilitators should not take over the participants' work. Facilitators should have their own materials with which they can demonstrate their suggestions.

It is important that facilitators need to interact with learners and be curious about what they are doing without feeling the need to control or direct the learners. Having meaningful conversations about what a learner is planning or thinking gives insight to both the facilitator, as well as the learner. Facilitators should look for possibilities in which learners can help teach one another. Facilitators should appreciate work done and be specific in their appreciation.

The process of guiding and mentoring undergraduate students in creating and facilitating Thinking Hands learning experiences has been an interesting journey. Interacting with children is not what many design students anticipate as a full time job, but there is joy and energy that is palpable while working with young learners.

Conclusions

Seymour Papert is an inspiration for many of us, and it would be beneficial if there were many more people who work and design for children in what he coined as constructionism. The Learning Mela and other such courses started at Srishti Manipal are envisioned as ways to expose young adults to the creative possibilities of working with learners. While many design students of Srishti Manipal will not pursue teaching as their primary profession in the future, we hope that these experiences will lead to future engagement with children directly or indirectly.

The Learning Mela has enabled us to think of important features in respect to planning activities as well as facilitating them, and this has led to many conversations and observations between faculty members and students at Srishti.

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455 St-Antoine Street West, Suite SS10
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