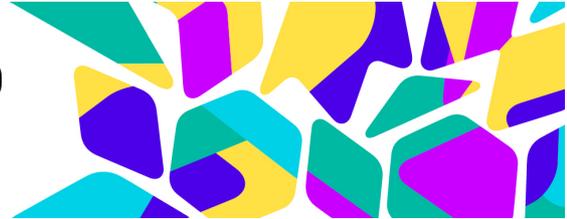




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Designing Cross-Disciplinary Relationships for Improving Safety

Laura Ferrarello^a, Ashley Hall^a, Paul Anderson^a, Rachel Cooper^b, Chris Ross^c

^a Royal College of Art

^b Lancaster University

^c QinetiQ

*Corresponding author e-mail: laura.ferrarello@rca.ac.uk

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Abstract: This paper describes how design research has been deployed to stimulate and facilitate two cross-sector collaborations between industry and academia. Two research projects conducted by the School of Design at the Royal College of Art illustrate how the engagement of more than 200 cross-sector experts fostered the development of a design led strategy to prevent and mitigate future global risks through a new culture of safety. This is a strategy designed upon the synergies of collaboration that value people and their resilient capability of bouncing back through adaptation and creativity. These research projects evidence the need for creative methods that use culture, knowledge and experience as assets to construct a human-centred safety approach. With the ambition to rethink how humanity reconciles the fundamental nature of machines (reliable repetitious function) and people (divergent variable behaviours) these two projects find that people and their behaviour can be the driving intelligence capable of tackling complex future, global, challenges in dynamic situations.

Keywords: Design for Safety, Cultural Collaboration, Global Challenges, Human Intelligence

1. Introduction

Tackling safety is an issue without a uniform viewpoint. As working procedures vary from sector to sector, safety is not consistently legislated and free from failure, as regulatory organisations often report (HSE, 2019). One of the most frequent factors contributing to risk is human error for its variable nature which is difficult to foresee and plan. For this reason people are often considered the weak part of health and safety procedures (e.g. people using mobile phones while driving). However recent strategies including the UNESCO's City Reconstruction and Recovery (CURE) Framework, Henk Ovink's Rebuild by Design or Eric Klinenberg's approach to social spaces revise the role of human behaviour under a different lens, which gives people the agency to tackle complex issues and promote safety. These



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examples demonstrate how people’s culture, knowledge and cross-discipline collaboration can play a strategic role in developing sustainable and resilient strategies to complex issues through creativity and knowledge exchange. To leverage complexity from this particular perspective requires new methods that can reframe procedures as a human intelligence led process. This paper aims to describe how design research can investigate and construct a new method of tackling and mitigating safety with culture and collaboration as its main assets. While the authors previous papers on design for safety deal with the educational, methodological and the design for safety subject, this paper specifically focusses on community culture building and how this research strategy uncovered new opportunities and understanding of design for safety.

1.1 The Lloyd’s Register Foundation Safety Grand Challenge and Design for Safety Foresight Review

In 2016 the Royal College of Art School of Design (RCA) was commissioned by the Lloyd’s Register Foundation (LRF) a Safety Grand Challenge (SGC) to redesign the ladder that ships pilots use on a daily basis to transfer from a pilot vessel to a larger ship to safely navigate in and out of port. The LRF considered this tangible and well defined task a complex and urgent safety challenge which is still the cause of significant fatal accidents in ports around the world (Hall, Ferrarello, Kann, 2017). The SGC was the first grand challenge the Foundation ever launched and the first open investigation on safety through the lens of design research. The project engaged 6 RCA researchers and 38 cross-disciplinary postgraduate students who collaborated with partners from the Royal National Lifeboat Institution (RNLI), Port of London Authority (PLA), International Maritime Pilots’ Association (IMPA), United Kingdom Pilots’ Association (UKMPA) and Confidential Hazards Incident Reporting Programme Confidential Reporting Programme for Aviation and Maritime (CHIRP) to research the development of new solutions that could rethink pilot transfers. Through the combination of action and participatory research – i.e. interviews, field trips, observation, project reviews and workshops - students, researchers, partners, stakeholders and experts exchanged experience and knowledge which took the shape of 7 models and prototypes. These illustrate how collaboration and knowledge exchange between academia and industry can deliver applied and design led approaches to saving lives like, for instance, materials that improve the sturdiness and portability of the pilot ladder (DynaWeb) or a rigging mechanism that globally fosters trust between pilots and ship crews (CLS) (Hall, Ferrarello, Kann, 2017) (Figure 1).

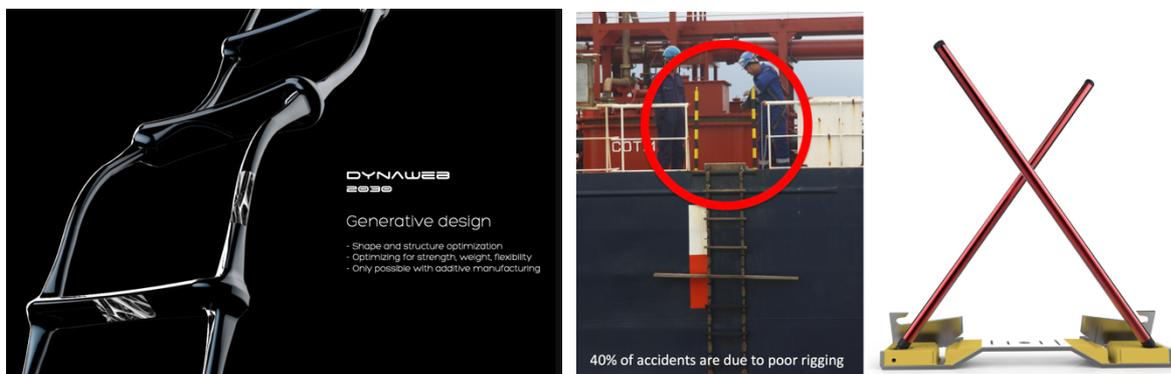


Figure 1 Dynaweb and Cross Lock System (CLS) combined as the Helm Innovation start-up

In this research the role of design was not limited to the development of the solutions but also to the governance of the project (Hall, Ferrarello, *et al*, 2017). The series of activities coordinated by action and participatory research generated a collaborative platform in which academic and industrial knowledge was exchanged, transferred and created through first hand experience. This was supported by the dynamics of these collaborations which generated critical and creative debates (Ferrarello, Hall, *et al* 2017). Design research helped *unsilo* the different kinds of knowledges across partners, stakeholders and experts by constructing an inclusive peer to peer mutual learning process; each participant had agency and voice independently from the expertise, geographical location, age and gender. Through collaboration design research leveraged the industrial partners' motivation to participate in the project, which was improving safety, to foster curiosity and creativity; this helped overcome the initial scepticism and lack of trust in the academic institution. With this strategy the experts' interest and number increased during the course of the project thanks to the proactive behaviour partners and stakeholders demonstrated in promoting and championing the research in affiliated sectors and organizations through different media (e.g. exhibitions and public lectures). For instance, a group of students was invited to participate and were shortlisted in the Seatrade award which is the most influential award in the maritime industry (Seatrade Awards, 2019). Furthermore, part of the SGC network still collaborates through Helm Innovation, which is a start-up founded by two designers participating in the research.

Industry's positive response to the SGC has been built upon the development of the design solutions and prototypes which helped cross-disciplinary experts understand how safety can be tackled by means of creativity. The SGC demonstrates that design can be a strategy to tackle safety as both an applied and strategic approach by governing the dynamics and relationships of its participants (strategy) through the design of products (applied). This defines a different approach to risk and safety which makes the beneficiaries of innovation proactive and creative components of the process.

With the SGC findings indicating how design can foster innovation in the maritime industry the RCA School of Design received a second grant from the LRF to further explore this approach when looking at future risks. The Design for Safety Foresight Review (DSFR) was aimed at researching how design can play a strategic role in tackling global future risks (e.g. flooding, cybersecurity, migration, terrorism etc.) across different sectors. In particular the ambition of the research project was to investigate what role design can play in safety to formulate a strategy that could be shared, adopted and promoted across disciplines and sectors; the knowledge gap the research focussed on was the very concept of design for safety. The literature review outlined a gap for an accepted general principle for deploying design methods and practices towards improving safety between people and machines. As Jasanoff indicates in the "The Ethics of Technology" book a gun is safe up to the time a

human shoots the bullet, or a car can't cause accidents if a human doesn't drive it. (Jasanoff, 2016). Even though literature has recognised the impact that people's perception, behaviour, understanding and exposure to safety have on risk assessment (Johnson et al, 2016; Jasanoff, 2016; Olstedal *et al*, 2004) at the time of the research there were not any examples indicating methods that deploy these wider factors to designing safety. For instance, the NHS funded Helen Hamlyn Design Centre research deploys design to prevent human errors in the medical sector, but this is a specific case study constructed for a specific scenario (Buckle *et al*, 2004).

Hence the DSFR ambition was to develop a cross-industry methodology that could design safety at a global strategic level and use this to develop methods to tackle future risks. Learning from the SGC, the DSFR placed the human at the centre of any safety procedures and issues and used the gap of knowledge found in the literature to initiate research on design for safety with more than 200 industry experts across 6 different sectors (Healthcare Technologies and Services, Consumer Product Technologies and Services, Transportation Technologies and Services, Food Technologies and Services and Manufacturing Technologies and Services) (Anderson, Hall, Ferrarello, 2018). Figure 2 represents how the research project framed risk from a human perspective taking as example a traditional and an IOT kettle; if in the former case the risk of skin burns or electrocution are known and tangible, in the latter one a third party data management is unknown and intangible.

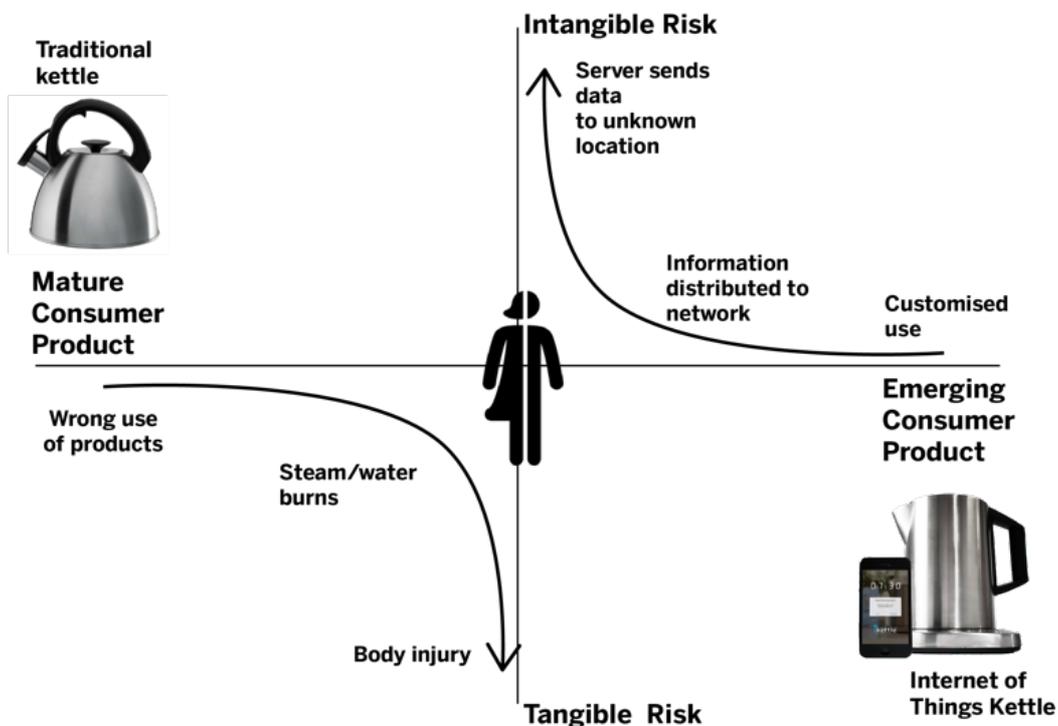


Figure 2. Diagram representing risk from the human perspective and the tangibility/intangibility of risk

By looking at the dynamic nature of human behaviour when interacting with technology the DSFR analysed the impact of these relationships on developing risk situations. This aimed to construct a people oriented strategy for improving design for safety through the collaborative cultural creativity of human experience. The research objective was not to define another procedure or regulation but to explore how the human capital can be strategic to safety and risk prevention and mitigation (Anderson, Hall, Ferrarello, 2018). By stimulating peer to peer learning and knowledge exchange design research co-designed design for safety through the dynamics of interactions between global experts across 6 selected sectors in the mature and emerging industries.

Both the SGC and DSFR research projects created the space and platform to generate synergies of collaboration for designing design for safety. Cross-sector collaboration was key, likewise the dynamics that transformed people into the resilient intelligence and assets to tackle complex problems (Ovink, Boeijenga, 2018).

2. Setting the Scene: Engaging Cultures through Cultures

Current strategies for tackling complex problems like safety often develop procedures aiming at regulating human behaviour. However, cases like the 2017 Grenfell Tower disaster in London outline that safety and risk are dynamic factors where prevention and mitigation struggle with the unpredictable nature of human behaviour in complex dynamic environments. In the Grenfell Tower example the fire was caused by a faulty fridge, however the context of the accident is more complex than an appliance failure. Current investigations evidence that more than 60 companies and bodies and 383 organisations were involved in the refurbishment of the tower (Nadj, 2019). Hearings outline how the series of decisions this network of people took created the conditions where a faulty fridge among other cascading issues caused 72 fatalities. This case and others demonstrate that strategies for tackling complex problems need to take a different approach to human behaviour and the SGC and DFS offer an example on how a designed collaborative culture can leverage change in safety procedures. By designing the dynamics of transferring the experts' knowledge and experience the SGC and the DSFR construct a methodology that uses design as tangible artefact (SGC) and intangible strategy (DSFR) as a means to "unlock" and connect existing cross-sector knowledge. Through culture and engagement the SGC and DSFR gauge different attitudes to safety to foster creativity and transform divisions in synergies. This is achieved by accounting for wider factors not specifically related to the research main goals. For instance, the SGC recognised that partners and stakeholders were not particularly familiar with design research, but shared a clear interest in design as a product (the ladder) which was interpreted as a way to bring innovation to the sector. This clear and familiar objective was the opportunity that developed a different understanding of design and safety which a

series of engagements incrementally constructed by shaping trusted relationships between academics and industry experts. Both projects indeed found that it was not sufficient just to adopt collaboration, but it was necessary to design collaborations acknowledging the experts' assumptions, behaviours and approaches. Hence trust played a key and fundamental role to construct innovation that "unlocks" and possibly reframes unknown knowns and mitigates the risk beneficiaries often perceive when exposed to unsettling scenarios. For this reason innovation in these research projects had to be inclusive, i.e. benefits needed to be acknowledged and accessible to the beneficiaries (Juma, 2016); this was achieved with a designed collaboration which dynamics keep the beneficiaries' perspective to also mitigate the disrupting nature of innovation. For instance the SGC design solutions represent a tangible language that beneficiaries understand. These products guided the experts construct heuristically a different culture of safety which was formed upon the governance and application of design enabling knowledge exchange. Hence the nature of these interactions evolved from designing products to ecosystems where discussion encouraged experts to question the existing culture of the maritime industry through their personal contribution to the products' development. Under these terms the final designs serve an accessible, inclusive and tangible culture to safety (Spencer-Oatey, 2012) as they strategically leverage through creativity the cultural conditions that trigger risk by outlining how roles, mindsets and interactions can affect or improve safety (Meadows, 1999). As cultural artefacts recognised by the maritime community, these design products are able to effectively nudge people's behaviour, values and attitudes towards risk and safety and develop a Syntax of Collaboration (the design of the dynamics of collaboration) that generates those trusted relationships necessary to foster inclusive innovation. The SGC and DSFR modelled this syntax building from Spencer-Oatey onion diagram structuring culture (Spencer-Oatey, 2000) and Hofstede (Dahl, S., 2003) as shown in Figure 3. This diagram guided the researchers' first hand observations of pilot transfers and the analysis of the DSFR discussions on how safety is practiced across sector. Following this a new diagram represented in Figure 4 was generated to display how the insights constructed through the onion diagram guidance have been redeployed as strategy to develop the design solutions. The concentric layers illustrated in Figure 3 and 4 aim to develop a method that (1) shifts the understanding of design, (2) develops knowledge exchange encompassing roles, expertise and experience and (3) parks ownership to enable a shared process of knowledge exchange.

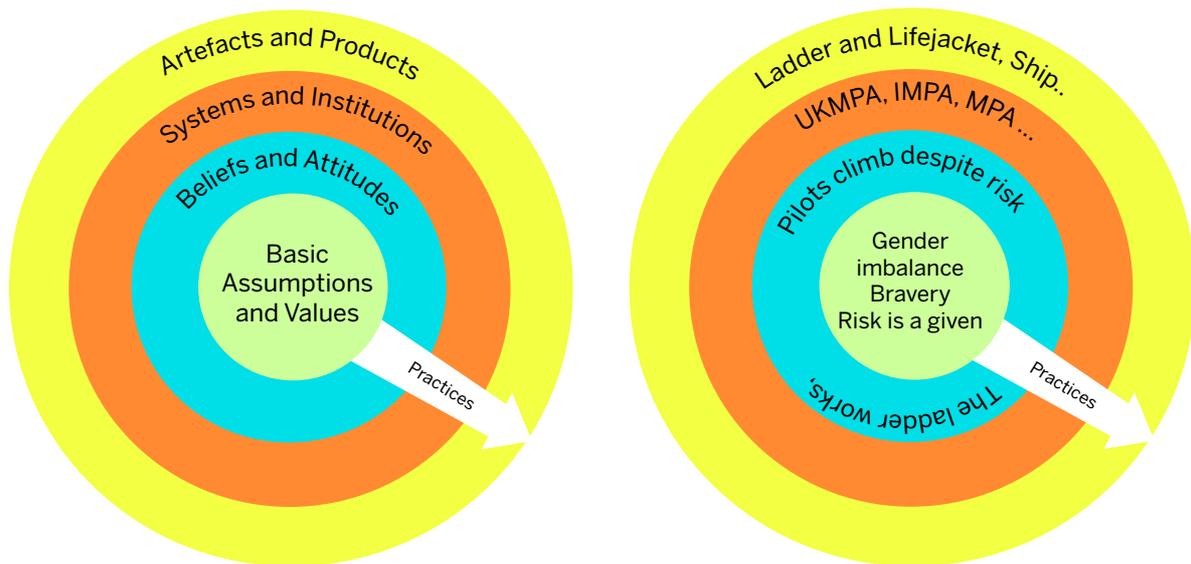


Figure 3 (l) - 4 (r) Spencer-Oatey diagram And its adapted version showing pilots' cultural layers with a safety focus .

The SGC and DSFR Syntax of Collaboration developed upon the Spencer-Oatey onion diagram supported the experts' engagement in the project, their trust, curiosity and motivation. Figure 4 shows some of the aspects the research considered to foster a different approach to safety and risk based on different beliefs, systems, regulations and artefacts. A similar context applies to the DSFR which had to face the plethora of meanings, systems, regulations, behaviours, artefacts, etc, on design and safety across industries and professions. In this case the diagram helped define a method that embraces this fragmented context as foundation of a collaborative approach that transforms the diversity of meanings of design and safety in opportunities that stimulate change. This was pursued by reflecting on the types of relationships innovation creates, identifying who and what supports them, how any involved party learn and exchange knowledge and what kind of governance holds this ecosystem (Juma, 2016). In addition, in the DSFR case the Syntax of Collaboration stimulated personal agency across sectors to nudge change and ensure inclusivity. Within this context design for safety was conceived as a "product", like the SGC models and prototypes, whereas design research as the method generating the Syntax of Collaboration guided by the Spencer-Oatey revised diagram. As illustrated in Figure 5 design - as product, strategy and product - enabled the development of the Syntax of Collaboration via the dynamic dialogue people exchange with their culture (as described by the Spencer-Oatey diagram in Figure 3) through design; this generates new behaviours and cultures and redesigns safety.

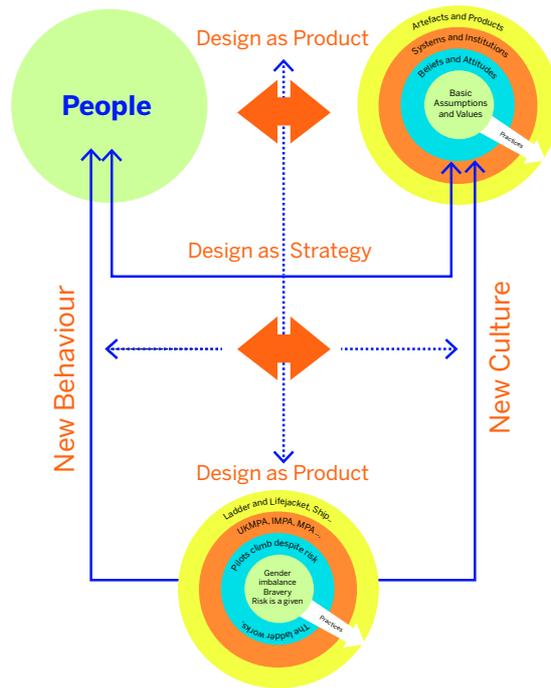


Figure 5. Diagram representing how the Syntax of Collaboration is developed through design to generate inclusive collaboration

The dynamics visualised in Figure 5 led to the development of the Figure 6 matrix which aims at interrogating what role design can play to prevent and mitigate risk when people and technologies between the mature and emerging sector interact. The matrix suggests that design can *unsilo* and reframe existing knowledge to draw strategies able to (1) nudge human behaviour, (2) question who owns safety and (3) holds responsibility.

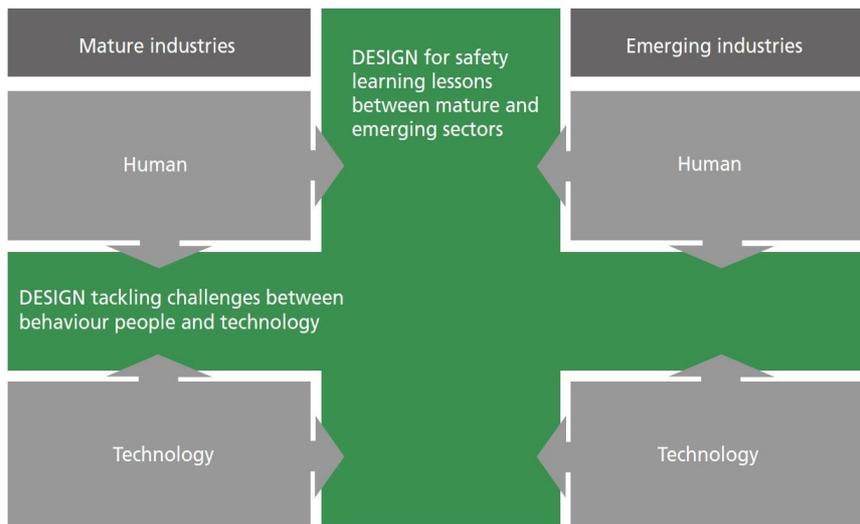


Figure 6. Design for Safety Matrix

Figure 6 reinforces the strategic role culture plays in safety prevention and mitigation for its capability to “speak” to different sectors at an individual and collective level. Nonetheless to

be effective this dialogue needs clear and accessible communication; to generate change the DSFR meaning of design for safety had to be equally acknowledged and understood across sectors. Hence a manifesto of design for safety (quoted below) was developed to overcome fragmentation and ensure clarity in communication between experts of different sectors and academics:

"We believe design for safety enables people and technology to operate safely. Design for safety is the actions taken to ensure that an item, system, system of systems or network is free from adverse impacts on individuals, organisations, communities and the environment, whether these happen as a result of implicit or explicit risks". (Anderson, Hall, Ferrarello, 2018, p.36)

Both the matrix and the manifesto disseminated the DSFR meaning of design for safety through an global online questionnaire and two symposia which the research project deployed to generate of an innovative approach to safety supported by cross-sector collective old and new values.

The DSFR Syntax of Collaboration collides and juxtaposes existing and potential design solutions with legislations and procedures to outline how the complementary nature of these relations can draw a new culture of safety (Juma, 2016). The cross-sector experts exposed to this strategy discussed safety approaches and legislations through artefacts representing safety issues. From a buoyancy equipment to a can of tuna, these cross-sector experts worked in co-design activities to learn from each other and propose a strategic cross-discipline approach to tackle future design for safety issues, like AI or climate change (Figure 7).

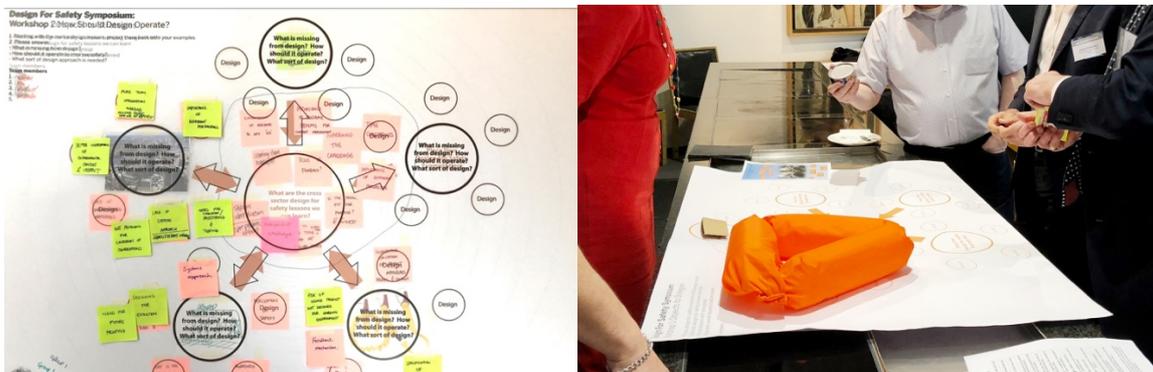


Figure 7. Example of DSFR mapping tools and cross-sectors experts discussing safety through the symposium templates.

4. Tackling Future Challenges through Designing Collaborative Culture

Both the SGC and the DSFR reflect how technology led innovation often increases human risk for failing to understand the nature of human intelligence and behaviour. Trust, accountability, ethics, values, morality and perception are some of the factors that can impact the success and failure of new technologies. The SGC and DSFR address this

particular aspect with the deployment of a syntax of collaborative cultures as human intelligence becomes the asset supporting the transformation of multifaceted complex conditions (e.g. boarding a ship at midnight on an unchanged 300 year old pilot ladder design in -15c temperatures; climbing up 9m on a 3m sea state carrying an armoured laptop with GPS beacons and knowing you only have a limited time window to safely navigate a ship with \$500m cargo into dock with only 3 engine reversals possible) into more desirable and human centred ones.

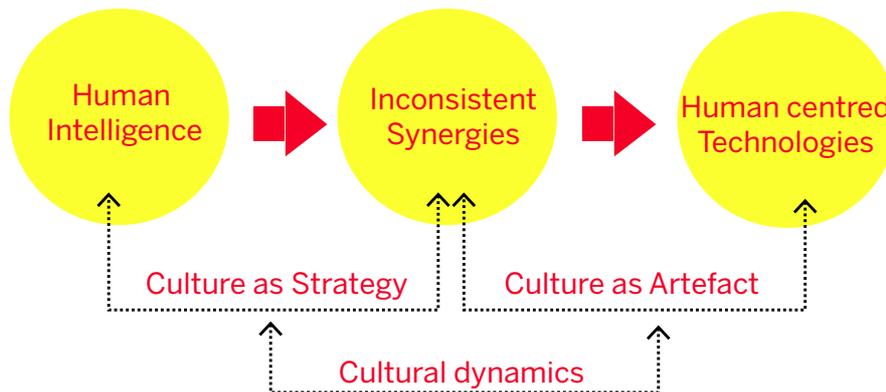


Figure 8. Visualising how the Syntax of Collaboration shaped by culture as artefact and strategy can develop human centred technologies

Figure 8 shows how culture is treated as a two-fold factor with a number of representations that can be both strategic and tangible artefact. The diagram identifies how the ambivalent role of culture of “speaking” to individuals, communities and organisations through values and morals (artefacts) and influencing the decision-making process (strategy) develops a research approach that can nudge behaviour (Spencer-Oatey, 2012). In safety strategies this two-fold and double role opens new opportunities as complex ecosystems of safety emerge from the evaluation of both tangible and intangible factors, both technical and cultural, that seldom operate at the same time. For instance, the decision to climb a ladder at -+ 40C depends on factors which a pilot needs to assess in very short frame of time. Equally the security of processed and unprocessed food depends on decisions varying from cultures to culture that rely on tangible and intangible aspects (e.g. plastic wraps sign uncontaminated food in developing countries and unpackaged food signs fresh products in developed ones) (Jasanoff, 2016). Building and learning from the Spencer-Oatey onion diagram the SGC and DSFR generate an iterated version of this diagram that revises the relationships between the layers to develop change and transformation. Figure 9 displays the new SGC and DSFR Spencer-Oatey model, the spiral diagram. It is no longer a series of concentric circles but a spiral showing how the Syntax of Collaboration generates and guides knowledge exchange which shifts and reframes the experts’ values and assumptions, beliefs and attitudes and institutions and organisations (dotted lines). The “ladder” in the outer circle visualises the change and shift of culture as it is both landing and departing parameter on an old and new culture. The spiral diagram combines the two-folded role of design products in shifting

culture (SGC) and the value of dialogue in stimulating peer learning and knowledge exchange (DSFR) to generate the Syntax of Collaboration that stimulates transformation and change.

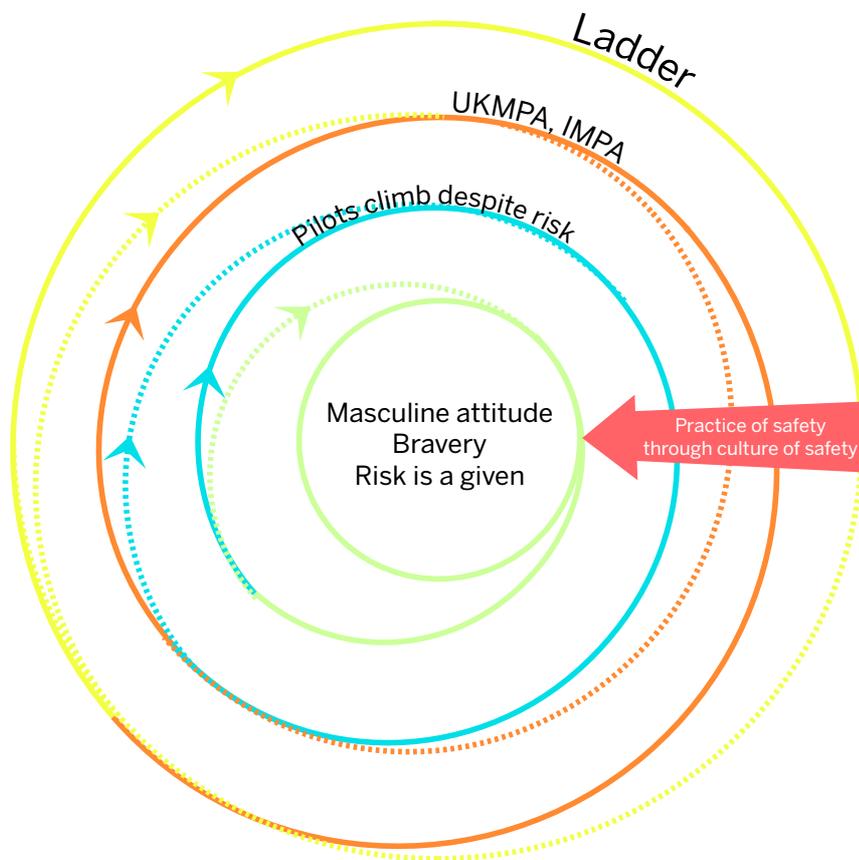


Figure 9. Reframing the Spencer-Oatley diagram to visualise the syntax of collaboration

This model is constructed upon the conditions that (1) risk could be something accepted and (2) social norms, traditional beliefs and rituals generate different perceptions of risk and safety (Garvey, 2008 – Jasanoff, 2016) (continuous lines). Despite these two conditions have been already identified as strategic in the literature, there is no particular indication on the methodology that deploys culture and people as asset. For instance, The Maritime Accident Investigation Branch (MAIB) recommends, but doesn't specify how, to challenge the practice of safety to avoid accidents following one incident in which a crew's bad safety practice caused the death of an overboarded trainee (MAIB, 2017). This is similarly outlined by the Nimrod Review which discusses but does not articulates the key role of personal responsibility (Haddon-Cave, 2009). The SGC and DSFR aim to fill this gap via the Syntax of Collaboration described in Figure 9 that reframes personal and individual morality, perception and rituals through proactive collaboration. This stimulates a heuristic and osmotic dynamic of knowledge exchange that assimilates risk as ingredient. Risk is indeed factored in terms of individual and collective values and habits inherited from norms, traditions and beliefs (Dahl, 2003).

4.1 Designing creative strategies to tackle complex problems

The SGC and DSFR Syntax of Collaboration builds from a literature that evidences successful examples of culture as an asset. Indeed the World Bank Culture and UNESCO's City Reconstruction and Recovery (CURE) Framework, Henk Ovink's Rebuild by Design and Eric Klinenberg research on American social infrastructure evidence that culture can play a positive and key role in complex strategies through collaboration and creativity. The CURE Framework outlines the importance of deploying the cohesive and shared domain of culture in the aftermaths of climatic or human caused disasters (World Bank; UNESCO. 2018); heritage, craft, rituals are indeed key artefacts that can reconstruct the social strati of shredded communities. Henk Ovink and Eric Klinenberg position the role of culture under the terms of knowledge and experience and point out that people of different backgrounds, expertise (and cultures) can design safer and resilient environments to climate and violence. In details Klinenberg points out that places for socialisation, like libraries and public spaces, can prevent violence and social isolation and support both the individual and collective sense of responsibility (Klinenberg, 2018). Henk Ovink's Rebuild by Design was founded to tackle the aftermath of Hurricane Sandy in 2012 with the intent to develop sustainable, creative, climate change resilient and implementable strategies for the city of New York. Through an architectural competition, that invited architects and engineers to collaborate with those local communities directly affected by the Hurricane, resilient strategies to climate change emerged from the dynamics of collaboration between local communities, cross-discipline experts and the government who altogether co-designed new strategies built on local knowledge (Ovink, Boeijenga, 2018). Under these terms the competition was a *cultural strategy* which deployed an inclusive approach to reconstruction through *cultural artefacts* (the architectural projects). "*Too big*" (Ovink, Boeijenga, 2018) problems, like climate change, have been tackled with culture as strategy and artefact to interface different kinds of people and expertise rather than an isolated group of experts (Ovink, Boeijenga, 2018). Altogether these three examples articulate how human led Syntaxes of Collaboration can design a space that includes/engages with individual and collective identities through membership and sense of belonging. This makes beneficiaries part of the innovation process (Juma, 2016), stimulates resilience by helping individuals cope with the uncertainty of the future and generates an inclusive change.

4.2 The Syntax of Collaboration Human Centred Innovation

The SGC and the DSFR are two projects that look at existing safety issues with a future oriented mindset aiming to design a strategy that activates human intelligence across expertise, culture and gender (Hall, Ferrarello, *et al*, 2019). Figure 10 illustrates the different kinds of synergies of collaboration, represented by the red lines, that offer both tangible and intangible infrastructures to navigate unknown future territories. The iterative process represented in the figure displays a system in which the continuous dialogue across disciplines and sectors, whether in the form of procedures or mindsets, can design a human centred future-oriented safety culture.

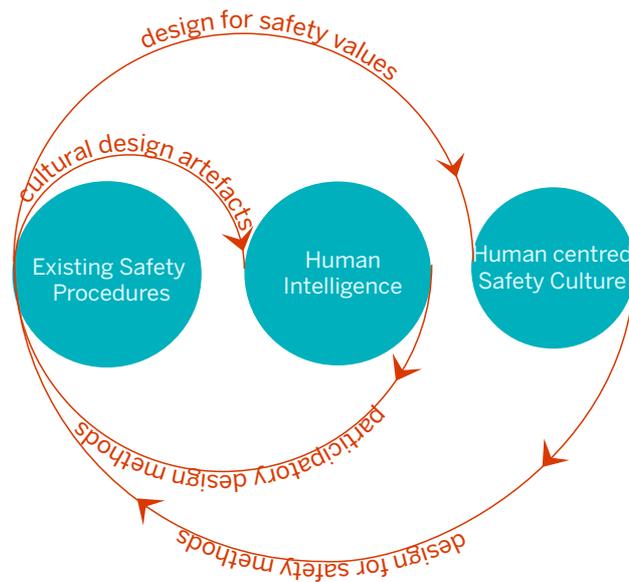


Figure 10 Diagrams showing how the syntax of collaboration develops new knowledge

Being human centred means being inclusive; under this framework innovation is outcome of trusted human collaboration exploring unsettling and/or risky territories. Through the narrative constructed by design beneficiaries of innovation are able to articulate heuristically new knowledge which is then perceived as an enhancement of existing knowledge (Juma, 2016). This approach, product of the SGC and DSFR methodologies (Hall, Ferrarello, Anderson, Cooper, Ross 2019) combined together, outlines how a group of people cohesive in its diversity and united towards a common goal can generate change in safety. This inconsistency stimulates an inclusive Syntax of Collaboration designing design for safety.

Despite the DSFR didn't have the opportunity to test its principles and recommendations, at the present these still resonate across its participants at different levels, from shifted mindsets to new principles of funding. The SGC created the conditions to fund a new business, Helm Innovation, which to date is still collaborating with part of the network the SGC designed.

4. Conclusions

The SGC and DSFR research projects have described how design research can leverage inclusive dynamics of innovation between academia and industry to develop a new culture of safety. With one project looking at the redesign of the pilot's ladder and develop prototypes that increase safety along the river Thames by 2030 (SGC) and another one that focused on investigating a strategic approach for tackling major future global risks (DSFR), these projects gave an example of how to deploy culture and people as asset to tackle complex future challenges. Through a process that aimed at generating and deploying creativity to reframe and enhance existing knowledge that develops a new understanding of risk, these projects formulated modalities of change and transformation which gave agency

and engaged those required to change. This has been achieved by interrogating, challenging and reframing existing knowledge, experience and insights through designing cultural artefacts that design and promote the ecosystems of change. By deploying the inconsistency and variety of safety procedures the SGC and DSFR make the beneficiaries' culture (and their perspective) asset that supports change. The spiral diagram revisiting the Spencer-Oatey model describes the Syntax of Collaboration and how risk and complexity can be encoded in safety procedures through heuristic and inclusive creativity. The transformational events experts experienced during the course of the research projects mobilised their knowledge towards an innovation that mitigates unknown and future risks through the collective and individual governance of culture. In conclusion the SGC and DSFR research projects identify possible strategies through which design research can support the exploration of unknown and unexplored (and future) territories and challenges through the inconsistent synergies that enable participants construct a kind of knowledge that transcends sectors and disciplines. The culture these projects use to tackle safety is not merely the individual knowledge acquired through experience but also the capability to listen, dialogue and share failures. Under these terms the SGC and DSFR Syntax of Collaboration becomes an epistemological approach to safety for the guidance it offers to knowledge development through the synergetic and unbalanced exchange of existing skills, experience and practices.

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About the Authors:

Laura Ferrarello is the Head of Programme and Design Pathway Leader of the Royal College of Art MRes Programme. Her research explores interdisciplinary collaborative methodologies that foster inclusive and accessible innovation through culture and technology. Focus areas include ethics, safety and future of work.

Ashley Hall is Professor of Design Innovation at the Royal College of Art in London. His research is on innovation methods in design thinking, design for safety, experimental design, design pedagogy, globalisation design and cultural transfer.

Paul Anderson is Dean of the School of Design at the Royal College of Art. Professor Anderson has extensive experience in higher education at an executive leadership level and an international profile in leading-edge research into 3D interfaces, haptics, 3D sound amongst others.

Rachel Cooper is Professor of Design Management and Policy at the University of Lancaster and Director of ImaginationLancaster (a design led research lab, researching products, places and systems for the future). Professor Cooper's research covers: design thinking; design management; design policy; across all sectors of industry.

Chris Ross is a Naval Architect with over forty years of experience in the specification, design, building and safe operation of ships worldwide. He currently works as the Chief Engineer for maritime consultancy at QinetiQ in the UK