Collaborating Design Risk

Dr Laura Ferrarello[1], Professor Ashley Hall[2], Mike Kann[3] and Chang Hee Lee[4]
[1234]Royal College of Art

Abstract

The "Safety Grand Challenge" is a collaborative research project between the Royal College of Art (RCA) School of Design, and the Lloyd's Register Foundation (LRF). The maritime industry is dominated by "grandfathering" leading to a slow-pace of adopting innovations that can reduce risk and save lives at sea. We describe how impact was achieved through collaboration and design innovations that bridged the risk gap between technologies and human behaviours. Starting from the project brief we designed a collaborative platform that supported a constructive dialogue between academia and partner organisations that aimed to foster innovative design approaches to risk and safety. The project generated an engaged community with diverse expertise that influenced the outcomes which included seven prototypes designed by a group of thirty students from across the RCA. Throughout the course of the project the network extended to other partners beyond the initial ones that included the RCA, LRF and Royal National Lifeboat Institution. The "Safety Grand Challenge" demonstrates how research can be an explorative platform that offers opportunities to analyse and design solutions to real life safety problems in mature industries through the prototypes that reflect the sophistication of the project's collaborations. Our conclusions support how design research helped identify the value of design for safety in tackling complex issues that intertwine human, environmental and commercial views and can shape new forms of collaborative research between academia and industrial partners.

Keywords: Design for safety, Action Research, Collaboration, Participation, Co-Design, Behaviour Change

Introduction

The "Safety Grand Challenge" is the first collaboration between the Royal College of Art School of Design, and the Lloyd's Register Foundation. It ran from August 2016 to February 2017. From the common intent to foster a new attitude and culture to reduce risk the two institutions agreed to explore how design can generate impact in the complex safety environment on water. Design is increasingly being incorporated in business models to encourage a creative approach to problems (Kimbell, 2009), understand the human factors and encourage risk (Kolko, 2015). However the influence design can draw from disciplines based on strategy, procedures and policies, like the prevention and intervention of risk, is still an emerging area yet be to be fully explored.

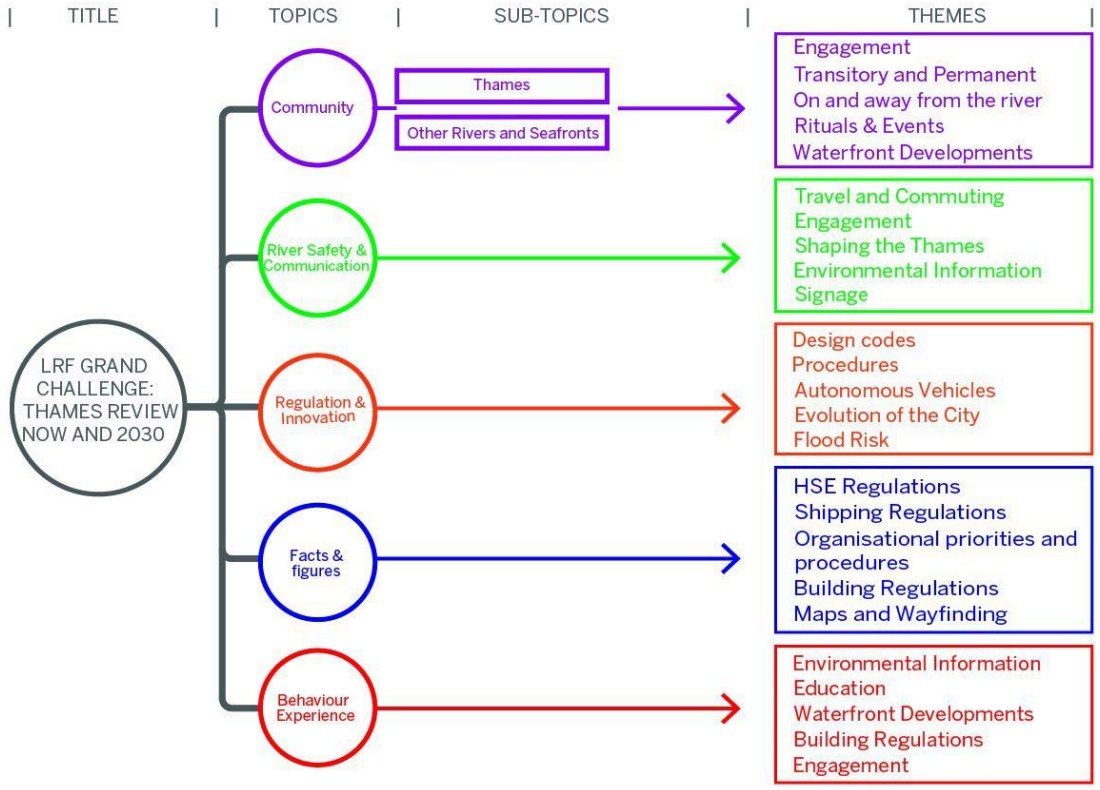
In the light of climatic fluctuations humanity needs to develop new strategies that both prevent and cope with events that endanger human life. The understanding of danger through the lense of design becomes an opportunity to grow resilient and creative human centred infrastructures that collectively understand risks through proactive methods. The "Safety Grand Challenge" research follows this overarching aim throughout. The project has been structured along two sub-projects: 1. Safe Ship Boarding- the exploration of a specific design safety issue that seeks solutions that improve safety for the ladders that

ship's pilots and crew use to transfer from ship to ship; 2. Thames Safest River 2030 - a broader analysis of the river Thames in London aiming at the development of future strategies that make this the safest river by 2030.

Literature Review

Tackling safety on water in a combined design, research and teaching project resulted in two different requirements from existing literature and case studies; to inform the design research team of existing and emerging issues for strategic design for safety and a repository of research sources that could provide creative inspiration for the design research teams.

We looked at a framing model used by the engineering firm Arup (Arup & Rockefeller Foundation, 2015) to analyse and collect the data on global cities. Arup used four parameters to structure information and illustrate the content. These parameters function as guidelines for any further study on the topic (Arup & Rockefeller Foundation, 2015). Using this model as an inspiration we structured two bodies of literature for both sub-projects' groups by dividing sources into five main topics and further sub-topics that could be navigated via two explanatory diagrams. We considered these diagrams as the transition point between research and teaching, as students explored the literature review through these structures. The diagrams were a quick and simple communication method that guided the students in the selection of the design directions to follow. As shown in the figure below (Figure 1) they list the ten themes which are divided in five per project; the first project's topics are: *Object and Products; Training and Education; Embedded Knowledge; Procedures and Regulations*; *Methods and Solutions*. The second projects's topics are: *Community; River Safety and Communication; Regulation and Innovation; Facts and Figures; Behavior and Experience*.



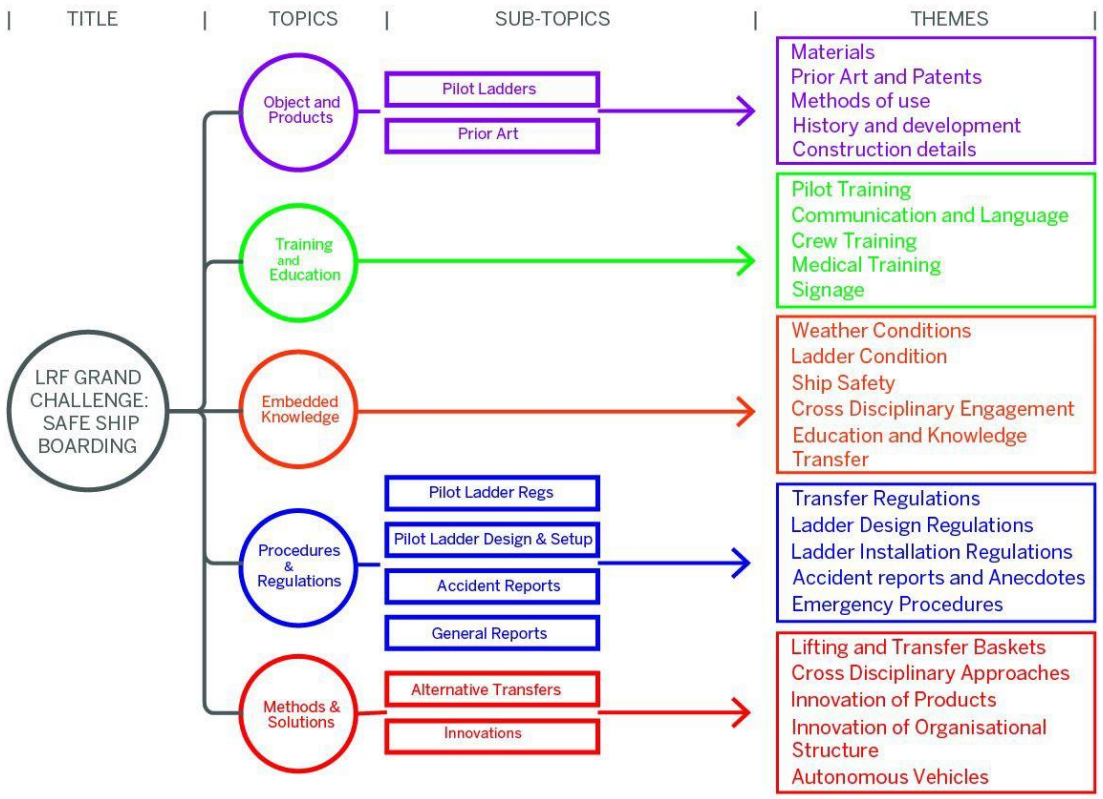


Figure 1. Diagrams of the literature review's structure

Design for safety moves beyond the simple regulation of human behaviour around technology and we found several examples that highlighted collaborations tackling risk. An emergent approach to complex problems can be seen in the task force that led the post Hurricane Sandy interventions in New York (US Department of Housing and Urban Development, 2013) and the community of UN Habitat, which in the new Urban Agenda includes risk reduction as a factor to be considered in any global politics of urbanisation (UN HABITAT, 2016). These emergent risk-collaboration examples seek solutions that work across design, intervention and prevention achieved through the collaboration of different parties and disciplines. For instance "Rebuild by Design" (2014), the global collaborative platform lead by Henk Ovink, Senior Advisor to the former US Presidential Hurricane Sandy Rebuilding Task Force, under president Obama, tackles climate change issues from a different perspective (Ovink, 2016). According to Ovink looking at intervention only through built infrastructure is not enough in preventing natural disasters. On the other hand the expertise of diverse communities has power, strength and resilience to create a sustainable ecosystem which connects infrastructure through the exchange of knowledge. For Ovink people, and their knowledge, are the most sustainable response for facing the risk from climate related challenges. By launching design competitions Ovink designed a mixed community of experts and the general public through which he began a cultural change; government and communities changed their attitude towards climate related problems and, by doing so, they demonstrated first hand that it is possible to generate a new inclusive culture of safety that works through the relationship people establish with the environment enabled through technology.

Another project that tackles safety at an ecosystem level is the London Thames Tideway project (Tideway, 2017) which re-engineers safe working practices through new ways of

engaging experts, workers and the general public. Tideway is an ongoing engineering project that will channel the London sewage infrastructure below the level of the Thames river bed. The value of the project extends beyond the infrastructural ambition and by reclaiming the water, Tideway aims to bring Londoners back to the Thames, by transforming the river into a place to live, rather than a barrier between two banks. The method used to pursue such vision is the sense of community, ownership and membership, which is currently built upon a method that departs from conventional current health and safety culture. Tideway designs health and safety through the individual's sense of membership and ownership, which equally applies to workers, engineers and primary school children. Members of Tideway staff participate and run workshops on health and safety, which are practiced as a core project activity rather than an add-on set of requirements. Health and safety is a core company policy designed-in specifically from the start with the intention to create an engaged community that any member owns and is part of by means of interactive participation. Health and safety workshops create a new culture of collaboration, which change behaviour through the sense of belonging.

A number of other sources provided insights in terms of behaviour and culture in relation to risk. Niedderer (2013) describes the ambition of shifting a culture of procedures to proactive behavior that supports responsibility via participation. Under this approach the perception of health and safety from a human's perspective shifts: from procedures and policies to everyday's lifestyle. Oltedal links the perception of risk to the cultural environment that people grow. Religion, society and beliefs play an important influence on the degree to which people perceive risks (Oltedal, *et al,* 2004).

In terms of human behaviour another important cultural aspect is described by ship's Pilot Cpt. Chris Hoyle who during one of the project discussions underlined the high number of global ship's crew who came from countries at the top end of the Hofstede (2011) power distance index. The power distance index describes the perceived distance between less powerful members and unequal authority in more powerful members. A high power distance index crew member may therefore be much less inclined to question a senior authority figure even when they feel there is a safety issue taking place. This can lead to a greater risk of accident and injury. Gladwell (2008) discusses how this feature led to a number of passenger aircraft crashes for one national airline and how the solution was a simple as changing the cockpit language to English due to its structure having a reduced number of deferential terms. Human factors including disciplinary language can become an issue. Syed (2015) contrasts the huge disparity between the aerospace and medical industries and cites the 1 in 2,400,000 deaths per flight worldwide in comparison to the 120,000 patients that die through medical errors in the USA per year in a recent Harvard University study. He traces this difference to the encouragement for pilots in a positive failure reporting culture so that others may learn, to the medical profession's language rebranding, or cognitive dissonance (Festinger, 1957) of mistakes as 'complications' or 'unforeseen outcomes' and the lack of any automatic investigation when these issues arise. Whereas pilots can happily report errors in an encouraging environment, medical staff and Doctors often lose reputation and respect when failures occur. The differences between industrial and disciplinary attitudes to cultures of risk and failures can be profound and at the core of this is the collaborative ecosystem of technology and people. From these insights we developed a central position of recognising that design for safety has to go beyond the prescriptive legislating of human behaviour for technology use (and integrity) and the physical design of products and has to consider and embrace the wider ecosystem of culture, behaviours and expectations of people and technology.

Emerging Collaborative Methods

The open ended process we engaged with during the literature review phase helped gain valuable information and identify potential design strategies. As previously mentioned the contribution of the partners' expertise in the project enriched the body of knowledge of design for safety and the role design can play in this specific area. As the literature review suggested the project should not be limited to built objects or infrastructure, we evolved methods based on participation and collaboration as the project progressed to support human infrastructure aimed at generating a resilient response intended as the capacity to "bounce back smarter, through collaboration, innovation and the best of science" (Ovink, 2016).

Our methodological approach was a combination of action research (AR) and participatory design research (PDR) with action research being the primary activity of the research team in navigating and developing the network of relationships and participatory design research explored by the teams who drew collaborators deep into their creative process and concept validation activities. AR acted as a guideline, PDR as exploration lens. Participation was used at different levels: the multidisciplinary academic research staff worked as a team to identify the literature review's topics and content, focussed on design practice inputs with a state of the art review, field trips and reflective sessions based on project progress and insights; the student groups used a participatory design research-practice mode where they combined industrial strategic expertise from the Lloyd's Register with applied industrial experience from the RNLI (Royal National Lifeboat Institution), MPA (Marine Pilots Association), IMPA (International Marine Pilots Association) PLA (Port of London Authority) and CHIRP (Confidential Hazards Incident Reporting Programme). The stakeholders and experts participated in the project reviews regularly scheduled across the duration of the project and individuals partnered with specific teams. This methodology develop a hybrid approach (Foth & Axup, 2006) that suited both the research design practice elements of the project and allowed them to act together in unison as shown in Figure 2.

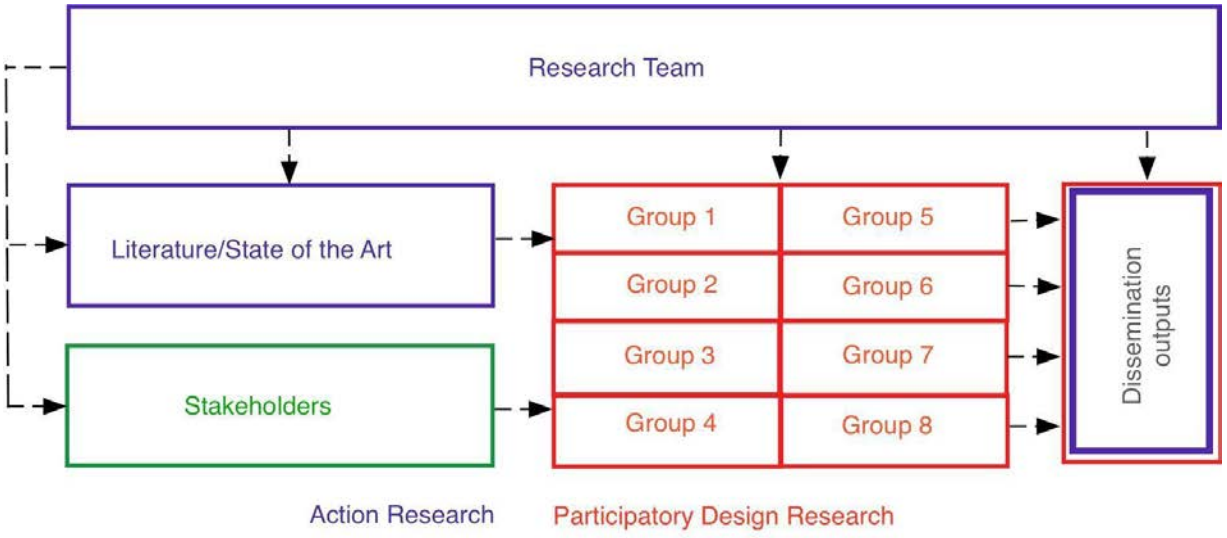


Figure 2. Hybridised action research and participatory design research methods

Designing for Safety

The design project phase began with AcrossRCA which is an intense week of activities and workshops where students from across the college work together in teams. Thirty students from different countries around the world and with expertises that span from engineering, fashion, sculpture, architecture, business, management worked in groups of three and four together on the grand challenge. Once the intensive AcrossRCA phase was completed the teams worked 'long and thin' up to the final exhibition and symposium at the Lloyd's Register Foundation Fenchurch Street building in London. During the reviews scheduled at different stages of the project stakeholders were invited to concept selection, concept development and design development stages. The exhibition displayed seven prototypes for saving lives at sea and the design researchers presented findings alongside presentations from the design teams to industry experts, safety bodies and project collaborators. These findings and industrial feedback were disseminated in the Safety Grand Challenge report (Hall, Ferrarello & Kann, 2017).

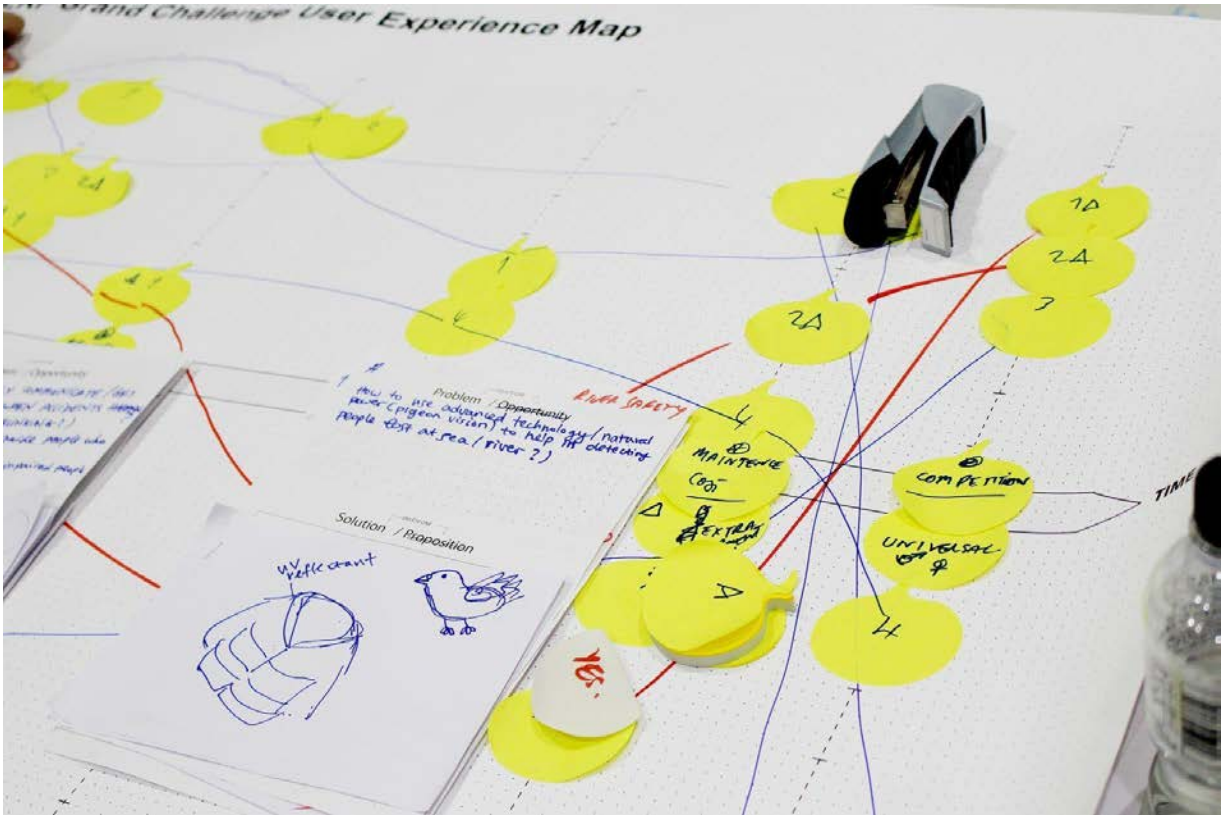


Figure3. Brainstorming session. Testing and measuring the user experience

The perceived ownership of the project was crucial for the dynamics of the collaboration and to support the external partners' confidence in contributing from their lenses of individual expertise. The perceived risk is that 'naive designers' who think they have the answers will alienate collaborators. From a participatory aspect the dynamics of the collaboration influenced the research methodology, hence the course and direction of the project through the feedbacks we gathered from the students' project reviews and field trips' meeting. We visited the PLA in Gravesend, boarded a Thames pilot boat to see at first hand river risks, the Lloyd's Register Technology Center in Southampton, the RNLI Headquarter in Poole and Tower Lifeboat Station in central London. As evolved the design research process shaped our role as researchers, which consisted on the creation of a

common ground for innovation, i.e. the space where everyone, academia and industry, would dialogue and exchange information to identify possible solutions. Through the literature review and research methods we understood that risk is something based on the individual perception; for such a reason it was important for us to identify factors beyond technology. An important element we took into consideration was human factors and in particular the behaviour highlighted in maritime culture through the impact of 'grandfathering' (OED Online, 2017). In a 'grandfathering' culture information is passed on from one generation to another, thus shaping an environment that resists innovation and new practices; in such an environment external influences are something that is often perceived as "alien". By participating in The Safety Grand Challenge experts, partners and stakeholders gained trust as well as excitement for new innovative solutions that could tackle cultural resistance. The excitement was particularly visible towards the end of the project, when the students received out of schedule invitations to exhibit the prototypes at an international conference organised by the IMPA at HQS Wellington in London, at the Lloyd's Register Technological Centre in Southampton and at the UKMPA Conference in Middleborough alongside alongside planned exhibitions at RNLI HQ in Poole and commercial interests in developing and manufacturing one of the designs.

The industrial value of the safe ship boarding project was made by clear by Captain John Rose (CHIRP Founder) "*You should be very proud of the achievements made with this project and with the students quality in their research, it has been an inspiration to me and to several others involved." and* also from Susan Cianchetta (Thames Strategic Review co-author) who noted the new innovation methods *"It's been a pleasure to work with you and the teams on such a new and interesting approach to problem solving."* The Lloyd's Register distributed the prototype images to its global marine network. We received comments from around the world, which include a pilot from Houston USA who wrote: *"These are all good ideas, each is unique and has identified a specific improvement to the current system in use".* He also added " *I am pleased to see our organization engaged in these type of initiatives".*

Reflecting on Collaborative Risks

The "Safety Grand Challenge" overarching themes focussed on risk, design and safety on water. Nonetheless the challenges extended beyond this list as we had to develop methods to interface the complex environment created through the themes. For this reason the early research tended to narrow down the number of elements to take into consideration even though we were open to creative detours and encouraged different areas to the ones suggested in the literature review themes. The two aspects students had to be aware of were communicating clearly the design aims and considering the potential impacts in a complex design field with many interacting elements.

Figure 4. Field trip to RNLI HQ in Poole. Students looking up at the ladder from a Trent class lifeboat

The role of the design researchers was in developing the infrastructure that would link and manage the dialogues among the parties. The hybrid combined methodology of AR and PDR created the common ground for innovations that supported the exchange and transferability of knowledge through the engagement of the different stakeholders. Through exposure to the challenge shaped by first hand experience students framed the issues from different perspectives which in their turn informed the design process. However because of the combined aspect of teaching and researching in collaboration with external partners we encountered communication challenges which didn't intrinsically concern designing but could create confusion and lack of clarity in the group. One of these was language. We had ships pilots, captains, chemists, designers, historians, architects, mechanical, aeronautic, electronic engineers, products designers and service designers. To keep every party engaged at an equal level we had to carefully consider the different interpretations of the design scenario from a language point of view whilst making sure that skills and expertise would be free to contribute to the project. For this reason we adopted methods that would work in an interdisciplinary context; through a brainstorming workshops students produced up to 100+ ideas per group in a two hour session. This was achieved by using design innovation techniques including character and context cards and design exorcisms alongside more conventional rules such as not discussing ideas, speed not quality, copy and improve and no judging etc.

Figure 5. Rendered image of Dynaweb pilot ladder

The brainstorm workshop was the first step in the design process which led to the final seven prototypes which "visualised" the value design design for safety can deliver. By tackling aspects that span from communication to equipment and technology, the seven prototypes make design a strategic medium that operates through tangible objects. Objects are "interfaces" that address problems through practice-based solutions. As students directed their thinking into the themes and topics, their design approach kept the large and small scale concerns in parallel. Students understood the complexity and multiplicity of the context and produced prototypes that spanned strategic and detail scales.

For instance one of the ladder prototypes Dynaweb (by designers Chia Cheng Kung, Chih-Hsing Huang, Irene Chiu and Nick Hooton) focused on innovating the manufacturing aspect of the ladder to improve weight, storage, maintenance and transportability by introducing rapid prototyping technologies that reinvent the joinery and flexibility of the traditional pilot ladder. If the final design upgraded the current ladder design that has changed little in 300 years (Hignett, 2012) to a supercharged contemporary design using state of the art materials and manufacturing processes. Through observation, collaboration and external partners' mentorship the group understood that innovation could be introduced in the behavior of the ladder under stressed provoked by the harsh environmental conditions it is normally exposed to ranging from +50 to -40c. Dynaweb rethinks joinery through a generatively designed composite flexible-rigid behavior that allows the ladder to flex and be stored easily. In addition the flexible-rigid ladder is much lighter that the current design. As the group understood the importance of the pilot's perception of solidity, they also designed the ladder visual interpretation through shape and colouration. This was achieved through a collaborative design process including expert ship's pilots, the RNLI and Lloyds Register.

Calm Object Remain Calm for Help (CORCH) developed the architecture of a videogame

as a training class for young adults that the RNLI could use in multiple locations. However, the use of a videogame for safety issue could increase risk as participants become better at the game. This could result in overconfidence and lower their perception of risk. To avoid this condition the group of designers (Linh Pham, Simon Cundall and Jennifer Haugan) introduced random variables in the code, which affect the environmental conditions of the VR game so that each experience is unique. At the end of the game each player gets a score and RNLI approved certificates. Score achievements make the player an ambassador of different grades and in charge of sharing and developing knowledge to virtual and physical communities.

Project Sea Pilot's Assistant (SPA), (Jingyi Wu, Marcus Comaschi, Yu Li and Jen Hsien Chiu) brings social network thinking and new technologies into the maritime sector by producing a pilot version of TripAdvisor. Each pilot using a ladder can report accidents, damage and crew behavior in the app. The availability of real time information in digital format makes pilots boarding the ship at the next port aware of any problems. At a strategic level the app is linked to a modular ladder system to tackle two existing problems: (1) the ship's crew already buys the ladder in parts, (2) there is a lack of knowledge of repairing the crafted old ladder which can't be safely repaired without a level of training. To incentivise the use of the ladder worldwide the group trademarked the modular ladder with the a certified logo. From a strategic design perspective the combination of the app and the modular ladder allows the group to develop an R&D platform based on direct live feedback as a result of collaborative design embedded in the risk environment and using regular industrial expertise and feedback. SPA is a project that understands people's behaviour and the environment they are in by using technology as a shareable and collaborative interface.

Figure 6. The user architecture of SPA

Throughout the Safety Grand Challenge we had the opportunity to test a different collaborative research approach for tackling design for safety on water. This emerged from the evolution of the project. We transformed the constraints of the physical output to motivations and opportunities to find solutions that would work in a real world scenario. Although faced with very tangible real life design safety issues the design teams were not limited to current problems and engaged with the deep knowledge we provided to understand how projects could positively impact stakeholders from different perspectives. Each group looked at future developments in different industries, from business models to multisensorial digital environments, communication and new materials and manufacturing processes. By mixing seminars, workshops, field trips and the literature review we allowed the designers to appreciate the complex nature of the scenarios, which helped to give a good picture of the composition and dynamics of the existing situations. Design is particularly open to failure in the creative phase (Hall *et al* 2016) and this can be an advantage when aiming to bring new thinking to complex design safety challenges. However encouraging failure when tackling design for safety can be seen by some as increasing project risk.

A strong motivation for students was the deep immersion in field trips to the RNLI headquarters where they went out on a lifeboat to get a 'pilot's eye view' of ship boarding,

a visit to the PLA Vessel Traffic Service (VTS) centre in Gravesend Reach and a trip on the River Thames with expert crew who pointed out waterborne safety risks. Everyone learnt by doing, and students achieved confidence and a clear knowledge of the topic. We believe that the practice-based research model developed for the project, has shown to be capable of fuelling a variety of inputs to the diverse groups of people that participated in the research. The strength of the project became the collaboration, which has shown to be effective in allowing diverse multi-disciplinary design teams to engage meaningfully in a complex design challenge and deliver outputs worthy of serious consideration by industry experts (Hall, Ferrarello, Kann, 2017).

Conclusions

In summary we conclude how the collaborative "social platform" we built around the project through design research offered a wide range of parties from academic researchers, student design groups, NGO's industry bodies, maritime agencies and individual experts a space to work together and engage. From the complexity of the existing context made up of a resilient culture of "grandfathering" and cultural challenges of power relationships along with a group of industry experts unfamiliar with design and academic processes, we tackled the problem and made complexity a strength by offering new insights through the collaborative relationship between design and safety. By establishing a common ground between academia and industry, we made design a social platform that enables people of different backgrounds to participate in risk reduction by combining knowledge gained from practice and theory. To enable this model we had to engage as participant researchers and directly collaborate with the organisation, field trips, teaching and building relationships with the partners. We believe that such an approach achieved the engagement aspect of the project the Lloyd's Register Foundation hoped to initiate in exploring the value that design led innovation could bring to safety through a grand challenge format.

From the first meeting, where one industry expert showed hostility to the idea of an 'art college' working on something they believed to work adequately, we managed to blur boundaries and build porosity across different fields (Sennett, 2013) to bring a wide range of views onboard to work with us and the team of students. This was a necessary step to enhance the value that design can bring to risk reduction and safety. Our ambition was to move beyond the existent engineering practice of safety, where strategic planning and risk assessments are structured on the base of scenarios; where risk is viewed as a mechanism made of events; where a group of experts define the risk scenario procedures, and where the user's role is to follow those procedures with a limited form of engagement and understanding. With this project we understood that risk is a very complex and dynamic environment; factors that increase risk are defined by entropic scenarios whose complexities and dynamics shift in real time. We define entropy here taking the second law of thermodynamics that systems tend to complexity and chaos and in the same way that design has a proven success in tackling wicked problems (Rittel & Webber, 1972); we suggest that it can also tackle the entropic scenarios of safety on water. As any entropic phenomena, where all variables present in the same environment have equal probability of configurations by chaotic relationships, risk related variables behave similarly. There is not a hierarchy that runs configuration of risk; all factors involved in risk play the same importance and it's the combination that makes the difference.

By working with partners and students, we understood that safety is achieved by strategically planning prevention over later intervention. We highlight that the combined

collaboration of human factors including both physical and psychological plays a pivotal rule, as human behavior can tackle risks. Behaviour can indeed adapt to environmental conditions and creativity reacts to that potential; hence design plays an important role. Through the students prototypes we demonstrated that by the observation of existing conditions, behaviours, trust, education, awareness and attitudes it is possible to frame risk into a combined physical-psychological design solution. By engaging other design related disciplines - like manufacturing, communication and user experience - the prototypes display design interventions that reduce risks; the final outcomes are not products but demonstration and visualisations of risk that offer solution that think ahead.

In our research design and safety shaped a creative territory that assessed risk under co-responsibility and collaboration. Design is the interface of communication between the parties which enables mutual understanding through creative thinking. It is a dynamic risk mediation process which makes any involved party responsible of action and intervention in the case of danger. Given the unpredictability of risk, which often happen in small time frames through the methodology of this project we understood that being creative and taking responsibility might be the method where design and safety find a common territory. Design for Safety doesn't aim to create another set of rules to observe, it can offer a holistic infrastructure of possibilities or a taxonomy of problems (Dorst, 2017) that maps the issues it aims to solve, thus influencing the direction of an event and preventing future risks. Design for Safety is an approach that mediates entropic situations. It engages the complexity of event rather than simplifying them to a set of reduced factors, specifications or criteria which might not take into account the micro-elements that contribute to increasing the level of risk. There is no single procedure that can comprehensively tackle future risks, however a deeper creative understanding of specific situations might reverse the emergence of new risks and contribute to safer experiences and livelihoods for those enjoying leisure activities and working on seas and rivers around the world.

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