

Impactful by Design:
Exploring
A New Product Development (NPD)
Framework for
Socially Responsible Technology

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Young Eun Cho-Imkampe

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ABSTRACT

Impactful by Design: Exploring a New Product Development Framework for Socially Responsible Technology

Researchers observed that digital products and services, such as social networking sites and online and mobile games, play a role in enticing users in ways that ensure increases in revenue of their providers. At the same time, with the advent of several disruptive new technology products in the not-so-distant future, including artificial intelligence-powered robots, drones and virtual reality, the boundary of ethically acceptable practices for the society by the technology companies is becoming an increasing topic of concern. Recent evidences show that technology companies and public organisations often find themselves in disagreement about what innovative features should be rolled out.

This practice-based MPhil thesis explores the potential of integrating a social stakeholder into a cross-functional New Product Development (NPD) team that comprises stakeholders in viability, feasibility, desirability and social responsibility. The public adoption and the commercial potential of the project outcome shows that the proposed NPD framework would be useful for the production of socially responsible technology products. In order to inform the technology and design communities as well as public services, the research looks at participants' gains raised by mutual exchanges of the participating stakeholders as well as identifying building blocks for the successful execution of such an NPD practice. These are: managing uncertainties, knowledge-brokering, managing conflicts of interests, locating knowledge and talent and raising awareness of digital technologies.

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Author's Declaration

During the period of registered study in which this thesis was prepared the author has not been registered for any other academic award or qualification. The material included in this thesis has not been submitted wholly or in part for any academic award or qualification other than that for which it is now submitted.

Young Eun Cho-Imkampe

5 May 2017

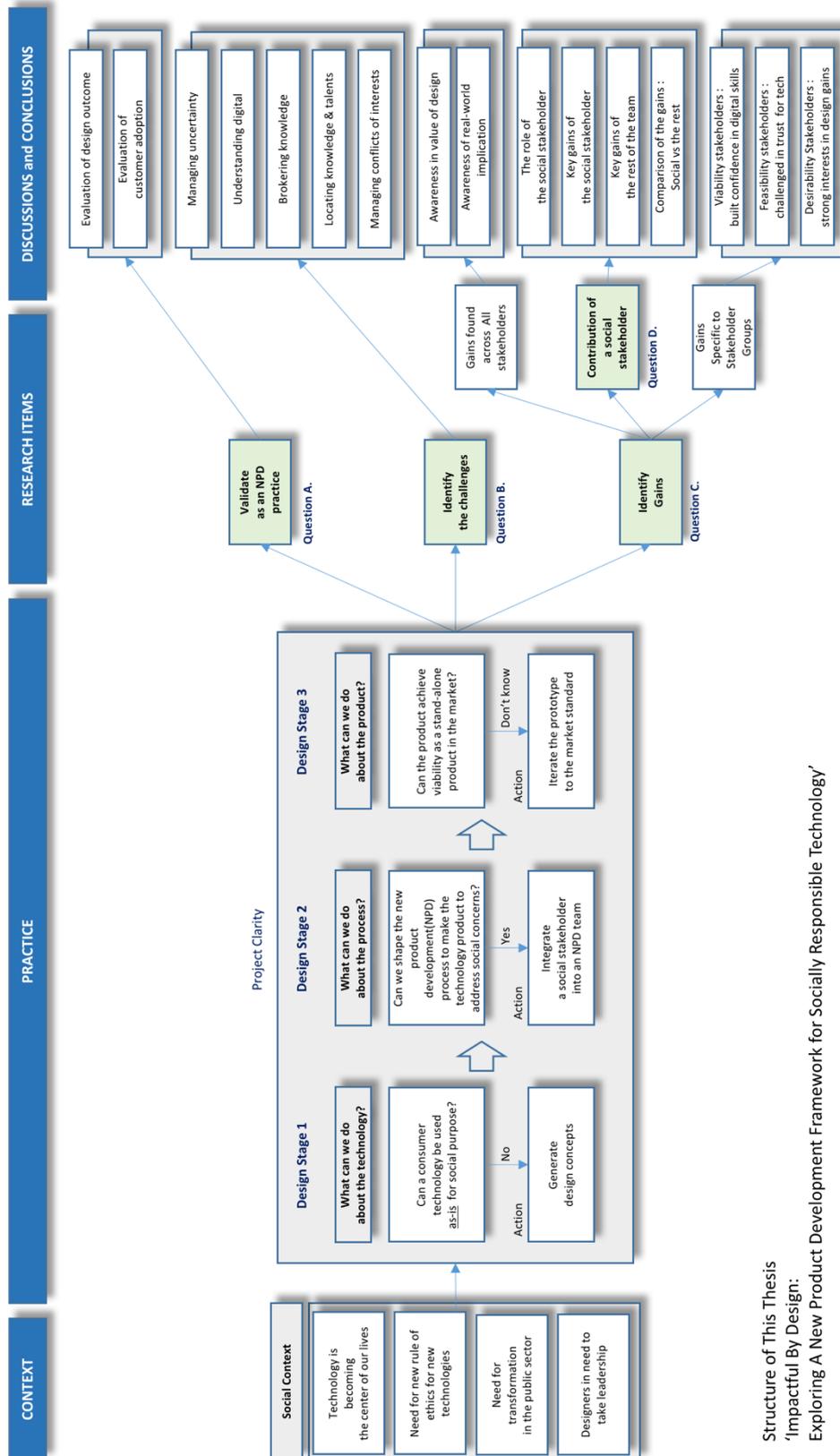


Figure 1. The Structure of This MPhil Thesis

CHAPTER 1: CONTEXT

1.1 A New Product Development Framework for Socially Responsible Technology

1.1.1 Why We Need To Consider Social Responsibility For Technology Innovation

An improved standard of living in many parts of the world has led to economic changes, including shifts in industries which impact people's lives.

For instance, focus on national infrastructure, such as roads, electricity and water and consumer goods as clothing and food, is giving way to growing concern with digital infrastructure, such as broadband, mobile phones (Schwab, 2016).

The culture of design and its values in society is diffused through not only tangible but also intangible products, such as digital devices and experiences (Jain, 2001). Digital experiences are, arguably, making the biggest impact on the western society today (World Economic Forum, 2016), and now at the centre of consumer lives.

Research has shown that digital products and services, such as social networking sites and online and mobile games, can play a role in captivating users in ways that ensure ongoing increases in revenues (Fogg, 2003, p.183-210). While it is clear that digital service providers are making efforts to maximise time spent by users which, in turn, would enhance their advertising opportunities, or grow the conversion ratio from non-paid to paid, few technology experience providers seem committed to helping the users make informed decisions about their

services, rather than to encourage them to spend more time or money on them (Harris, 2016).

As a result, following an initial period of unbridled belief that digital products would offer great solutions to many if not all social problems by connecting people together, there is an increasing awareness that digital products could themselves be causing social and mental health issues (American Psychiatric Association, 2013; Griffiths, 2015).

Emerging new studies argue that digital products and services create a variety of social and mental health issues among vulnerable populations, such as some groups of young people. Uncontrolled digital interactions with smartphones and tablet devices are reportedly disrupting young children's social and emotional growth (Reid Chassiakos, 2016). Other studies also indicate that social media is used as a tool for online bullying amongst schoolchildren (World Health Organisation, 2016). Games on mobile phones provide instant gratification, making them addictive (Chen.C. and Leung.L., 2015). Studies suggesting that is of particular concern with vulnerable people, such as people who suffer from loneliness or depression. Researchers have argued this addiction is more detrimental than that of substance-based drugs (Griffiths, 1995; New York Times, 2017). Other researchers observed children who have been addicted to the instant gratification that digital games deliver, found it hard to go through a day of doing hard work later in life, which increases the likelihood for them being jobless and spending time playing on-line games at home instead (Avent, 2017).

Facebook reached two billion monthly active users in the fourth quarter of 2016, with two thirds of them using it daily (Facebook, 2017). If one out of six people in the whole world engages in a particular technology product every day, it would be reasonable to expect the technology provider to be keen to address public concerns about their product development process.

It is not completely unheard of that consumer technology providers take social responsibility into consideration. However, such moves are often driven by external pressures delivered by regulatory organisations involved with standardisation or consumer protection.

For example, in June 2009, many of the world's largest mobile phone manufacturers signed a European Commission-sponsored memorandum of understanding (MoU), agreeing to make most of their new mobile phones marketed in the European Union compatible with a standard charger (European Commission, 2009). The objective here was to harmonise mobile phone chargers for significant economic and environmental benefits. With this initiative, consumers were finally free from the need to buy a new charger with every new mobile phone.

While more efforts may be being made for sustainability and environmental concerns, the advent of several disruptive new technology products in the not-so-distant future, such as artificial intelligence-powered robots, drones, virtual reality, will make the boundaries between what is legal, and what is right for a technology company to do a topic of concern.

As a matter of fact, technology companies and public organisations often find themselves in disagreement over innovative features, as shown in the legal cases illustrated between State of California and Uber. Uber ran driverless car trials within the state of California without a test permit, which the state regulators require firms from carrying out driverless car trials. While Uber stated that their trials were within the legal limit as the driver was present, the Californian regulators did not agree and revoked Uber's registrations. As Izabella Kaminska, a journalist at Financial Times observed.

“The spat between Uber and California regulators over permissions for the ride-hailing company’s autonomous vehicle fleet has exposed the degree to which information technologists believe that the world can be treated as a Petri dish for their experimentation. Innovation comes first, on this view. Unintended side-effects can be dealt with later.”

- Kaminska,I., 4 Jan 2017 Financial Times -

This example illustrates the new questions of ethics arise when technological innovation reach beyond the boundaries of previous ethical systems.

If a mobile game becomes so captivating for the teenagers to such a degree that teenagers spend more time on mobile games than getting drugs, and the teenagers spend all their money and time, lose educational opportunities to pursue education and social skills, should the product come with a warning, like those of new cigarette packs?

With such difficult questions arising in the society around new technology, those questions are not being fully addressed in the technology organisations when developing new products. According to a former ethicist at Google, questions that might lead to the reduced time spent per user are avoided or being given low priority (Harris.T., quoted by RECODE, 2017) for its correlation with increased advertising revenue.

However, this particular question about addictive mobile games may become a particularly resonating reality in the next few years with virtual reality technology products.

Not only the users’ mental well-being is at risk due to the evasiveness of digital products manufacturers, but new technologies on the consumers’ horizon brings

light to the necessity of a public consensus on how the product should be conceived.

If a drone is being developed to address humanitarian concerns such as delivering aid to warzones or remote islands, is it acceptable for the regulators to permit their trials, when there is cause for concern for the same drones to be misused and cause collisions with airplanes?

If an artificially intelligent robot companion is developed to address the health needs of the elderly people at a disruptively lower cost than hiring carers, should the society encourage such development to take over to get rid of the jobs of human carers? Which of them can better address the loneliness issue and need for companionship? Should we encourage the development of the robot to address those concerns that were previously only addressable by real people, which might lead to a complete redundancy of human carers one day? Will such a move make the care by real people a luxury that people without means cannot afford? Or will it make the interactions with the robots so real to the extent that care provided by real people will become altogether obsolete?

Porter and Kramer listed up in the value chain (2006, p.5) presenting opportunities for a corporate to address social responsibility more proactively. Their list did not specify how product attributes could also address this, even though the product is at the centre of a company's activities. Corporate Shared Value is a concept addressed by the same authors in 2011, which touches upon new opportunities for corporates to become a market leader by taking initiatives in public concerns, as illustrated in Toyota's hybrid cars (Porter and Kramer, 2011). However, a 'Shared Value' would align with maximised profit opportunity only when the value is widely known to the public. For example, Toyota Prius became successful in the market as the public awareness on the effect of greenhouse gas emission has been raised sufficiently by that time.

Lack of public's being aware of consequences does not mean the corporate is exempt from its responsibility to explore its product's consequences to the public and give the public an opportunity to make an informed decision, as historically shown in the tobacco litigations worldwide (Daynard et al. 2000).

Unless it's a non-profit organisation, a corporate is a going concern that is always driven by profit. But the sheer scale of the impact on the global population's daily lives by the consumer-facing global technology companies such as Facebook, Google, Apple or Samsung, and growing new players such as Tesla, Uber, DJI mandates them to explore ethically conscious practices and socially beneficial purposes for their product itself as an obligation to the society, not only to fulfil their corporate citizenship by peripheral Corporate Social Responsibility(CSR) activities.

It is significant noting there have been no academic studies investigating on how we could systematically integrate the public's input on ethical concerns and social purposes at the product development stage for technology products.

In this regard, this MPhil thesis identifies a research opportunity on looking at the new product development stage for technology companies as a point of entry for their social responsibility.

1.1.2 We Need New Product Development Framework For Socially Responsible Technology Innovation

By July 2016 Pokémon Go, developed by Niantic Labs, a subsidiary of Google, had become the highest revenue-generating app in history of the Apple App Store in just 14 hours. At one point, people spent more time playing Pokémon Go than being on the number one technology provider platform, Facebook (Business Insider, 2017).



Figure 2. Pokémon Go by Niantic Labs, image courtesy of Niantic Labs

Pokémon Go was a success story of 3 factors that are critical to any technology products' success, feasibility, viability, and desirability.

First of all, the combination of feasibility and desirability Pokémon Go has successfully put together aligns well with the model proposed by Verganti, who describes a sweet spot where technology and design meets. (Verganti, 2009, p.61).

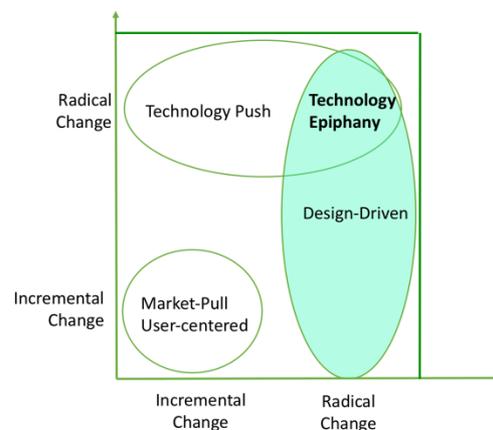


Figure 3. Technology Epiphanies, by Verganti

Niantic Labs has found a usecase of an emerging but underused technology, such as augmented reality, with layers of images onto a camera's viewfinder, in a form of a location-based services(LBS). In addition, It has made the game became very desirable to many, through partnership with a famous character brand Pokémon. Through the viewfinder, the monster characters of Pokémon a legendary cartoon brand from Nintendo in the 80s and 90s, which invokes nostalgic sentiment for

many of game users today in their 30s who played Nintendo, as well as attract young users in their 10s and 20s.

With the in-app purchasing feature enabling the users to buy strengths and other characters, Niantic Labs made an engaging game into a seriously viable business, demonstrated in the fact that it had become the highest-ever grossing app in the App Store.

As in the case of the NPD team at Niantic Labs, it would be critical for an NPD team working in a technology firm today to meet the three criteria – feasibility, viability and desirability - successfully.

The three criteria are explained by Brown (2009), as following:

- (1.) Feasibility (what is functionally possible within the foreseeable future);
- (2.) Viability (what is likely to become part of a sustainable business model);
- (3.) Desirability (what makes sense to people and for people).

Being able to do so would require diverse competences not only in R&D but also in marketing, sales and design. Cross-functional integration of an NPD team is considered as one of the key success factors for product performance (Gemser and Leenders, 2011; McDonough, 2000; Nakata & Im, 2010; Troy, Hirunyawipada & Paswan, 2008; Leenders & Wierenga, 2008), particularly for technology providers (Jassawalla & Sashittal, 1998). Most recently, cross-functional integration of finance into the NPD team has been researched by Hempelmann and Engelen (2015).

However, the three criteria don't seem to be enough for the product to address more public & social concerns, even with goodwill from the team who creates it, as shown in the following *Verge* interview. The interview with a mobile game designer at Niantic Labs paints a vivid picture of how the world's most popular

digital products are made, illustrating that social responsibility is not at the heart of the new product development process.

As Denis Hwang, a designer behind the popular game observes:

“We’re sort of trying to paint an optimistic future, where technology is really bringing people together, not like you’re strapping a screen in a dark place to your face, where every interaction becomes through a camera . . . it saddens me a little bit when I see a lot of people hunched over outside . . . my memory’s a little fuzzy because our whole team was so sleep-deprived around launch time (2016).”

What the interview above indicates is that while the designer and his team were clearly motivated to change lifestyles through digital interaction, they did not manage to achieve this goal while successfully achieving other goals, such as high revenue generation and the time-to-market.

The pressure for time-to-market could provide another explanation for why it is so challenging for technology companies to encourage diversity, as a cohesive rather than a diverse team is known to be more productive. It is difficult for a highly diverse cross-functional team to also be cohesive (Sivasubramaniam et al, 2012). Such sentiment is echoed by a technologist in Silicon Valley, who is calling for designers to be engineers as well (Maeda, 2017).

A certain extent of functional diversity, however, is considered a must.

Businesses around the world have become aware of their needs to meet the sustainability related challenges and many have responded by changing their business activities in turn. This includes how they do their purchasing, product development, marketing and corporate strategy (Sharma, 2000; Pujari, D., Wright, G., Peattie, K., 2003; Aragon-Correa & Sharma, 2003; Menon & Menon,

1997; Drumwright, 1994).

A few technology businesses, however, seem to address the ethical concern more systematically, by engaging more with the stakeholders of public interest in order to incorporate the social and ethical concerns into new product development processes more effectively. Moreover, there have not been studies carried out to investigate the potential of a stakeholder who advocates for such values as part of the NPD process, with the exception of one study which was carried out to examine the role of integrating an environmental specialist into sustainable new product development (SNPD) (Genç & di Benedetto, 2015).

This thesis looks into the potential of integrating a social stakeholder into an NPD process for developing technology products. While not necessarily radically different to a conventional NPD, this approach aims to more actively engage social and ethical concerns in addition to the other factors required for market success of a consumer technology product.

Due to the open-ended approach it took, this thesis did not define the form of its practice outcome to be a particular physical product or a service. Terminologies such as, 'products', 'services' and 'offerings' were used interchangeably to describe an experience provided by both products and services.

While this research largely benefitted from referencing to the body of literature built by the well-established discipline of New Product Development(NPD), it is worth mentioning that many of innovative technology offerings today come in the form of services, and that there is a young, growing innovation discipline termed 'New Service Development(NSD)' which effectively addresses service creation processes with specific focus on experiences and intangible benefits (Carr et al., 2009; Han. Q., 2009; Kimbell and Seidel, 2009; Morelli, 2002).

New Context For Technology To be Socially Responsible

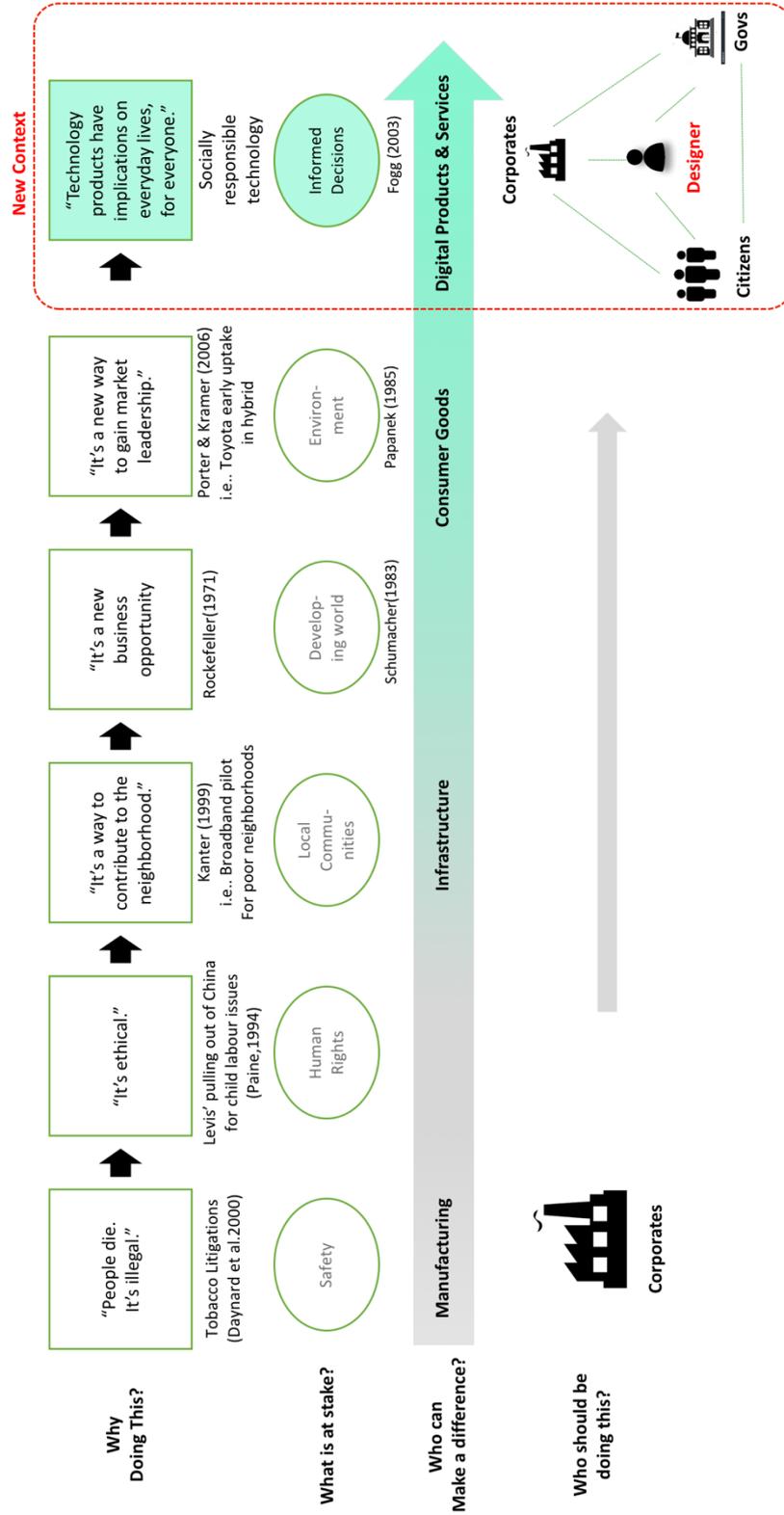


Figure 4. Time For Technology To be Socially Responsible, Illustration By The Design Researcher

1.2 Why the Society Will Benefit

1.2.1 Urgent Need for Transformation

The pace of change across society implies greater complexities of social needs. Nesta, an innovation charity in UK, argue that due to long-term economic challenges and public spending cuts, exacerbated by an aging population, a higher number of people experience chronic health problems (2009). The result is that public services are simply at the crossroads of either transforming themselves or having to discontinue a part of their services offered, as the demand and the capacity to supply becomes increasingly out of balance. As discontinuing provision would not be a best case scenario, it is clear that public services need to embrace transformation in both their nature and how they are delivered. Technology will clearly play an important role in this, but so will new models of provision.

Expectations of the quality of public services are rising as the public experiences digital services and products in the private sectors that change at breakneck speed. The department of Government Digital Services, effectively the UK government's in-house digital agency, and its Gov.uk website strongly exemplify a successful digital transformation in public services.

1.2.2 Achieving the Necessary Scale

Technology, especially digital technologies, remove barriers to time and place. An experience can be easily replicable by virtual reality technologies and messages can be simultaneously communicated by online platforms. With the development of new sensors and artificial intelligence algorithms, there is a room for improving public health services and public front communications on a nationwide scale.

A few others called for new design initiatives in public services and policy domain (Brown, 2009; Steinberg, 2013; Junginger, 2014). However, such initiatives are limited in achieving the necessary scale to make an impact on the public without the aid of digital technology.

Reports by the European Union on digital social innovation make a strong case for technology and digital innovation at the center of new social movements for change in the public sector and that digital technology is the tool to make the scale of change possible (2014, p. 40-50).

It is noteworthy that most big consumer technology manufacturers, both the software and service providers and governments share an audience at a very similar scale, both addressing the mass public, and so covering a very wide range of age, income brackets, and all sexual orientations. From the perspective of public services, governments addressing the same audience as technology companies such as Facebook, Twitter, Google or Samsung means their own target audience is already being influenced by the experience of technology provided by such entities. Whatever happens in the industry of consumer technology has a direct impact on or for the citizens. In this regard, being engaged in the NPD process would be a logical step for the social stakeholders, including public services.

1.3 Designers Must and Can Play a Leading Role

1.3.1 Design is the Logical Next Step

Traditionally and presently the public sector tends to engage strategic consultants, often institutions such as the large professional services firms: Accenture, EY, Deloitte and IBM. However, great strategic advice would not be complete without great execution, with the input from professional designers. This view is backed by many public sector leaders (Design Commission Report, 2012 p.13) who observe that ‘redesigning services to meet users’ needs in a different way’ was most likely lead to significant improvements.

It is also becoming evident to the large professional services firm themselves, as they acquired design companies; Accenture acquired Fjord; EY acquired Seren; and IBM and Deloitte have been hiring designers to build their in-house design capability.

Social entrepreneur Hilary Cottam suggests a new role of design and why it must engage socially (2009). This is not only because it aligns with the designer’s skillset, but also because the public and policy sector must start to think like designers, putting themselves in the context of the user, according to Manzini and Statzowski (2013, p.1-27).

Putting themselves in the context of the user, also known as empathy, is something designers care about. The Design Commission report ‘Restarting Britain 2: Design & Public Services list five activities that could be led by designers. (Design Commission, 2012, p.1):

- Retain the user-centered focus;
- Give a structure for being creative about problem-solving;

- Test iterations of possible solutions in order to learn more about the problem;
- Identify new, more relevant ideas and services and steward them through delivery; and
- Engage users (citizens and employees) in the design of change.

This empathetic framework is particularly applicable to the recent social, political and economic developments of society, notably the rising tensions among different pockets of people in the society. Evidence of this includes the deep disparities of understanding among different segments of society illustrated throughout the process of the Leave referendum vote in the UK Brexit referendum and the 2016 presidential election in the US. Successfully engaging with the public at a mass scale in terms of communication of messages and understanding the public concerns is a top priority for the governments.

1.3.2 Designer's Leadership Is Necessary for Change

Designer has always been a profession with many challenges. These start from getting the project, making enough profit after the estimated cost, satisfying different stakeholders, protecting the design, keeping the production cost low (Dreyfuss,1955). But above all, the designer needs vision, an understanding of what direction society is moving in, and the drive to lead the client in this direction. If the designer lacks any one of such qualities, he/she would risk being called short-sighted.

An article by *Dezeen* illustrates how even a world-class studio like Heatherwick's is not exempt from such challenges.

The Thomas Heatherwick-designed double-decker buses will no longer be produced for London Routemaster buses – a major election pledge of previous mayor Boris Johnson – were designed by London-based

Heatherwick as an update of one the city’s most iconic old transport designs. New mayor Sadiq Khan first suggested his plan to discontinue the buses during his own election campaign, as a cost-saving measure to help pay for a four-year freeze on fares. The decision has now been confirmed in the Transport for London business plan for 2017.

According to the report, no new Routemaster buses will be purchased for London, and the funds will instead go towards upgrading the city's existing fleet with the latest sustainable technologies . . . According to the Guardian, the first 600 buses purchased in 2012 by Johnson cost £354,000 each, while the next 200 bought in 2014 cost £325,000 each.

(.)

The design later came under scrutiny when passengers started complaining about the high temperatures on board. But it emerged that Heatherwick had originally wanted to include natural ventilation – and TfL responded by adding opening windows. Transport for London(TfL) had also recently purchased a new fleet of buses that take their cues from Heatherwick's version – although the designer had nothing to do with them. Alexander Dennis' new Enviro400H City Bus was being rolled out on the 78 route at the end of last year. (Frearson, 2017)



Figure 5. London’s Routemaster bus designed by Heatherwick Studio

What does this incident reveal about the problem of design practices today?

The truth might be, that Heatherwick is not alone. Behind every shiny launch of success stories, there are as many stories untold - like the discontinued Routemaster design by Heatherwick studio.

Here is the design-researcher's analysis of what might have been the main causes in the misfortune of the iconic London bus project.

- Lack of long term strategic alignment (Switching to emission goal - lack of leadership from the designer side encouraging the client toward bigger sustainability).
- Lack of understanding in business feasibility (production cost too high) and overly focused on the aesthetics (curved glass).
- Disproportionate influence of one decision maker (the ex-Mayor Johnson's preference for hop on-off deck) rather than collaborative prioritisation based on rigorous analysis of all true stakeholders (citizens, drivers, TfL).
- Lack of ability to protect the design (TfL owns the design & produces similar design with another design firm).
- Clients' influences doing disservice to the user interests (TfL's rejection to install ventilation window on the top, despite Heatherwick's original design included this).

The common understanding of the design profession is that designer is a taste master for the public (Woods, 2011). But as the Heatherwick's Routemaster story suggests, designers also have challenges to stay relevant to the customers, and being a taste leader would be just one of the goals, with new goals moving toward speculating what the society would need in the long-term.

The designer's social responsibility was pointed out by Papanek (1985) during a time when industrial designers were most often considered as taste leaders at best, creators of non-existing consumer needs at worst. Thanks to Papanek's vision, public organisations such as the UN, and corporates and designers opened their eyes to sustainability and what has now become known as the circular economy, epitomized in books such as 'Cradle to Cradle' (McDonough & Braungart, 2002). The need for socially responsible design is increasingly gaining awareness within the design community, with more systematic approaches. (Melles, de Vere & Misic, 2011).

What Papanek also argued for which was not pursued by the design community as a movement that was as prominent as the circular economy, was the designer's need to lead technology with a social purpose in mind. The most advanced version of technology is not always necessary to make an impact (Schumacher, 1983, p.143-160). One example of this was Papanek's development of a tin can radio, which didn't need batteries and was only one directional; with this object he served the public in emerging countries better than any other radios equipped with the latest technologies (1985, p. 224–225).

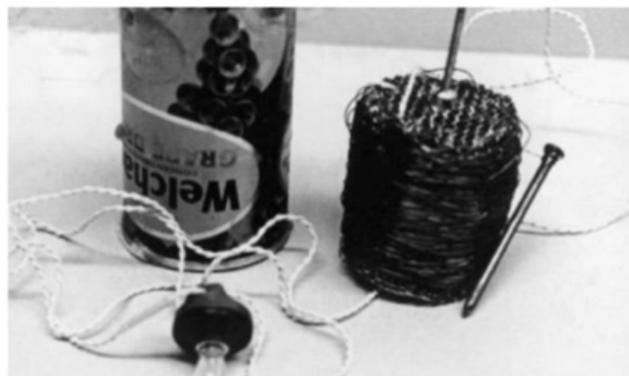


Figure 6. Tin can radio for developing world, designed with a student by Papanek

Designer's Roles

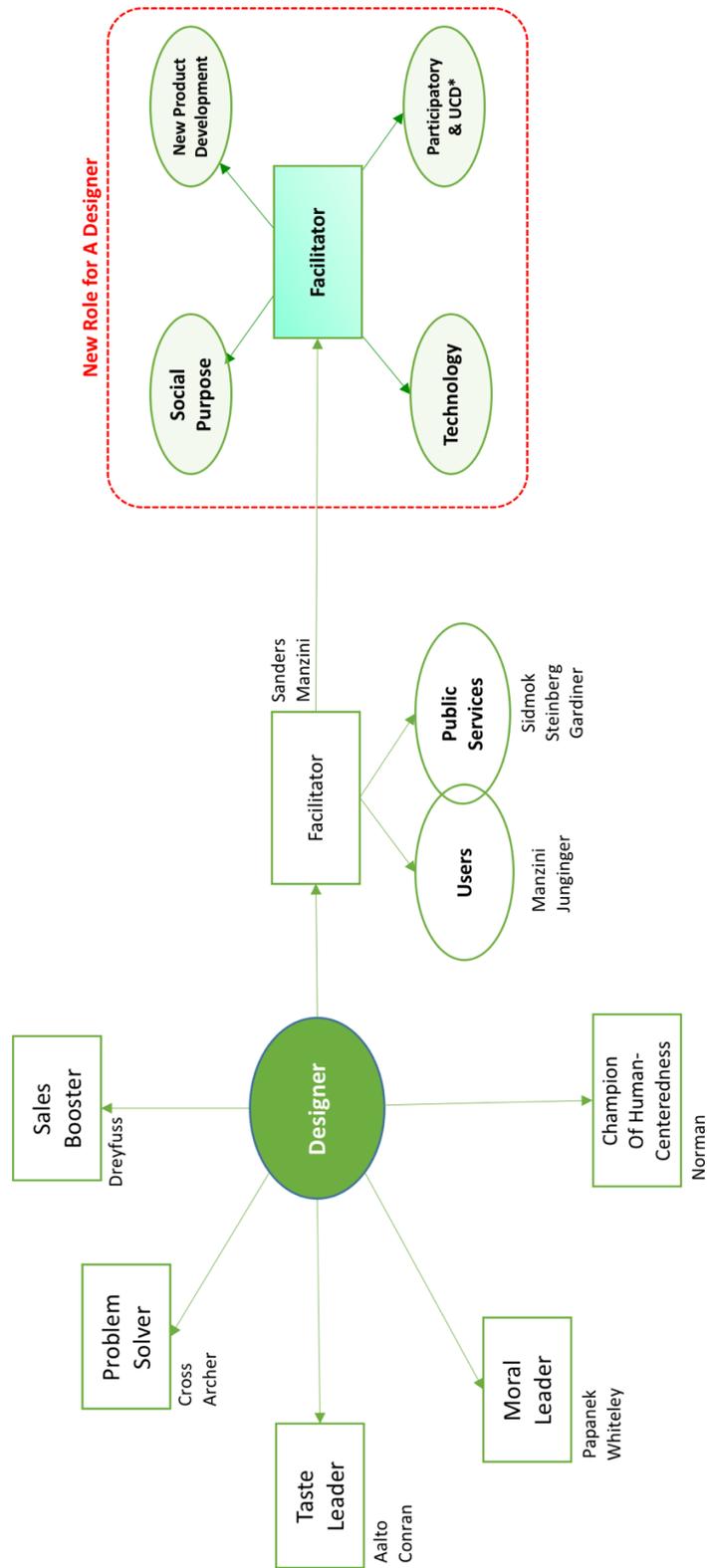


Figure 7. Designer's Expanding Roles, As Interpreted By The Design Researcher
See the list of references for the references used in this illustration

CHAPTER 2: RESEARCH QUESTIONS

The Potential of the Socially Responsible NPD as a Viable NPD Framework

As stated earlier, digital experience significantly enhance the lives of consumers today; however, there is also an increasing awareness that digital products themselves are creating new problems amongst users, in particular mental health and developmental issues (see section 1.1.3).

Feasibility, desirability and viability have been active in the practice of NPD teams in technology providers and the value of having a cross-functional team that spans these values has been widely understood (Ernst, H., Hoyer, W. D., & RübSaamen, C, 2010).

Nevertheless, to the best of the researcher's knowledge, practices that are designed to incorporate social values into the NPD process for technological outputs remain very few.

In response this research proposes a new NPD framework which more effectively integrates social responsibility alongside the existing criteria of feasibility, viability and desirability. To effectively do so, the team integrates a person who is a subject expert or a professional involved in public service to work alongside other members of the cross-functional team.

As a part of the practice of the body of research written up in this thesis, the researcher built a cross-functional team whose members were responsible for the product's viability, feasibility and desirability. Henceforth they will be referred to

as ‘stakeholders’, with the addition of the stakeholder of social purpose, who will be called ‘a social stakeholder’.

The focus of this research on the technology industry unfolds against the backdrop of two particular facts: first, the impact of technology products on society has grown in the last two decades and there is also growing appreciation for negative consequences of this on users and communities (see section 1.1.3); and second, in the next decade society can expect a plethora of disruptive technology products whose ethics are not clearly defined yet.

Through this practice, the research aims to investigate the following question:

What is the potential of a new product development (NPD) framework for socially responsible technology that incorporates a social stakeholder in a cross-functional NPD team in ways that supplement its existing commitments to feasibility, viability and desirability?

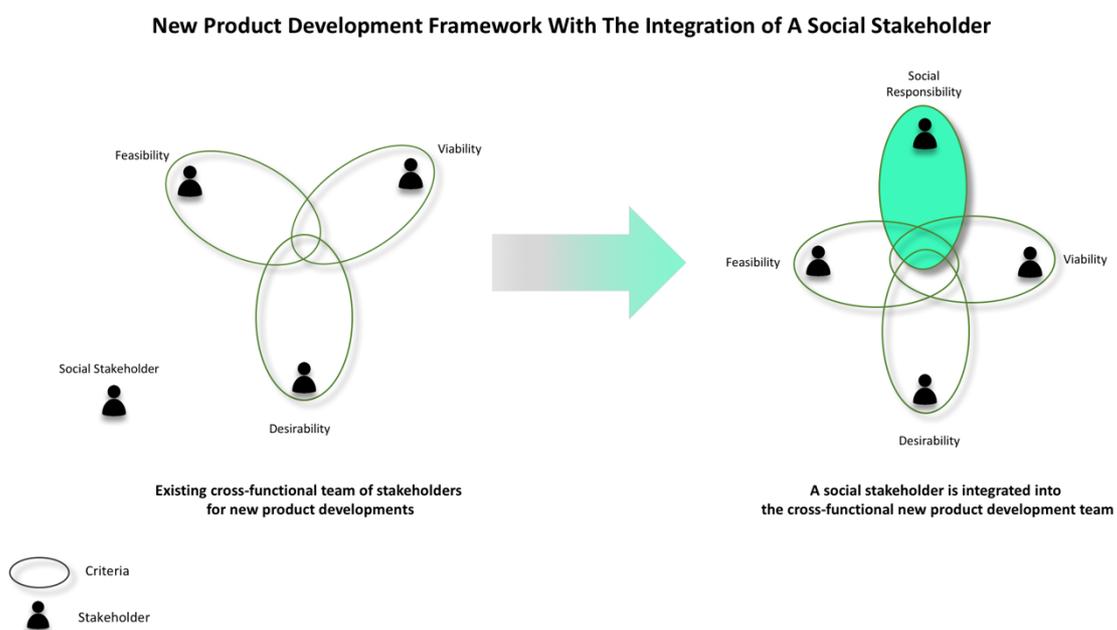


Figure 8. A New Product Development (NPD) Framework For Socially Responsible Technology, With The Integration Of A Social Stakeholder, The Proposal of This MPhil Thesis.

Illustration By The Design Researcher

In the researcher's view, this question can be answered by way of four other questions.

2.1 Does It Work? (Viability as an NPD practice)

First, the team will work to produce a technology product based on such NPD practice.

A) Does this NPD framework have viability as an NPD practice?

Question A. can be answered by evaluating the quality of the product outcome, as well as the decisions taken by the social and viability stakeholders with regards to moving forward with the product.

2.2 What Does It Take? (Elements for Success)

This research aims to map the practice journey, observing key obstacles along the way. The experience and knowledge gained through practice could inform practitioners in all communities concerned with innovation opportunities: technology experts and businesses; design practitioners and academics; and public services. For this reason, the research will look to answer the following questions based on the researchers' reflections as a practitioner, including an analysis of post-project interviews with the stakeholders.

B) What are the essential elements and challenges for the successful execution of this NPD framework for socially responsible technology?

2.3 What Will The Team Learn? (Participatory Design Gains)

As the team tests the new NPD format, it will be useful to investigate the experiences of the stakeholders who participated in the project. Several similar experiments with reference to gains of the participatory design, have been conducted within the field of participatory design (Bossen et al. 2010, 2012; Bowen et al. 2013; Simm et al. 2013). which often refer the participants' gains as 'PD gains'. However, no questions have been asked to determine the mutual learning gained by the stakeholders, especially with reference to sometimes conflicting criteria, such as feasibility, viability and desirability. Further, mutual gains have been investigated with regards to the integration of the social stakeholder.

The question above subsequently leads the research into the sub-question below.

C) What are the impacts of this new NPD framework for socially responsible technology on the participants of the cross-functional NPD team that carried out the project?

This question will be answered through an analysis of the stakeholders' post-project interview responses, along with the researcher's more general observations regarding the project.

2.4 Will It Matter? (The Role of the Social Stakeholder)

Similar studies have been carried out to examine the role of an environmental specialist when integrated into an NPD, thereby making it a SNPD - sustainable new product development (Genç & di Benedetto, 2015). However, to the best of

the researcher's knowledge, the role of the actual stakeholder addressing social concerns and constraints as part of their work on an NPD team has not been examined before. In this regard, exploring the contribution of the social stakeholder who is integrated into a cross-functional NPD team is considered valuable to understand the validity of such a practice for the future NPD teams that aim to more actively address social concerns pertaining to their products.

D) What is the role and contribution of the social stakeholder throughout the NPD process within a cross-functional team?

The question D can be answered by looking at the qualitative self-assessment of all stakeholders, as well as the researcher's reflections as the key practitioner of the project.

CHAPTER 3: APPROACH

3.1 A Practice Guided by Evidences and Own Reflections

The practice-based approach is essential to respond to the researcher's inquiry in validating the potential of a new NPD practice, and in identifying issues that could face real-world practitioners with the real-world depth and width.

For example, the practice enabled the author to uncover issues such as high uncertainties involved with working with relatively unknown technologies; the detailed challenges of knowledge-brokering, which might have been difficult in a conventional workshop setting, that in turn are often associated with a participatory design project.

While in action, the design researcher learned to be more reflective, through projecting a distance between the design researcher to the situation, so enabling an informative experience for herself and other practitioners (Schön,1983).

Being reflective helped the research to be agile in approach (Agile Alliance, 2013). In more than one instance this was especially useful: depending on the participants' background and age, the preferred style of communication was significantly different, which will be illustrated in the findings. This research result would not have been possible to be discovered, if the whole communication during the product development was in a controlled workshop setting.

Being able to reflect upon also enabled the design researcher to be able to inform next steps based on evidences. In Design Stage 1, effectively the concept development stage, instead of framing the question early and decide on a product format to design, the team used qualitative evidences at the concept stage to reframe the question on what needs to be produced. While the research as a whole has not been designed as a ground-theory research(Charmaz,2006), it would be worthwhile to mention that the researcher was informed by the wide range of possibilities it opens up to this research.

3.2 Participatory and User-Centered Design

Emerging social needs (see section 1.2), combined with the need for this researcher in particular and designers in general to take an active role in designing socially responsible technology (see section 1.3), opens up the opportunity for the designer-researcher to be a facilitator in this cross-functional NPD team.

The research experiments with a new composition of a stakeholder group to work together for a socially responsible NPD for technology and, accordingly, the author will investigate the impact it has on the stakeholders.

Often a participatory design practice is considered when the end-users are invited to the team as co-creators. However the design researcher would like to consider, the addition of the social stakeholder, who is traditionally considered as passive observer outside the boundary of the new product development process. The inclusion of this stakeholder gives this research a highly participatory aspect. A similar trend is observed by Sanders and Stappers (2008), who broaden the definition of participatory design as “...creativity of designers and people not trained in design working together in the design development process ” (p.6).

At the same time, the design practices of this research is strongly informed by the philosophy behind user-centered design practice, proposed by Donald Norman (1988). Norman’s proposal is that any user experience with technology must put the user at the centre, so that it has be easy-to-use and to be comprehended without any need for an additional training or manual. The observations during the user testing, and the design directions at the end of each of the design stages consider enhanced usability as the major goal.

Sanders (2008) and Sanders and Stappers (2008) observed these two trends approaching one another, noting that the boundaries between them are blurring and called this new form of design as ‘people-centered innovation’(Figure 9). Being positioned within this new dimension, it could be concluded this research-design practice is one of the new emerging practices of ‘people-centered innovation’.

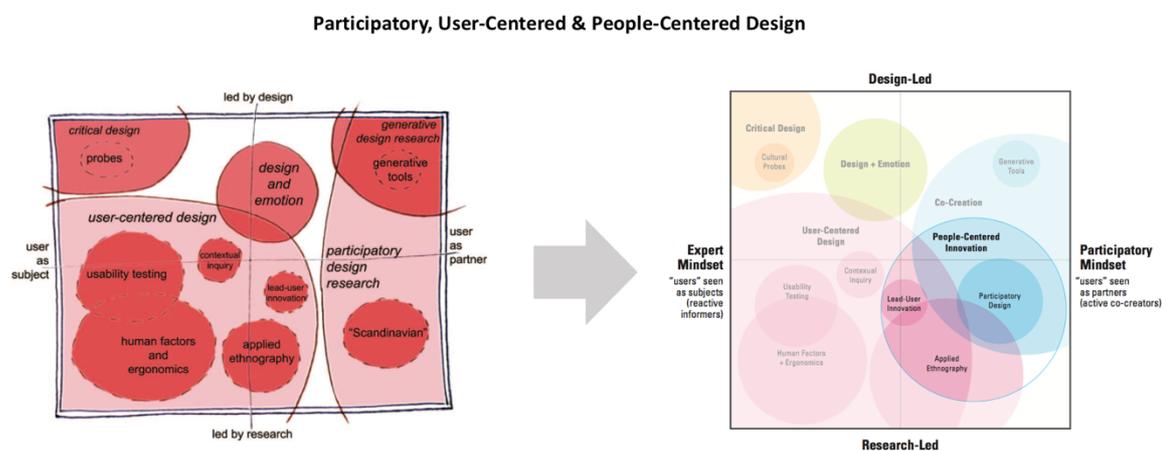


Figure 9. Evolution of design landscape, observed by Sanders & Stappers (2008) (Left) and Sanders (2008) (Right)

3.3 Research Methodologies

3.3.1 The Designer-Researcher's Diary While Exploring the Practice

The design practice journey has been captured by the designer-researcher in on and off line diary notes; episodes illustrating obstacles and key issues were captured via email and messaging app exchanges with other members of the project team. The interactions with the participants of Clarity were captured in a variety of formats throughout the process, such as videos, emails and text message conversations.

3.3.2 User Trials for Design Outcomes

The design outcomes were tested by the end users and potential target users (public campaigners) at various stages of development with an aim to validate the potential of design practices based on the four design constraints.

The data was collected and analysed primarily using qualitative research techniques, such as observation and interviews. This was undertaken with the aim of understanding the context, identifying key issues and judging the potential for the design outcomes and reactions, rather than looking for its statistical significance.

The majority of the interviews at public venues, such as the London Bike Show, were conducted in an unstructured format, and the designer-researcher captured responses in the four-criteria scoreboard. The respondents were not asked to fill in a questionnaire, as it was felt inappropriate for the hectic setting of the exhibition. All data related to children have been captured by the design researcher through observation and verbally; no video recordings were made, in keeping with concerns related to child protection.

Some young adults and agreed respondents in the professional group have consented to video recordings.

3.3.3 Post-Project Interview of Participants

After the 3 design stages of the project, semi-structured one-on-one post-project interviews using a paper-based questionnaire were conducted with key stakeholders involved in this research. The questionnaire was developed with a focus on the participants' experiences and awareness of what they had gained from the project, which the respondents were asked to describe by writing it up as text or by making illustrations. After each respondent completed the questionnaire, the designer-researcher talked it through with them.

Thematic analysis was used to identify key insights from the full data gathered, which include verbal discussions, text-based responses and illustrations used to describe the stakeholders' experiences.

	Research Objectives	Research Questions	Research Methods
1.	The validity of the NPD process of incorporating the social stakeholder by evaluating the design outcome	<ul style="list-style-type: none"> - Is the design outcome as impactful as expected? - What are the social stakeholders' contributions to the NPD team? 	<ul style="list-style-type: none"> - User trials of the design outputs at the end of each design stage - Evaluation of the project results in terms of next steps; observation and exchange regarding the social stakeholders' contributions throughout the practice
2.	Learning as the key practitioner of this NPD framework about how to execute the project successfully	<ul style="list-style-type: none"> - What are the key management elements that will make a project successful or challenging, and in what circumstances? 	<ul style="list-style-type: none"> - Researcher's notes and reflections on key issues, exchange with other team members through email, messaging apps, verbal conversations - Post-project participant interviews: semi-structured, based on a questionnaire and a discussion
3.	Learning as a new NPD team working on socially responsible technology	<ul style="list-style-type: none"> - What did the participants of the team learn throughout the NPD process of creating a socially responsible technology? 	<ul style="list-style-type: none"> - Researcher's notes and reflections on key issues, exchange with other team members through email, messaging apps, verbal conversations. - Post-project participants interviews: semi-structured, based on a questionnaire and a discussion

Table 1. Research Methodologies By Objective

CHAPTER 4: PRACTICE

[*See Appendix 3 to Watch the Videos Mentioned in this Chapter.](#)

4.1 Overview of Project Clarity

4.1.1 The Background of ‘Exchanging Places’

570,000 cycle journeys are made daily in Greater London. About a dozen cyclists die every year. More than a majority of fatal collisions involve heavy goods vehicles (HGVs) (Delmonte et al., 2013, p.21-47).

Exchanging Places is an award-winning public safety campaign by the Metropolitan Police whose focus is to educate cyclists and pedestrians about how to ride and walk safely around HGVs.

While there is no question the safety campaign is a great opportunity for members of the public to experience the road from the point of view of lorry drivers and learn to cycle and walk more safely, the campaign’s research is nevertheless limited. Since its launch about a decade ago, the program has put 20,000 people behind the wheel of a lorry, giving them the experience of being inside of an HGV (Metropolitan Police, 2016). For people with limited mobility, however, climbing inside the HGV is an issue. Further, for people who do not live close to central London, attending events related to the safety campaign has been challenging, as most take place in or near the capital.



Figure 10. Exchanging Places by Metropolitan Police

4.1.2 What Virtual Reality Can Do For ‘Exchanging Places’

This research looked at the current circumstances where the potential of digital technologies is not maximised for public interests due to business priorities. In the early stage of this research, the design researcher made an experiment of using a new technology on the horizon for a social purpose. The technology in question is virtual reality(VR).

Mixed reality technologies - virtual and augmented realities combined - are receiving increasing attention thanks to strong backings from technology providers, such as Facebook/Oculus, Samsung (Gear VR), Sony (Valve) and Microsoft (Hololens).

The market for mixed reality technologies is expected to grow up to \$80 billion (Goldman Sachs, 2016, p.7). Goldman Sachs predicts the adoption of the VR/AR technologies will be heavily driven by consumer products, in particular, video games.

VR/AR Total Addressable Market by 2025(Unit: \$ billions)

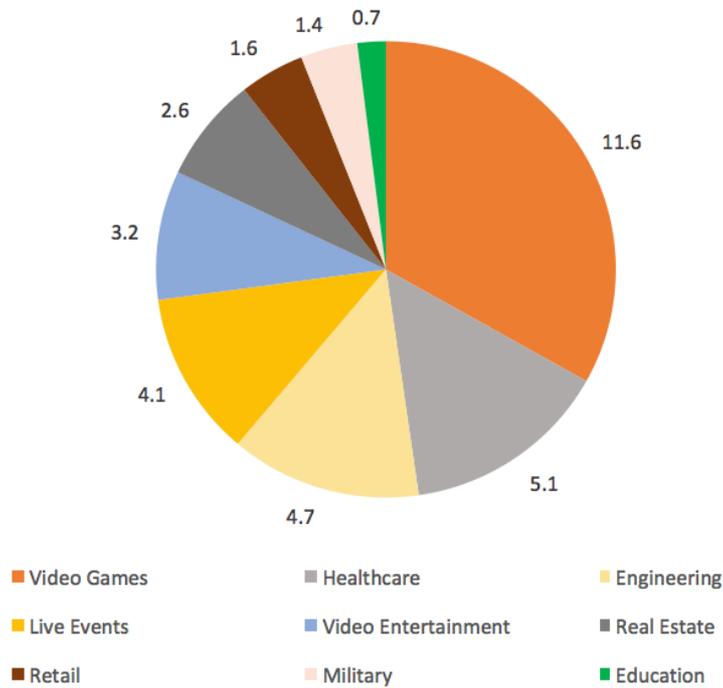


Figure 11. VR/AR Total Addressable Market By 2015 (Source: Goldman Sachs)

The key benefit of a VR content is its capacity to transport the user, providing them access to any imaginary viewpoint that can be replicated in a VR format, giving the experience of immersiveness that often has not been experienced.

The immersiveness is the key selling point for the potential video games and other entertainment that are being developed for virtual reality technology. However, could this benefit be put to use to serve a social purpose, for example by promoting empathy between people in conflicting positions?

Chris Milk, the founder of Milk & Vorse, a leading VR content studio, has referred to VR as ‘an empathy machine’. He described a virtual reality experience as capable of making people relate better to the lives of others by ‘sharing places and experiences in such a manner that comes powerfully close to walking alongside them’ (2016).

Research indicates experiencing first-hand a traffic safety scenario from a different point of view, viewers could learn to behave safely in traffic (Schwebel, Gaines & Severson, 2008).

With a VR version of ‘Exchanging Places’, the Metropolitan Police could serve a wider public than they currently do, as this alternative experience would not face the same kinds of limitation when it comes to time, place and number of people who can be accommodated.

4.1.3 Overview of Design Stages

Based on the main objective and the key activities the project ‘Clarity’, titled with the design researcher’s intention to give clarity to a virtual reality experience, can be divided into following three design stages.

In the Design Stage 1, the practice investigated if a consumer technology product can be used for a social purpose, and tested the current consumer virtual reality products in a public campaign scenario with a proof-of-concept 360° film content produced with the Metropolitan Police. With the user testing, the design researcher concluded that the current consumer offering is not fit for social stakeholders to use the technology products as-is. With the social stakeholder, she generated new concepts for an ideal virtual reality experience that could be used by public campaigners, which are; a new virtual reality headset, a new user interface and a new storyboard for film.

As a next step, in Design Stage 2, the practice looked at integrating a social stakeholder into an NPD team to learn if it can be informed by social purpose to develop a suitable a technology product. During this process, the team created a new prototype based on the design concepts generated at the end of the Design Stage 1.

The prototype created with a social stakeholder in Design Stage 2 proved its potential as an end product, but certain quality issues made its market potential as a stand-alone product uncertain. So in Design Stage 3, the team iterated on the prototypes to learn if a commercially viable technology product could be developed for a social purpose.

Project Clarity

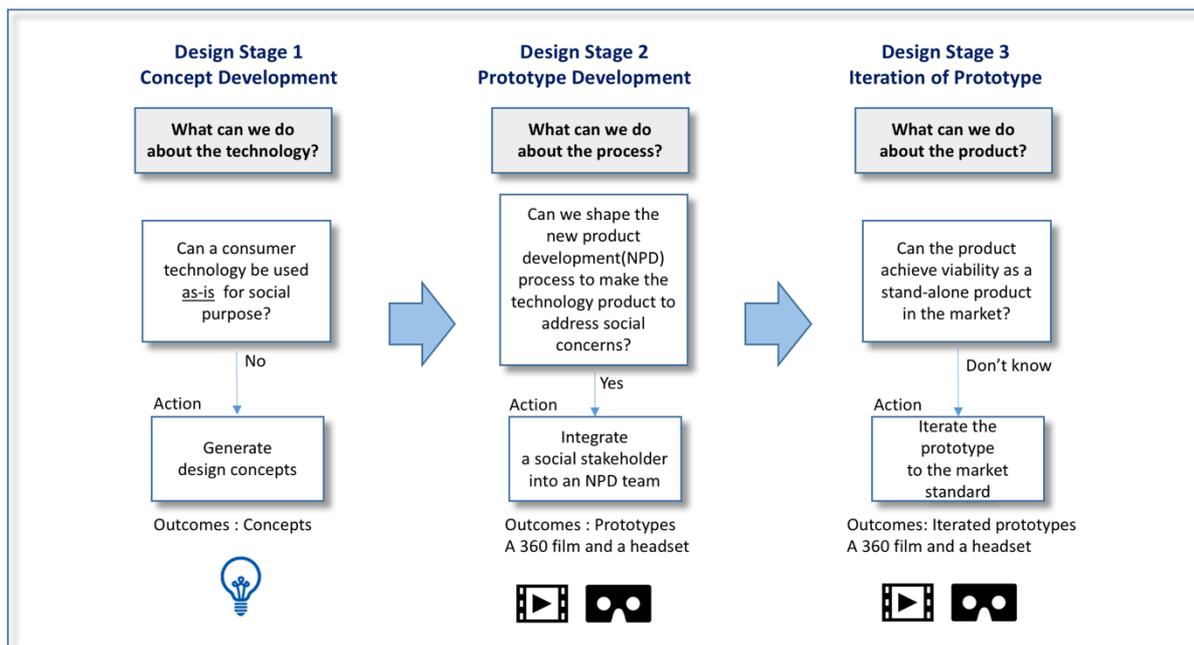


Table 2. Overview of Design Stages

In line with previous research on NPD stages (Ernst, Hoyer, & Rübsaamen, 2010; Song & Parry, 1997; Song & Swink, 2009; Song, Thieme, & Xie, 1998) the first stage can be classified as Concept Development (CD), and the second and third stages can be considered both as Product Development. The Product Commercialisation stage, which is the last stage of an NPD development according to the literature, was not pursued as part of Clarity, by dint of residing outside its research scope. However, a potential avenue for commercialisation of the prototypes is currently being discussed with business stakeholders (Chapter 5: 2.2).

4.2 Design Stage 1: Concept Development

4.2.1 Objective

VR is an emerging technology in consumer space and is finding its form as headsets, interfaces and experiences that are largely developed around gaming and entertainment (Goldman Sachs, 2017). The design researcher decided to carry out experiments to see if VR could be used as a medium for a public good, and if the current consumer offerings are adequate enough be used by public organisations to communicate a message for a social cause. The design researcher worked together with a social stakeholder, the Metropolitan Police Cycle Safety Team, one of the public organisations who could benefit from this practice-based research.

4.2.2 Workflow

The first 360° video for experiencing the viewpoints of both a cyclist and a truck driver was produced in January 2016, thanks to support of a 360° camera by Giroptic, a French start-up. The video is in MP4 format and has been showcased using a first generation Samsung Gear VR headset.



Figure 12. 360° Video Shoot In Design Stage 1.

It was unclear how to fix the camera onto the helmet and how to orient it.

Photo Taken By The Design Researcher

The video shows a simple narrative of four scenes, switching the places between the cyclist and a driver. The first and the second scene describe a scenario at a junction where the cyclist locates him/herself too close to the vehicle and out of sight of the driver. This happens too often in real-life as many cyclists are not aware of the blind spots around an HGV, and it is one of the biggest causes for fatalists involving cyclists and HGVs. The third and the fourth scene show the viewer an ideal scenario where the cyclist stops more than five meters ahead of the vehicle, and makes eye-contact with the driver, dramatically reducing the risk of a collision.

Storyboard (Design Stage 1)

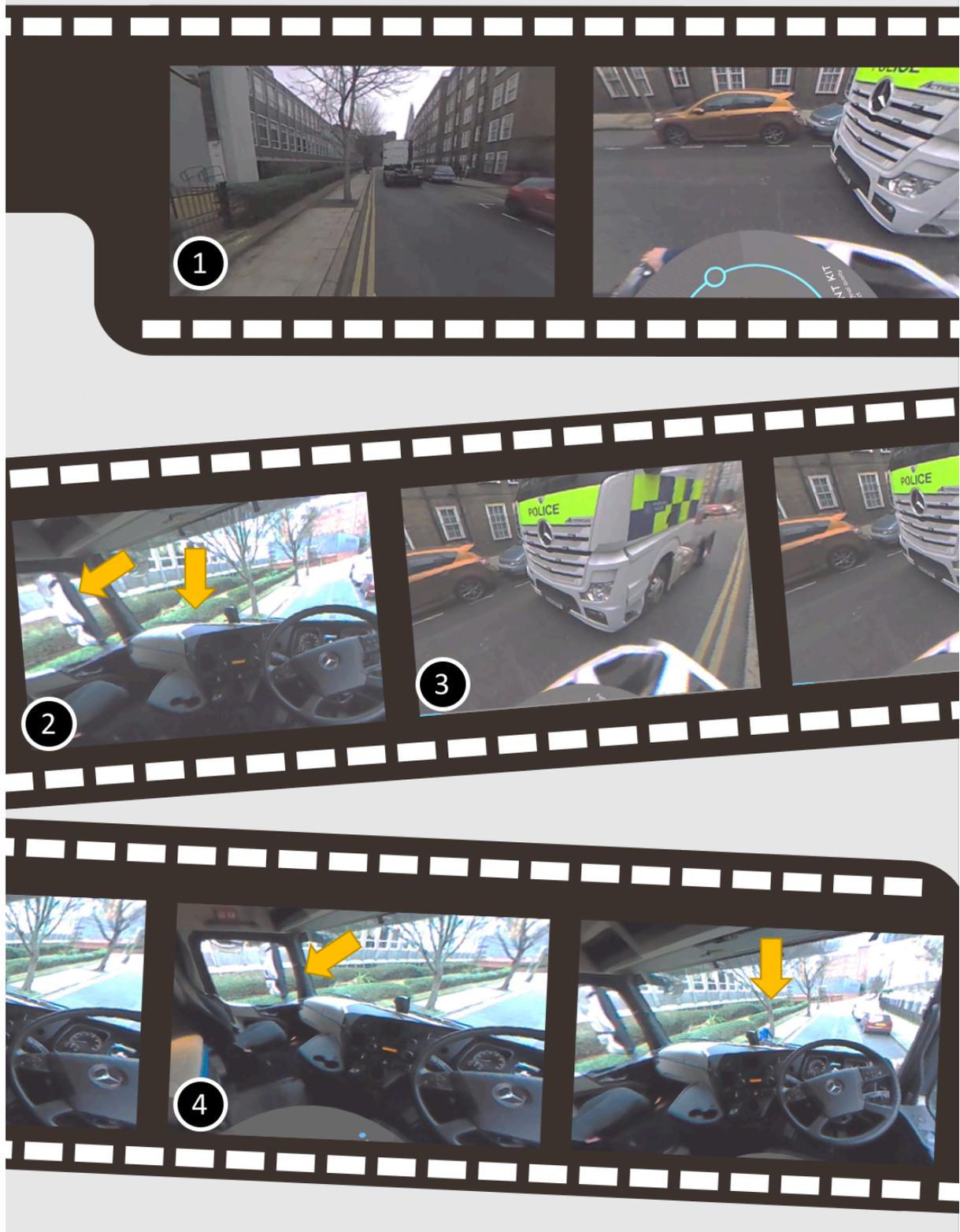


Figure 13. Storyboard in Design Stage 1 (See Appendix 2 For the Detailed Synopsis), Illustrated by The Design Researcher

4.2.3 Testing

The proof-of-concept video was showcased to members of the public in busy venues, such as bike shows, public cycle safety events, a local community youth hall event and at college design exhibitions.

The responses were captured by the designer-researcher after the testing. Most data from responses was captured spontaneously and without prompting. These comprised initial reactions as soon as the user finished the video and removed the headset.

Overall, the users' reactions showed they had had a highly positive experience. The strengths of the experience mostly come from two factors. The first factor is the powerful nature of the message, as it enables the user to really understand the danger of the blind spot from a first-person perspective. Many felt it was an eye-opening experience to see the situation from the truck driver's point of view, especially just how small the cyclist looks in the mirrors and also how quickly the cyclist passes out of the driver's line of sight.

The second factor that helped to make the experience so compelling is VR as a medium. Many were intrigued by the sight of the headset, and volunteered to try it. For the majority of users, this was their first VR experience; however, many showed interest in experiencing more in future. It was observed that people linger longer inside the virtual reality space, even when the video is finished, waiting for something else to happen.

A respondent from the professional user group opined that he could see the potential of the technology to be used for the drivers in a very scalable and economic way.

	Evaluation of the 360° Video (See Appendix 3 For YouTube Link)
Strengths	<ul style="list-style-type: none"> - Learning impact of the message: ‘Good to see the required distance from the truck.’ ‘Good to see how tiny the cyclist looks in the mirror and barely recognisable from the driver’s point of view.’ - Interests to VR as a medium
Weaknesses	<ul style="list-style-type: none"> - Lack of dynamic narrative: ‘The story seems too bland/static.’ Some were expecting to experience going around a busy dangerous London street. - User Engagement: The user is alone within the VR space, only guided with a voice narration. The experience can be described ‘lonely’ or slightly ‘creepy’, not evoking engagement of the user as hoped.

Table 3. User Testing Result in Design Stage 1: 360° Video

Occasion	Date	Venue	General Profile of Respondents	Number of Respondents
Work-in-Progress Show RCA	January 2016	RCA	Art & Design Students, Tutors	20 (approx.)
London Bike Show	February 2016	ExCel London	Cycle Enthusiasts Mass public aged between 10 - 55	45 (approx.)
Informal gathering	March 2016	Staines Congregational Church	Teenagers & Young Adults	8
Commercial Vehicle Show	April 2016	NEC Birmingham	Professionals in commercial vehicles & road safety sector	15
Marble Arch 'Exchanging Places' event	September 2016	Marble Arch	Cycle Enthusiasts Mass public aged 10 - 55	6
Marble Arch 'Exchanging Places' event	September 2016	Marble Arch	Police Officers from Cycle Safety Team	5
Westminster City Council	October 2016	Westminster, London	Road Safety Officers from the Westminster Council	2
Total			End Users Group	79
			Professional Users Group	22

Table 4. Respondent Profile in Design Stage 1

The supporting hardware, however, the Samsung Gear VR headset, was not optimal in the following respects.

Portability

The headset felt heavy in the hands, and required a dedicated bag to protect the fragile front parts. The dedicated bag that was offered as a bundle by Samsung was round at all corners, which seemed to intend a sleek image but too big to grab any corner. The bag also only has a small handle strap attached and not possible to carry on the shoulder. After the first few days, the designer-researcher decided to use her own camera bag with a shoulder strap, to free her hands while carrying it.

Wearability

The headset had a tight headband, which was intended to provide stability. But to use the headset most users needed assistance from the design researcher. Also, in was tightening the headset around the face users with glasses didn't know if they should take their glasses on or off. The tight headband also affected the hair of the users, which was not a barrier for male users, but mildly discouraging to many female users.

Exterior Design

While the headset attracted a large number of viewers who are interested in trying new technology products, this largely comprised males between the ages of 13 and 49, and some children.

In other words, it failed to appeal positively to female users. They did not seem to appreciate the black and white aesthetic, plastic exterior and the headset's overall look and feel. The facts that it needs to be worn with a headband and that the user would be fully immersed in the environment, seem to serve as an attraction point

to the former, technologically oriented user segment; however, and curiously, this also seemed to repulse users who were more resistance to new technologies.



Figure 14. Design Outcome Testing in Design Stage 1.

The first video tested along with the consumer virtual reality technology offerings.

Samsung Gear VR headset(first generation); a bundle bag included in the original package, embedded Oculus interface for the navigation. As soon as the user wears the headset, the user is presented with a contents library mostly not available without purchasing. The user gets easily confused within this environment, it is difficult to find a particular video within this environment.

Navigation Interface

The navigation interface proved woefully inadequate for users who are not used to trying new technology gadgets.

The user is shown a virtual environment of a lounge with a swimming pool within a mansion. The user is shown a virtual library of videos, mostly not available without purchasing. It is very difficult for the user to find one's own content, such as a video in the user's own library, this is due to the platform provider's need to generate revenue by selling virtual reality content. For users who have never used an Oculus platform before, it was virtually impossible for the design researcher to guide them through to watch a video that is saved in the library section which stores own content, that the design researcher would locate the video first and then show it to the viewers.

However, the location of the user in proportion to the navigation path had to be checked every time to make sure the right video content was ready to be played. In some cases, some users who are technologically literate started watching other promotional videos inside the library, unsuitable for the purpose of the public campaign. There are a number of other usability issues, but the commercial purpose of the platform provider is the biggest challenge for the user experience in a public showcase scenario. (Check Appendix 3 for YouTube Link on 'Usability summary'.)

	Hardware (Samsung Gear VR, 1 st gen)	Navigation Interface (Oculus)
Strengths	<ul style="list-style-type: none"> - Strong appeal among young male users or children is perceived the headset's external appear as 'cool' or 'eye-catching' This arouses interest in trying it - Durability and build quality 	<ul style="list-style-type: none"> - Catchy images of the 360° environment, such as a garden with a swimming pool
Weaknesses	<ul style="list-style-type: none"> - Weak appeal among female users especially women above 40s, perceived the headset as 'geeky' and 'technophilic', which does not chime with their self-image - Low usability: Tab button is not well communicated. It is basically a small touchpad, unrecognisable and very unfamiliar for many users - Weak portability: The carry bag is difficult to grab and there is no option to carry on the shoulder (Figure 14) 	<ul style="list-style-type: none"> - Navigational difficulty (long path and unfamiliar); difficult findability. The interface might need a physical 'lock' button to save settings and fix on one video. The navigation path to go to a particular video is too long from the oculus home. Magnetic sensor error: The play bar is sometimes not set horizontal or not where the users eyes are.

Table 5. User Testing Result in Design Stage 1: The Samsung headset and navigation interface

4.2.4 Conclusion

What implication does Design Stage 1 could give to an NPD process for socially responsible technology?

The first prototype served the purpose of testing the functionality of the public campaign and was technically a work-in-progress. However, the issues of the whole user experience show that it is yet an easy-to-use, desirable-enough product neither for the mass user nor the campaigner.

The first prototype could be translated as an outcome that serves social responsibility in a functional way, but does not yet live up to the demand of two other constraints: desirability and viability. The weaknesses in terms of desirability were identified in the headset hardware and the navigation interface, and the next logical step was to come up with a new design that would mitigate such issues. The reactions from the professionals signalled that there could be a viable business opportunity for the content to be used for training purposes, once the user-experience issues discussed above had been resolved.

4.3. Design Stage 2: Prototype Development

4.3.1 Objective

The first design stage helped create a concept of what an ideal virtual reality experience might entail, should it be used for the purpose of communicating a message to the public. It also opened up possibilities for the next steps for product development. It highlighted that if the whole experience – software, hardware and the film narrative - to be more user-friendly and enjoyable, experts need to come in to improve the quality of the experience to the professional level.

Based on these findings, it was assumed that once the headset was made more desirable, there would be more possibilities for commercial viability. At this stage, the key viability stakeholder, who manages the Fleet Operator Recognition Scheme(FORS) for Transport for London agreed to be part of the discussion, to advise on the business potential as a training service. A group of designers as a part of the desirability group and a technical assistant were recruited as the first the desirability and feasibility stakeholders completing a small replica of an NPD team.

Concepts for new experiences were drawn up as follows:

	Generated Concept
360° Contents (See Appendix 3 For YouTube Link)	<ul style="list-style-type: none"> - Have the police officer as the key narrator <u>inside</u> the film to make it more personal, interactive and engaging. - More dynamic movements within the storyboard. - A background music to be added.
Headset Design	<ul style="list-style-type: none"> - Lightweight, and high portability (potentially foldable, flat-packable). - Approachable, friendly enough to engage a wider segment of the public. A degree of formality would be good, but not as geeky/technophilic as Gear VR; but also not as casual and hacker-feeling as Cardboard. - Better wearability to easily take on and off.
Navigation Interface	<ul style="list-style-type: none"> - Extreme findability and simplicity, so that the user does not have to spend time navigating around or get lost in the navigation path

Table 6. New Design Concepts With The Findings From Design Stage 1

4.3.2 Workflow

The narrative for the new 360° contents has been brainstormed together among three desirability stakeholders, the key social stakeholder and the key viability

stakeholder. The video shoot was done in London, in September 2016 with the aid of the police staff blocking a part of the street near the Metropolitan Police Cycle Safety Team's office. After the shoot, the 360° footage was post-produced, which involved cutting, image-stitching, sound and colour enhancement and adding special effects and music. Since the new film involved a more complex narrative, the post-production required much longer workflows for a viable video content.



Figure 15. 360° film shoot in the Design Stage 2

Key challenges involved technical issues around using the camera and the post-production. Using the new cameras with an ambition to create higher resolution video added more complexity. Unlike Giroptic camera, the one the team had used in Design Stage 1, The Samsung 360° camera did not support real-time stitching algorithms and it took many hours of searching on the Internet to locate the editing software, and 'how-to' videos.

For the headsets, the author recruited two industrial designers as a part of the desirability stakeholder group, briefed them on the key design considerations identified in the Design Stage 1, and met with them regularly for the first 3 weeks to discuss materials and shapes. The two industrial designers did not work with each other and each came up with a new headset design and a prototype individually.

The Industrial Designer A produced the ‘Clarity Dee’, a fully flat-packable headset made of recycled felt into which a mobile phone can fit which would play the 360° content once assembled. The Industrial Designer B produced a cube-like headset accordingly named ‘Cube’, composed of two halves of shells that can be assembled as one VR headset. Cube also fitted a mobile phone to play the 360° content.

In addition, the Clarity team had planned to develop a new VR interface, and UI concepts were developed to make the VR environment extremely simple to understand and appropriate for the communication of a short message. However, the development could not move forward at this stage due to the issues with recruitment of a suitable developer.



Figure 16. Headset Prototype Brainstorm With Industrial Designers, Photo Taken By Design Researcher

Storyboard (Design Stage 2)

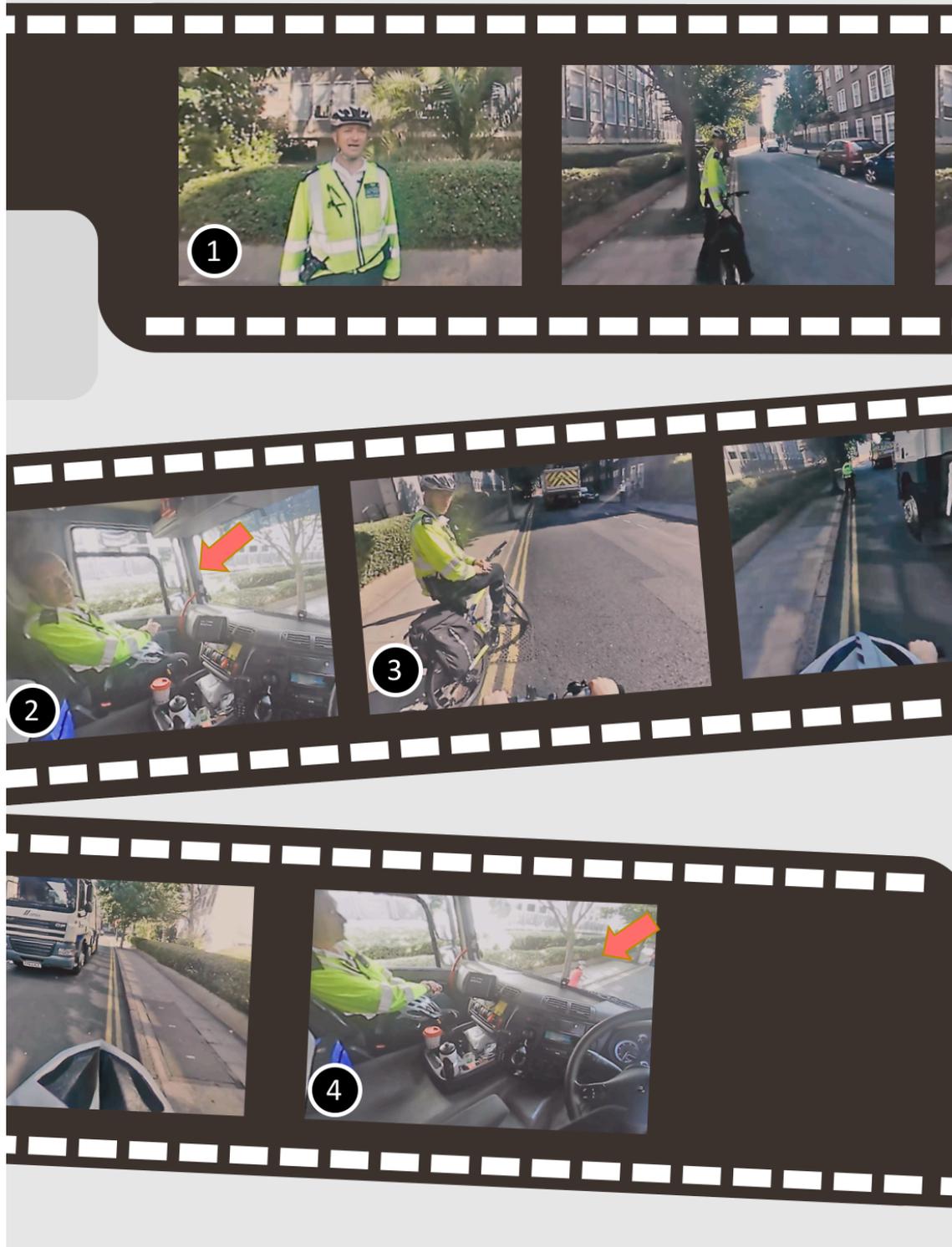


Figure 17. Storyboard in Design stage 2 (See Appendix 2 For the Detailed Synopsis),
Illustrated By The Design Researcher

4.3.3 Testing

The proof-of-concept video was showcased to the members of the public at RCA’s design exhibition, to staff of the Cycle Safety Team and to two road safety officers of Royal Borough of Kensington & Chelsea.

For the end-user trials at the design show, some of the test data was captured on video with the respondents’ consent. Some of the professional group’s trial data has been captured by the design researcher by way of observation and videoed with the respondents’ consent.

Most responses were provided soon after the interviewees finished and removed their headsets. No prompting was necessary.

Occasion	Date	Venue	General Profile of Respondents	Number of Respondents
Work-In-Progress Show, RCA	January 2017	RCA	Art and Design Students and Tutors	30 (Approx.)
Professional Trial	December 2016	The office of the Metropolitan Police Cycle Safety Team, the Royal Borough of Kensington & Chelsea	Public and Business stakeholders	5
Total			End User Group	30 (Approx.)
			Professional Users Group	5

Table 7. Respondent profile in design stage 2

The new storyboard seemed to convey the message more effectively. However a critical weakness was identified: It was not possible to see the cyclist in the mirrors inside of the vehicle, which is a key element in communicating the message of how to cycle safely around an HGV. This was due to the overexposure as it was shoot on a very sunny day and partly due to the team’s lack of professional expertise in 360° film shooting. Due to this, a tense discussion took place at length among the team, especially between the design researcher and the social and viability stakeholder regarding what the next steps to take, an outline of which is covered in Chapter Four. Both headsets intrigued the viewers positively, with more interests was given to ‘Dee’ because of its completely foldable form.

For the navigation interface, ‘VR theater’ a simple VR content player app available on Google Play was used as no app development had been started at this stage. This app was chosen for its simplicity of enabling a mobile device to play a 360° content, without the need for a customized VR headset such as Samsung Gear, while it didn’t provide the full capability of an easier interface conceived by the team.



Figure 18. Testing at Work-In-Progress Show, Royal College of Art

	Evaluation of the 360° Content (See Appendix 3 For YouTube Link)
Strengths	<ul style="list-style-type: none"> - Easier to follow the storyboard, thanks to the police officer featured on the video; Having the police officer explaining it to the viewer made the whole experience more personal; - Sunny weather within the film made the viewer feel safe, while the topic of the video is traffic safety and which could feel heavy
Weaknesses	<ul style="list-style-type: none"> - Image sharpness issues due to the sunlight during the demonstration. This was critical because the users couldn't see the cyclist from the mirror inside the vehicle; - The music was considered too cheesy by police officers.
Overall	<ul style="list-style-type: none"> - The storyline proved a much more engaging experience for users, however, the missing view of the cyclist due to the fact that the image was not sharp enough required a serious breakthrough either an add-in in the postproduction or a reshoot.

Table 8. User Testing Result For 360° Video in Design Stage 2

	Evaluation of the Headset Dee
Strengths	<ul style="list-style-type: none"> - Fun and friendly 'personality' thanks to the flexibility of the textile and D shaped design; - Fully flatpack-able, high portability; - Washable and recyclable, using PET friendly material; - Printable material, and therefore potentially customizable for promoting organisations.
Weaknesses	<ul style="list-style-type: none"> - Optical focus is problematic due to the lack of rigidity of the material; - Can't accommodate different sizes of the phone well.
Overall	<p>Highly positive responses proved the novelty and the product's potential viability; giving implication that a few iterations could yield a viable product.</p>

Table 9. User Testing Result For The Headset 'Dee' in Design Stage 2

Evaluation of the Headset ‘Cube’	
Strengths	<ul style="list-style-type: none"> - Elegant ‘personality’ conveyed by the square shape - Fun ‘personality’ conveyed as well from the assembly element - Could be skinned with a different material. such as leather or textiles
Weaknesses	<ul style="list-style-type: none"> - The aluminum structure could scratch the phone screen - Can’t accommodate different sizes of the phone well
Overall	<ul style="list-style-type: none"> - The reactions to the design were very positive, however a few details such as the aluminum scratching the screen would be difficult to address, unless an overall re-design of the form factor was undertaken.

Table 10. User Testing Result For The Headset ‘Cube’ in Design Stage 2

4.3.4 Conclusions and Next Steps

The film showed the viability of the new storyboard; but the image quality was disappointing and did not reach the acceptable quality standard. Two options were discussed. One was to add the view of the cyclist into the film using post-production visual effects. Some initial attempts were made, but it was soon realised that the cost of post-production would not justify the viability of the first option. The second option was a complete reshoot, which involved hiring a professional 360° filmmaker who would guarantee the sharpness of the image. The second option would cost approximately the same amount as the first. Also, the resolution of the image did not convey a professional feel with which that the Metropolitan Police Service and FORS wished to be associated. Therefore the team decided to go ahead with a reshoot.

As a viable product, the headset ‘Dee’ was deemed to be more promising for its flatpackable form and fewer significant barriers in iteration, unlike ‘Cube’ which is deemed more complex for mass manufacturing due to its aluminium structure, therefore the team decided to try a few more iterations with only ‘Dee’.

4.4 Design Stage 3: Iteration of the Prototype

4.4.1 Objective

Through testing in Design Stage 2, the narrative of the content was validated but due to the image quality disappointment, the team decided to go for a reshoot with a professional 360° filmmaker. The planned improvements were additional rather than wholly new, and the storyboard was simplified, through organising the whole narrative in just two scenes, partly to make the story easier to understand but also partly due to the expense of hiring a professional 360° filmmaker. The user testing in this Design Stage has been specifically designed to validate the new product concept, a suitable VR experience that can be used for public campaign purpose, which serves well 1) all walks of end-users including who are not technophiles and 2) public campaigners who would showcase to them.

4.4.2 Workflow

The reshoot of the film led to the recruitment of an additional feasibility stakeholder; a 360° filmmaker whose expertise involved handling not only six GoPro cameras on a rig, but also sound equipment on the shoot and post-production.



Figure 19. Fixing 7 GoPro cameras with a rig onto a helmet, Photo Taken By Design Researcher

While preparing for the reshoot, the team continued to rewrite the script and change various elements, based on what was learned from shooting and testing

the film output in the Design Stage 2. Adding the pedestrian element but trying to keep the lengths of the film short enough to watch, the film was organised into two scenes only instead of four, with two cyclists featured - one ordinary citizen cyclist and a police officer- who the user could watch from inside the vehicle.

Storyboard (Design Stage 3)



Figure 20. Storyboard in Design Stage 3. (See Appendix 2 For the Detailed Synopsis),
Illustrated By The Design Researcher

For the headset ‘Dee’, a few structural issues were addressed to make the assembled headset more stable. The iteration work by the Industrial Designer A was largely unsupervised, while from time to time the design researcher met up with her for updates on the progress. Making the headset adaptable to different sizes of phones that fit into the headset and keeping the rigidity proved a bigger challenge than originally esteemed. Adding a plastic board inside the structure was explored but not adopted in the end to keep the simplicity of manufacturing process, and the team opted for using more layers of textile to provide additional rigidity.

For the navigation interface, the app development started remotely with a UI designer/developer in India and an android app developer in Italy. However, it was still largely unfinished, and the team continued to use ‘VR Theater’ as chosen in Design Stage 2.

4.4.3 Testing

The number of users involved with the testing of the Design Stage 3 was smaller than the two previous tests. This is due to the fact that the concept validation has been largely done with the testing as part of Design Stage 2.

Testing during Design Stage 3 required validation of a few remaining points.

At the same time, the sampling targeted to crucial user groups. For the end-user groups, an older and less tech-enthusiastic demographic group was recruited: men and women in their 50s; and for the professional user group; five police officers within the Metropolitan Police Service Cycle Safety Team and one cyclist trainer providing training sessions organised by a London council and one road officer from the council were interviewed. The interviews took place in a group format, and the interviewees were invited to try out the prototypes and freely discuss their strengths, weaknesses and any other reactions that emerged. This process was

moderated by the design researcher and it was made clear to the participants that this data was being collected as part of her research.

Occasion	Date	Venue	Profile of Respondents	Number of Respondents
Cycle Training provided by the Royal Borough of Kensington & Chelsea	April 2017	Westway Sports Center, London	- A cycle trainer - Road safety officer at the Royal Borough of Kensington & Chelsea, - Five cycle trainees (males and females in their 40s and 50s)	7
Public campaigner testing	April 2017	The office of the Metropolitan Police Cycle Safety Team, London	- Police Officers of Metropolitan Police Service Cycle Safety Team	5
Total			End User Group	6
			Professional Users Group	6

Table 11. Respondents profile in Design Stage 3

Professional Users

Task Completion

The professional users, who are in public campaign/training positions, were given a task to complete using the outputs produced, which required them to replicate the scenario of showcasing the VR experience to other users. After an initial demonstration by the design researcher, the participants were asked to assemble the headset on their own and play the video to the person next to them.

Almost all of them learned the task without difficulty, and could complete the task of the headset assembly and playing the video from the viewer app, within 10 seconds, which is a dramatic improvement compared up average one minute 30 seconds it took in the Design Stage 1, even with the initial aid of the author who helped with wearing the headset, and locating the video. However, the stability of the assembled set caused concerns for some users in terms of dropping the phone; hence the stability of the headset was considered as an issue to address.

Acceptance

On a side note, there was slight resistance to evaluating the prototypes positively in the police group were also members of the Cycle Safety Team, which is dedicated to the Exchanging Places campaign. This was potentially because some respondents may have seen it as a competitor to their current service format of Exchanging Places, rather than as a complementary aid to achieve their public safety goal. ‘This will never replace EP’, opined a police respondent. A social stakeholder who did not belong to this group made the point as follows: ‘[The police] like their trucks’. As a result, the issue of image resolution has been highlighted by the police group (detailed in Chapter 4. Discussions).

Regarding the headset, they continued to prefer the Oculus headset for the techy look and for the immersiveness of being hands-free. However, the police respondents all belonged to the same demographic: males in their 40s, this preference stemmed from seeing themselves as the end-user, without considering the wider demographic of users among the mass public. This was understandable as only the key social stakeholder has seen the trials of wider user groups. This factor highlights the relevance of participatory practice. More participation from the whole stakeholder groups in the NPD team, would have helped with

achieving more common understanding among the whole team for the end goal. For this reason, their responses will need to be analysed with caution.

	360° Video (See Appendix 3 For YouTube Link)	Headset 'Dee'
Strengths	- Very easy to watch, clear; the message is well communicated.	- Easy to assemble and carry. Potentially customisable with branding to promote organisations.
Weaknesses	- The image (2K resolution) still seemed blurry to professional and some end users.	- The optical focus was not perfect. - Concerns for the stability of the phone fixed into the case for the police officers.
Overall	- Overall a reasonable quality has been achieved in terms of communicating an important safety message to the public, with a format (VR) with a novelty factor that encourages members of the public to try.	- Provides a new possibility for the road safety officer working for a council. - The portability and potentially the low cost of the headset was a very appealing factor. One social stakeholder suggested a scenario in which a police officer could distribute the headset with a recommendation to watch the film content to the minor traffic offenders, which would change the whole concept of police enforcement.

Table 12. User evaluation in Design Stage 3: 360° video and headset 'Dee' for Professional users

End Users

A female user in her 50s, who was relatively resistant to technology gadgets still happily tried wearing the headset while ‘warning’ others by saying “This is my first time trying virtual reality. Please understand, I might act in a weird way’.

This response was a clear validation of the new headset prototype, whose goal is to remove the fear of trying virtual reality, that has been highlighted among such user groups. The communication of the film still seemed a little fast-paced for ordinary citizens who are unfamiliar with public safety information regarding an HGV. However, having experienced from the perspective of a truck driver, the users by declaring that they would cycle a lot more cautiously, and would also be happy to watch the film again to absorb the content better. They agreed that they now plan to keep their distance, which shows the key objective of safety education was fulfilled.

	360° Video (Check Appendix 3 For YouTube Link)	Headset ‘Dee’
Strengths	Like the format (end users); Easy to follow, Some users found it very fascinating new experience.	Conveys a fun and ‘friendly’ personality thanks to the flexibility of the textile and the D-shaped design.
Weaknesses	For some, the pace was still too fast to grasp the message fully; Volume of the video could be a problem with background noises.	The sound might have been muffled by the textile material.
Overall	Very interesting new format	Served as an intriguing talking point

Table 13. User Evaluation In Design Stage 3:360° Video And Headset ‘Dee’ For End Users

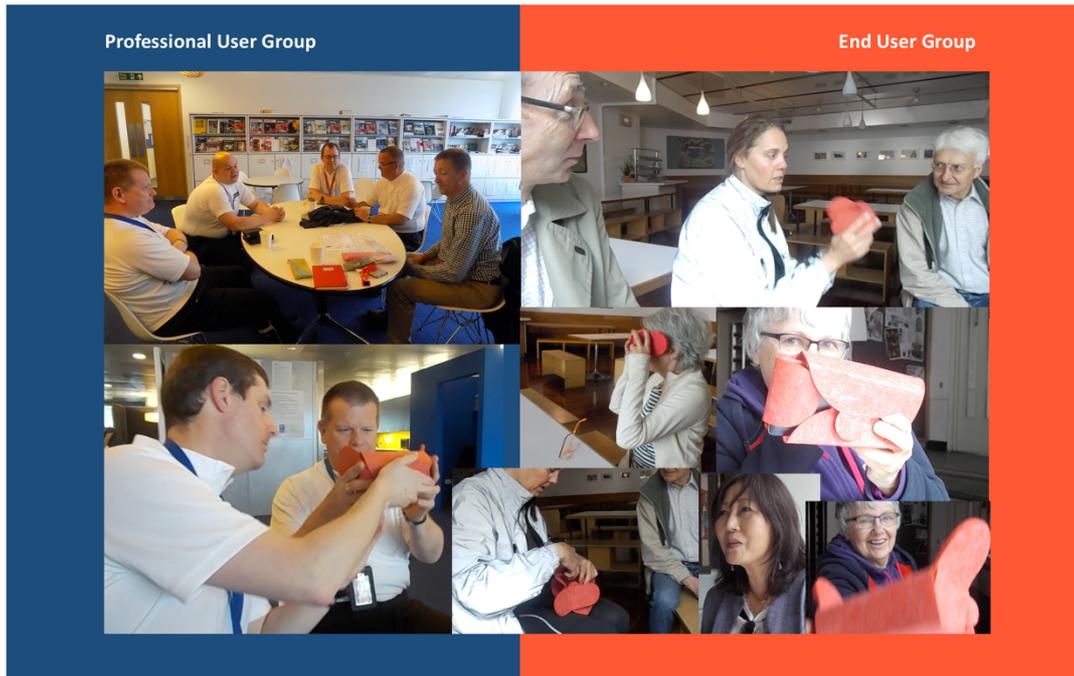


Figure 21. User Testing in Design Stage 3.

(Left) Professional Users (Right) Cyclist Users with a cycle trainer (center in the top right)

Photo Taken By The Design Researcher

Conclusions

The testing with the professional user group proved the new experience fulfilled the major goals, in terms of ease-of-use for an outdoor campaign scenario. Except for a minor iteration to improve the headset's stability holding a phone, and the film was evaluated as effective. The respondents were generally favourable to the medium.

The testing with the end user group showed the new form factor was effective in addressing the population that were hard to engage with, while still attractive to other user segments.

CHAPTER 5: DISCUSSIONS

5.1 Does It Work? On The Potential of a Viable NPD Framework

5.1.1 Evaluation of the Design Output

One way to know the validity of a new product development(NPD) framework would be to practice it and evaluate the design outcome. In this vein, four criteria were considered, each of them closely related to the four values that were used. ‘Message effectiveness’, ‘ease-of-use’, ‘business potential’, and ‘appeal’ were scored out of five, with one being the lowest and five, the highest. The dimension generated out of the four scores illustrates the strengths of the product each prototype has in relation to other stages.

Figure 20 enables the evaluation of the NPD framework in terms of two aspects. The first relates to the quality of the outcomes in each stage and the implication that it has improved as the project progressed from the Design Stage 1 to 3. The second relates to the final outcome being evaluated highly in three aspects out of four aspects, except viability. Fully exploring the business potential of a design prototype is beyond the scope of this research.

Prototype Evaluation by Stages

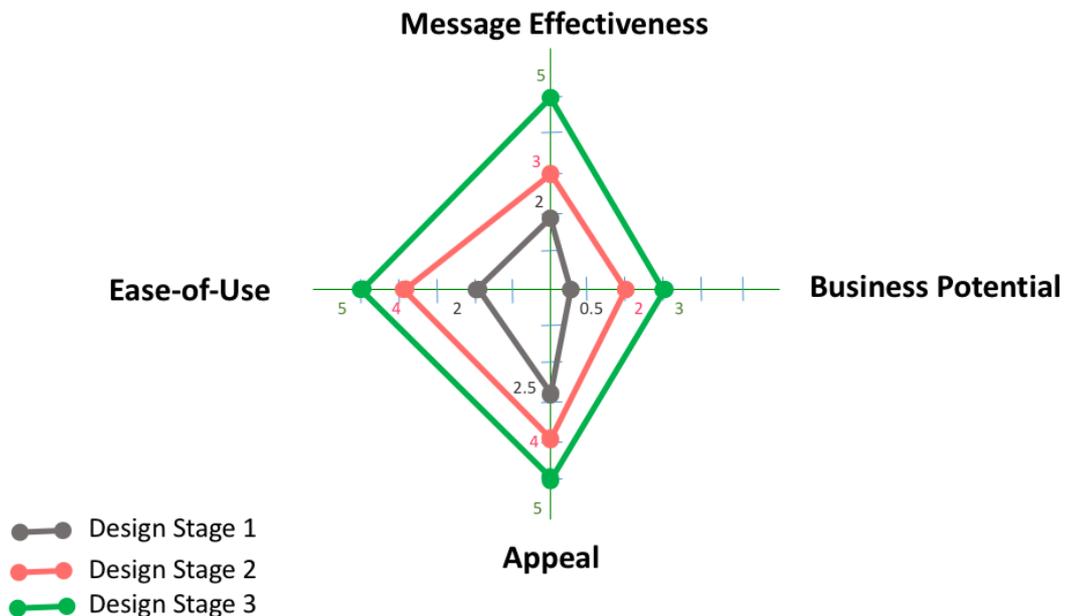


Figure 22. Evaluation of the VR campaign experience provided with the prototypes, by Design Stage

*5-point score scale with 1 starting from the inside

Message Effectiveness

1 = Poor 2 = A Little Effective 3 = Moderately Effective 4 = Quite Effective 5 = Strongly Effective

Overall Ease-Of-Use

1 = Very difficult to use 2 = A little difficult to use 3 = Acceptably easy 4 = Somewhat easy to use
5 = Very easy to use

Appeal of the Experience

1 = Not Appealing at all 2 = A little bit appealing 3 = Moderately Appealing 4 = Appealing and enjoyable 5 = Very appealing

Business Potential

1 = No or hardly any commercial potential at all 2 = Might be a commercial opportunity, but uncertain
3 = There is a certain path of commercial 4 = There is a commercial opportunity with a customer 5 = A commercial opportunity worth investing

5.1.2 Evaluation of Customer Adoption

As noted above, it is beyond the scope of this research to actively seek out a commercial opportunity. The quality of the outcomes has instead been validated by the key supporters of this research. The latest version of the video is planned to be officially promoted by the social stakeholder organisation involved in this enquiry; the Metropolitan Police will screen it at their public events and on their YouTube channel. This outcome validates the research not only as a proof-of-concept but also as a final product. The headset prototype Dee, has received an inquiry from the business stakeholder's organisation('Company A'), who are interested in up to 400 units. These would be customised with the company's logo and distributed as a promotional gift at conferences for safe practices of commercial vehicle industry, demonstrating Clarity's commercial potential to be an innovative stand-alone product. After watching the latest version of the video, Company A also decided to endorse its content and retrospectively sponsored the shooting expenses.

The endorsement of the final outcomes of the project demonstrate the validity of the NPD framework of integrating a social stakeholder which this research has explored.

5.2 What Does It Take? Challenges to a Successful Execution for an NPD Framework for Socially Responsible Design

5.2.1 Managing Uncertainties

In the case of technologies that have been around years, methods for harnessing them is often well mapped. However, finding solutions by using nascent technologies can be more difficult. An important consideration in this regard is workflow, which is often difficult if not impossible to predict.

Based on Clarity as a case in point, a big challenge to making a new VR experience a reality is the limited accessibility to information related to technical know-how and where to locate the right skillsets. This is largely due to the novelty of VR technology. Most VR providers and the developers are in the early learning stage.

Being a nascent technology, the user-friendliness of VR and VR products available in general have room for improvement. There are still many ‘bugs’ to work out in camera products and editing software. and the knowledge to work around these problems becomes critical. When it comes to ‘workarounds’, developers seem to depend on picking up this knowledge as they go along or asking amongst other professionals and enthusiasts in their online communities.

For example, very little technical knowledge and information on VR is available through well-established sources such as books or training providers. The Clarity team faced many stumbling blocks just to find basic information, such as:

- Where to get the 360° camera
- How to position the camera
- How to operate the camera
- How to adjust to different lighting conditions
- How to edit the footage
- How to do the colour correction
- How to add effects and text

5.2.2 Understanding the Digital Aspects

The Metropolitan Police Service and Fleet Operator Recognition Scheme have been broadly supportive of this new digital initiative to bring 360° content to safety education. However, digital-based services are relatively new to their work

remit and there was a steep learning curve for both organisations, which was illustrated in the verbatim of a feasibility stakeholder during the post-project interview.

Feasibility stakeholder: “[It was frustrating] When the devices we’ve got didn’t work as we intended them to be. And then other participants [social & viability stakeholder] started losing faith/became unenthusiastic [because of the bugs]. It’s hard to explain [the imperfectness of] new technologies to participants who cannot understand.”

There are a few illustrative examples which showcase the lack of understanding in organisations to harness the unique advantage of digital for a challenging task. These examples have been given titles of i) Harnessing the unique benefits, & ii) Specification vs Scale.

i) Harnessing the Unique Benefits

The first video was made in complete silence, with the idea that narration would be provided by a police officer whenever it was screened. There was a genuine conviction from the police stakeholders that the VR version must be an exact replica of the physical version of Exchanging Places, which would enable him/her to pace the content accordingly, moving faster or slower depending on who was encountering it.

That the police had been carrying out the program using live narration for many years seems to have influenced their view that a voiceover was not an ideal format. Nevertheless, it was suggested to them that the voiceover feature would also have the crucial advantage of being digital and hence easily scalable. With the voiceover, the experience could potentially be enjoyed independently at home and hence beyond the scope of cycle safety events, which are usually hosted around central London and thus inaccessible to many.

Further, public campaigns are often carried out in noisy public environments. Those supervising the VR experience would surely find it challenging to rehearse the same narration in such difficult contexts.

After observing the programme's development and listening to the researcher's argument, the police team finally agreed to the voiceover on the grounds it was more effective to have it integrated into the video content.

ii) Specification Versus Scale

The second video shoot aimed to implement new ideas for the digital narrative, such as having the police officer appear in the video. However, the project also experienced a major crisis due to these added complexities. In the second shoot, a Samsung Gear camera was used instead of a Giroptic camera, that had been used previously for the first shoot. Unlike Giroptic, the Samsung Gear 360° does not have any real-time stitching functionality. Moreover, the team's technical assistant had no prior experience with 360° image stitching software. After a steep learning curve involving inquiries to the camera provider, searching YouTube tutorials and online forums, the team managed to progress the project, before hitting further stumbling blocks. For instance, the image quality of the final output was rather disappointing. The key element of the video of the cyclist in the driver's mirror was extremely difficult to spot, putting the narrative's message of safety at stake.

To make the most of the shoot and work with the footage that was captured, the design researcher suggested a post-production solution: making the cyclist's image in the mirror clearer using Photoshop-like effects. However neither the public stakeholder nor the business stakeholder felt this was satisfactory.

The social stakeholder had the opinion that the output did not reflect the status of the latest technology. He believed using a GoPro would improve the image quality, making it a better standard than what was captured by the Samsung 360° camera. His disappointment in the latter had led him to compare the video quality in general to a 2D video officially announced by Transport for London, which was considered to be a big budget project with about £20,000 worth of investment.

However, from the design researcher's point of view, the video was not suitable for the mass public. At twenty minutes, it was lengthy and very technical. It was clear the video was made for safety training professionals; it was not engaging sufficiently for the mass public.

The email correspondence (Figure. 23) was from the design researcher to the social stakeholder, explaining why with the VR format, featuring the police officer in the video makes an important difference to the narrative.

According to the participant from the Company A, the audience to whom the film was screened the video was disappointed with the image resolution. None of them had seen a 360° video before and being unfamiliar with this new technology, had expected stunning image quality, comparable to High Definition television(HDTV). The result of this perception was that they strongly complained of the image quality.



Figure23. Correspondence between researcher-designer-facilitator and a social stakeholder.

Illustrated by Design Researcher

Company A's resistance to VR, despite appreciating that VR is a nascent and disruptive technology format with great potential shows their preference for established technology with a higher specification but with lower scalability. This situation is not uncommon as explained in Clayton Christensen book, *The Innovator's Dilemma* (1997).

The following email excerpt, which was sent from the design researcher to both the public and business stakeholders on 23 December 2016, helps to illustrate the challenges risen by such disparity in views: (see Figure24)

Re: Concerns about the pixelated image issue.

Sent: 22 December 2016 at 19:54

Dear OOO

I've watched other footages with taken with 6 GoPros on a mount (8K resolution while Gear360 is 4K) and while it looks slightly better, it DOES have pixelated images. I've spoken to my contact at Discovery channel who've also used 6 GoPros (which he used for their content purpose) and his opinion as content expert is the same. The issue of pixelated image was there but they are using it for some purposes, it will not go away unless we involve a very, very high end major production studio quality camera, which they will only use for certain broadcasting purposes, but not all even as a production company.

Image loss during post-production is rather a myth & it is minimal. The reason why it looks worse on Gear360 or any other headset is that while watching on any headset, the images are effectively stretched out 4 times more in front of our eyes. So it is as if 8K resolution becomes 2K, and 4K resolution becomes 1K. And 2K & 1K doesn't make a huge difference as long as they both look pixelated.

At the same time, YouTube or Facebook 360 viewer has up to 4K as maximum resolution, so going any higher would be meaningless, unless you would like to preload each video in each device of the viewer, which is really not the point of doing a digital format that can be shared or downloaded individually.

So my judgement is that we should focus on completing the loop of the story, by focusing on improving the cyclist visibility separately (I think this post production would still be required even with different cameras) and enhance them as much as we can.

In my project video one teenager mentioned about the pixel. After about a hundred of testing with different users, I only had that remark from 1 or 2 people in reality, but I kept it here intentionally for now, to intrigue that we keep that in mind and there will be definitely something done about it.

Last night I've watched a black & white movie by Alfred Hitchcock. It shows how any highest production quality of the time quickly gets outdated, and how it is not the main point of anything we watch. A footage that might look okay next 6 months will be outdated very soon, and I do think you should grab the opportunity to be the first rather than fixating over the pixel issue.

Pixel is not something anyone will talk about your video after even in 12 months' time, but it will be your legacy you can even tell your grandchildren to say that you are the first one to have released the 360 format of the campaign in your organisations.

Many thanks
OOO

Figure24. Correspondence between researcher-designer-facilitator and a viability stakeholder. Dated 22 Dec 2016

5.2.3 Brokering Knowledge:

Madhavan and Grover (1998) understand the key task of an NPD process as knowledge management. The challenges for team members include objectifying implicit information to effectively share with other team members. Bradfield and Gao (2007) attribute problems associated with knowledge sharing to the ambiguity and priority of what knowledge has to be shared.

The coordination of knowledge sharing and communication proved both challenging and vitally important for the successful execution of Clarity. The design researcher observed that a big aspect of knowledge sharing during the project was the mode of communication and facilitation.

The practical nature of the research made it possible to look for the best solution and optimise the process, rather than simply experimenting in a controlled environment. The mode of communication was one of the biggest influencing factors in this case. In the early phases of the project, a workshop format was explored with as many participants in one meeting as possible. However, as this work was unfunded and the participants had other jobs to which they were committed, the high degree of attention proved impossible. So a page at Slack, a collaborative project platform, was established for all participants to keep abreast of the project's development; nevertheless, the participants' different roles and degrees of contribution made it difficult to establish common interests with regard to the project status and having an overarching discussion was challenging.

Also, the age group and the variety of positions the participants held impacted their preferred mode of communication significantly. Communication with younger members of the project was relatively more frequent, spontaneous and expressive, with many emojis. Such communication could be flexible and rich in information but could prove inconclusive. Communication with the viability and

social stakeholders was less frequent and relatively formal, often by email and face-to-face meetings that were scheduled in advance. The responses were not always provided on time but well-structured. It was difficult to gather all the participants in one place and communicate with them all in the same way. In this regard, the researcher attempted to move between communication styles as required and on a one-on-one basis, for most of the time. In doing so she assumed the role of a facilitator.

It is beyond to scope of this study to investigate in-depths how different communication tools have their own strengths and weaknesses and how these might be used strategically. However, it is noteworthy to point out the extent of the variety of the communication, as it illustrates one of the challenges of a multidisciplinary team. During Clarity it was possible to accommodate different communication styles by interacting with them individually. However this required a substantial investment of time and effort from the design researcher. One focus of further research could be to consider what new forms of communication might be able to incorporate various communication needs of multidisciplinary teams.

Age		Role	Email	Face-to-Face	SMS	Whatsapp (Individual)	Whatsapp (Group)	Skype	Google Drive	WeTransfer	Dropbox	Slack
20s	Feasibility Stakeholder	Technical Assistant	●	●		●	●	●	●	●		
		Developer	●									
		360 Filmmaker	●		●					●		
	Desirability Stakeholder	Industrial Designer A	●	●		●	●	●			●	
		Industrial Designer B	●	●		●	●	●	●		●	
		Industrial Designer C	●	●		●	●					
30s		Developer	●									
		Designer-researcher	●	●	●	●	●	●	●	●	●	●
40s		Social Stakeholder	●	●	●							
50s		Viability Stakeholder	●	●							●	

● Always
 ● Sometimes
 ● Used for the first time during this project & considering to use more
 Long-distance

Table 14. Diverse Modes Of Communications Among Stakeholders: By Age Group And By Functions

This person-to-person approach has both strengths and weaknesses. The strengths lie in the adaptability and flexibility, as the style and needs of communication are so diverse, as indicated by the table above. However, learning about the subject matter can be more effective when interfacing directly with the subject expert, even though this is not always the case. Sometimes the communication skills of the design researcher mediating between the needs and the eye level of two parties are crucial in establishing common ground. There were some incidents where a face-to-face exchange would have made things easier, especially when breaking negative feedback. However, constructive feedback is necessary and must be taken on board for the project to progress. For such communications, the design researcher could smooth things out. There were other occasions when the design researcher did not establish enough authority and a subject expert was necessarily better placed to provide the information that would prompt action or some other response. Based on the example of Clarity, it is a good practice to combine both group-level and face-to-face exchange as well as facilitator-to-member exchange, when required.

5.2.4 Managing Conflicts of Interests

Project teams often suffer from conflicts of interest and other differences when members bring different circumstances, understandings and personal preferences to the table. So, by definition, the stakeholders in each area are in conflict with one another and a level of disagreement is predictable as the team need to establish a common ground where all of the criteria of each area are to some degree protected.

In a participatory design project, the tendency to agree with the person in an authoritative position, especially in a group setting, has been readily observed (Athavankar et al., 2014).

In Clarity, as the majority of the communication was one-to-one and not in a group setting, it was the design researcher's job to mediate the differences into some kind of agreement. She made it her mission to represent each party's position to the others and not promote one party just because that party seem to have stronger interests or a more authoritative voice. This was not easy but it was easier than managing conflicts in a group setting.

Coming up with the narrative of the 360° content illustrates this commitment. The original narrative suggested by the social stakeholder in Design Stage 1 was rather monotonous without voice narration, with no background music and no visual cues as to where to look.

The table below illustrates how different elements of the 360° content related to each. For example, to make the video more impressive for the viewer, the narrative designers were hoping to use a large articulated lorry to add more dramatic impact by its sheer size thus capturing more attention, especially from children. However, for the social stakeholder, it was more important to communicate rigid trucks not as intimidating in size as this would be more dangerous being statistically more involved with cyclists and pedestrian fatalities. Similar examples of high-visibility jackets, which would help viewers to recognise actors more easily recognisable. However, this was not acceptable from the social stakeholder's point of view, as many cycle safety activist organisations are against the police encouraging the wearing of high-visibility jackets, in light of it putting undue responsibility onto cyclists to be visible.

Criteria		Desirability	Responsibility	Feasibility	Viability
Stakeholders function		Designers	Cycle safety Campaigner	VR film maker Technical Assistant	Safety promotion program manager
Goals		Powerful & engaging message communication	Realism & compliance with positions of cycle charities	Technically achievable	Minimum project cost at maximum quality
Elements Of the 360 Content Affected	Vehicle	"Big articulated lorry adds more drama & interests from the viewer."	"We shouldn't use articulated truck but use rigid truck as they are the biggest causes of accidents in reality"	-	-
	Costumes	"To make it visible, high visibility jacket & helmets for all actors would help"	"Cycle charities protest their right to wear normal clothes and we don't want to provoke them. So no high visibility jackets & helmets."	-	-
	Length of the video	"We need to keep it less than 2 minutes not to bore anybody"	"To convey the message for safety at least 3 minutes is needed."	-	"Each minute would add the cost in editing."
	Lighting	"A bright sunny day is ideal for a nice atmosphere, as the message can be heavy"	-	"It's better not to bright to avoid overexposure."	-
	Acting	"As good as it gets"	-	"It is not possible to have a real-time view of the footage, or the director to be present in the 360 environment so very difficult to monitor the acting."	"Hiring vehicles cost money for our partners. Time is limited for hiring the vehicle, cameraman, and extras."

Table 15. An illustrative case example: conflicts of interests for the storyboard

So how do we resolve such conflicts? Paul Hennessey, an executive of marketing, research, and development at Bay Group International, a consulting and training firm is quoted in saying ‘Stay with the tension, in our work, the best teams and their leaders are able to “hang in there” with the tension and keep exploring creative options. It’s much more likely that innovative solutions will emerge’ (Kling, 2009). The researcher learned that resolving the disagreements is about maximising common ground. To be able to do so, the design researcher needed to lean into the tension and face it. For only then will the exact boundary of how much each participant is able to accept or not would emerge.

5.2.5 Locating the Knowledge and Talents

VR developers continue to discover many technical errors or bugs. Much of this work takes place in crowd-sourced formats such as developer forums and on-line communities. So the technical troubleshooting in many cases is not documented or centrally aggregated. Quite often, the Clarity team had to resort to personal networks of members of the technology community.

Here are some examples of knowledge sources that the design researcher and other members of the team found helpful.

Personal Networks:

- Personal contacts at Samsung (camera & software provider)
- Personal contacts at Giroptic (camera provider)
- Email inquiries to GoPro Kolor team
- Personal contact at the Discovery Channel and introduction to a 360° film maker
- Enquiries to Nokia regarding loaning/sponsorship of their OZO camera product

Online or Crowdsourcing Communities:

- YouTube searches on how to use AutoPano software to edit outputs from Samsung Gear 360°
- Oculus and Unity Developer forums search on information about large file size error issue Mettle Skybox – editing software
- Mettle Skybox tutorials
- 360 Hero (Equipment lender) tutorials

There were also paid workshops held by 360° camera manufacturers or editing software developers (360° Heros, Mettle, Adobe) to help with troubleshooting. But often these workshops were expensive and hence beyond the reach of many low budget technology entrepreneurs.

Finding a VR app developer was one of the biggest challenges during the project. The limited budget made it impossible to pay market rates to the developer, quite

aside from the difficulty of finding a developer who had the skills to work with a VR interface. After three potential candidates turned out to be inappropriate, a breakthrough came when an established VR developer was willing to donate his time and his VR viewer app to the service of social innovation. Notwithstanding, the development remains ongoing at the time of writing up the research. This points to the challenges faced by low-budget projects that also require highly specialised and hence often expensive skillsets to ensure their full development, identified as another challenge to their potential success.

5.2.6 Summary of Essential Elements for Success

As indicated by Clarity as practice-based research, it can be concluded that for the successful execution of an impact technology practice, five essential elements discussed above may be involved. Among these, the three elements – Managing Uncertainties, Understanding the Digital Aspects and Locating Knowledge and Talent proved particularly challenging being linked to the emerging nature of the technology therefore making the successful overcoming uncertain. Understanding Digital Aspects is particularly more challenging when the partner organisations are unfamiliar with the capacity and the limit of the digital technology in question and have unrealistic expectations.

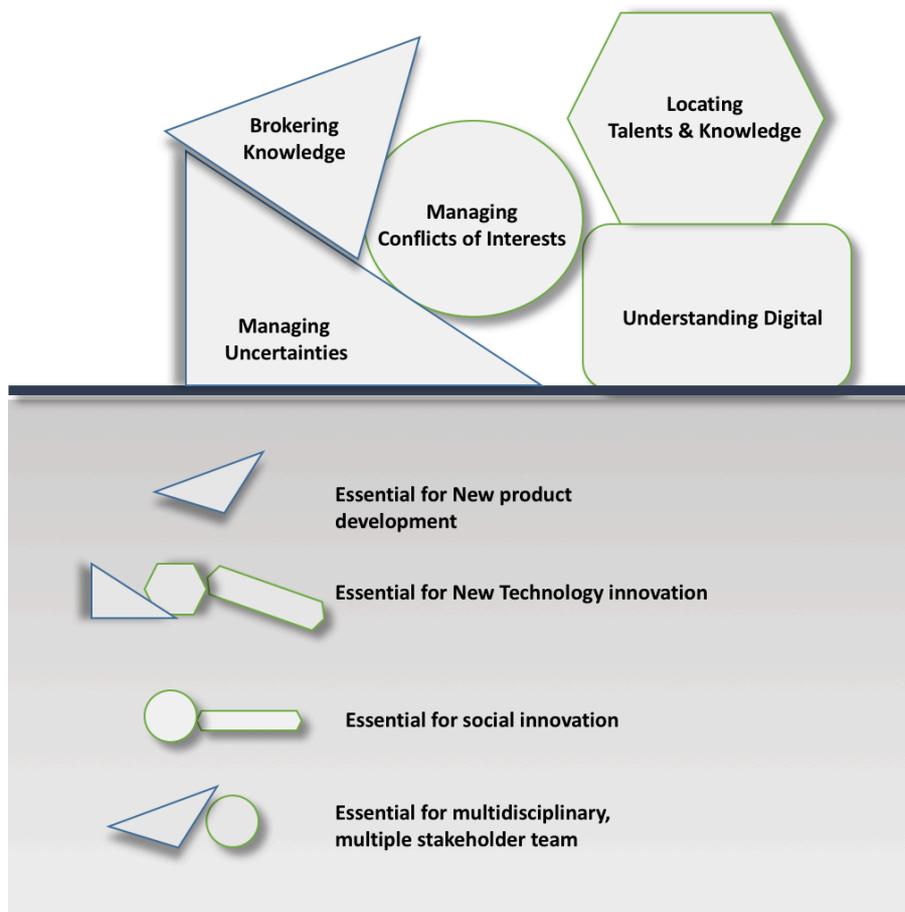


Figure 25. Building Blocks for a Successful Execution of the NPD framework for Socially Responsible Technology, Illustrated By The Design Researcher

5.2.7 How We Might Be Able to Mitigate the Challenges

Here are measures the researcher proposes for each challenge.

5.2.7.1 For Managing Uncertainties

Setting a reasonable time scale is critical to the success of the project. As the workflow is not defined, such initiatives must be approached as a longer term R&D project rather than short-term development jobs that span across up to several months, which have well-defined workflows.

5.2.7.2 Understanding the Digital Aspects

Successful case studies of digital transformation could be shared with the organisations. Before starting an impact design technology project, potential team members may benefit from an induction in what digital technologies can do to help achieve their organisations' goal.

5.2.7.3 For Brokering Knowledge

The facilitation and the communication process during Clarity showed that communication works best when adapted to the level of understanding and the preferred language of team members. The mode and style of communication would benefit from adaptability on a case-by-case basis.

5.2.7.4 For Managing Conflicts of Interests

It is imperative that the project leader is not afraid the tension that can arise when the interests of stakeholders come into conflict. Based on her experience, the design researcher proposes that the project leader should to his/her commitment to resolve this issue. One tactic used during the research to establish and maximise common ground was to ask for the same requirement of each the stakeholder in multiple ways, to understand exactly what part of the requirement the stakeholder was most essential and thus to be prioritised.

An example exploring the challenges involved in establishing common ground was discussed above in the same chapter section 5.2.4.

5.2.7.5 For Locating Talents and Skills

A skill exchange or a skill donation platform would help mitigate some of the challenges involved with working on new technologies. On such a platform, technical experts are given space to declare their willingness to spend time on a particular component of a social project. Similar form of skills exchange can be found in new social technology initiatives, such as Techfugees (<https://techfugees.com>).

Another solution for tackling such technical difficulties could be to secure funding early on. This would enable the team to achieve the necessary security to hire a highly specialised expert who is well placed to handle the majority of technical difficulties and could give more visibility to the success of the outcome. However such a decision would be challenging to make early on, as there is much uncertainty as to which components of the technology will become critical to the project's success.

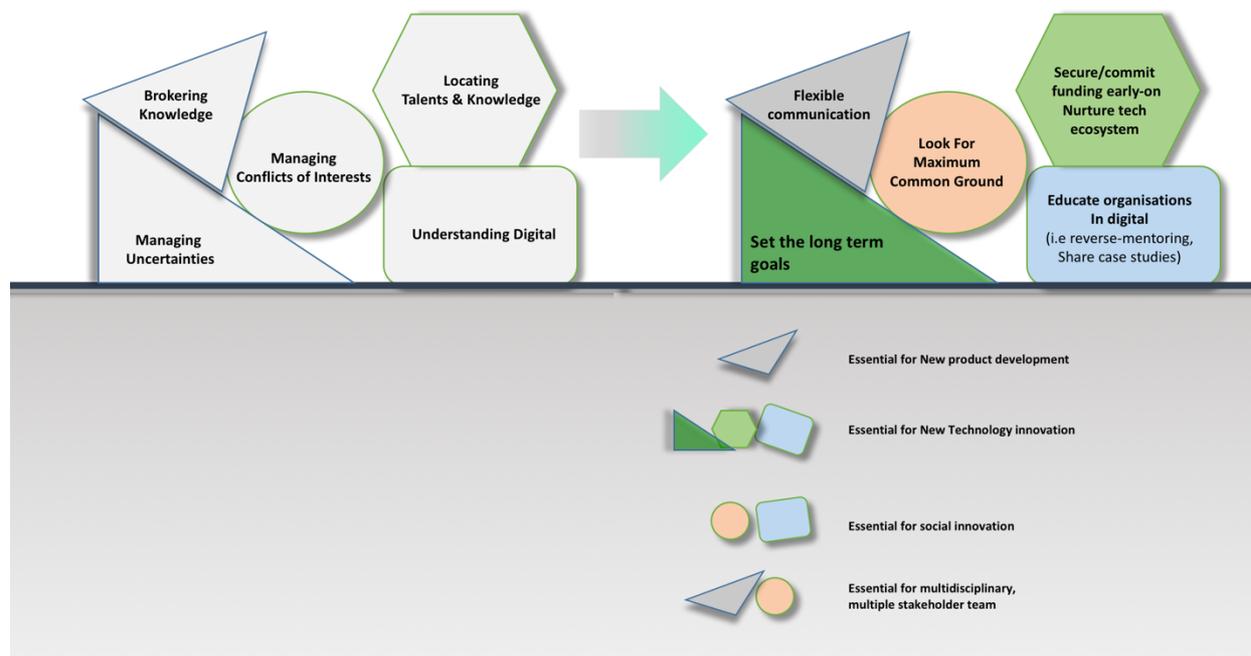


Figure 26. Building Blocks & Mitigating for a Successful Execution of the NPD framework for Socially Responsible Technology, Illustrated by the Designer Researcher

5.2.7.6 Implications

This research proposes that designers are likely and suitable to play the role of the facilitator via assuming the position as the project lead (See Chapter 1.4., Why Designers Must and can Play the Leading Role). For the design community, this research proposes that members strive to build more awareness and if possible, training, to build experience in managing conflicts and adapting communication skills. The lesson here begins with refusing to assume that a project's business stakeholders and social stakeholders will have the same understanding of digital and other new technologies, which makes good induction essential. It is also important to communicate the explorative nature of the project to the stakeholders in advance, while at the same time managing their expectations to ensure they are reasonably aware of the project's timeline. If possible, securing some budget at the early stage of the project to facilitate the recruitment of necessary technical skills, hardware and software.

For the project's social and viability stakeholders, this research underscores the value of coming to the table with an explorative, open mind and with some patience in the face of uncertainty. Large corporate organisations could potentially use their corporate social responsibility to help build a platform where engineers, developers and social stakeholders could 'matchmake' each other's problems and skills. Some developers, such as the VR experts in this project are open to skill-donation or skill exchange for a good cause, so long as it does not require too a time factor, which the project lead remained sensitive to.

Stakeholders can also share amongst themselves successful case studies of digital disruptions or innovations that use new technologies. This could help employees better understand the benefits as well as the limitations a new technological solution can bring.

5.3 What Did We Learn as a Team?

5.3.1 Previous Researches in Participatory Design Gains

It is very rare in research projects involving participatory design to address or focus on the gains of participants, the exception being the work of Bossen et al. (2010 & 2012). They have analysed user gains and impediments to these in participatory projects involving multiple stakeholders in Danish primary and secondary schools.

Similarly, Bowen et al.(2013) have analysed the participants' experiences after a participatory service design project for National Health Service(NHS) outpatient care. However, the main focus of this research was on the experience on the satisfaction and dissatisfaction level throughout the participation.

Simm et al. (2013) have carried out a digital technologies co-creation project on homeless people that involved a diverse group of academics and voluntary community advocates. This research covered participatory design gains among the project's team members. However the primary focus was on the benefits that centred around the new network of people, as also highlighted in the research of Bossen et al. (2013).

Athavankar et al. (2014) have learned the value of using service design toolkits, such as persona and storytelling, by way of a participatory design project composed of multiple stakeholders who represent different design constraints.

The investigation of previous participatory design gains indicate two important considerations. First, very few of the studies examined what the stakeholders learned from the project rather than the end-users. Secondly, none of the studies examined when stakeholders found themselves in a situation of conflicting

interests, or how their understanding or attitudes towards the challenges of the working with others improved during the project. With this in mind, this part of the analysis aims to address this gap in the research by looking at the participatory design gains (To be referred PD Gains) in a cross-functional NPD team setup that integrates a social stakeholder. It was the design researcher's expectation that there would be cross-functional learning gained by participants. However, in which areas this might happen and to what extent was unclear until the participants' post-project interviews.

5.3.2 Methodologies Used to Measure & Analyse Participatory Design (PD) Gains

The following analysis will specifically focus on how and to what extent working together impacted participants' attitude/awareness/confidence in the other three domains. Such knowledge gained could contribute to the successful execution of future projects of similar nature.

During the post-project interview, the participants were asked to fill in a self-reportage questionnaire on the learning of all four criteria – social responsibility, feasibility, viability, desirability – both before and after their participation in the project. They were also asked to consider any changes in their level of awareness, knowledge, and confidence all the four domains. Participants were asked to highlight on the list of criteria, and also to explain in detail or recall the moments which made them particularly appreciate that they had learned something related to the project. Some responses were written down on the questionnaire and some participants provided the responses verbally which were captured in video format. The responses on the questionnaire were used as a key basis for analysis of the learning but not as a whole. In addition to the questionnaires, the design researcher also used her own observations of the changes in awareness, attitude and confidence throughout the project and other exchanges with the stakeholders

and other participants to assess the learning that took place in Clarity using a five-point scale scoreboard. The scores were made into charts with the aim of visually comparing the participants' learnings before and after the project.

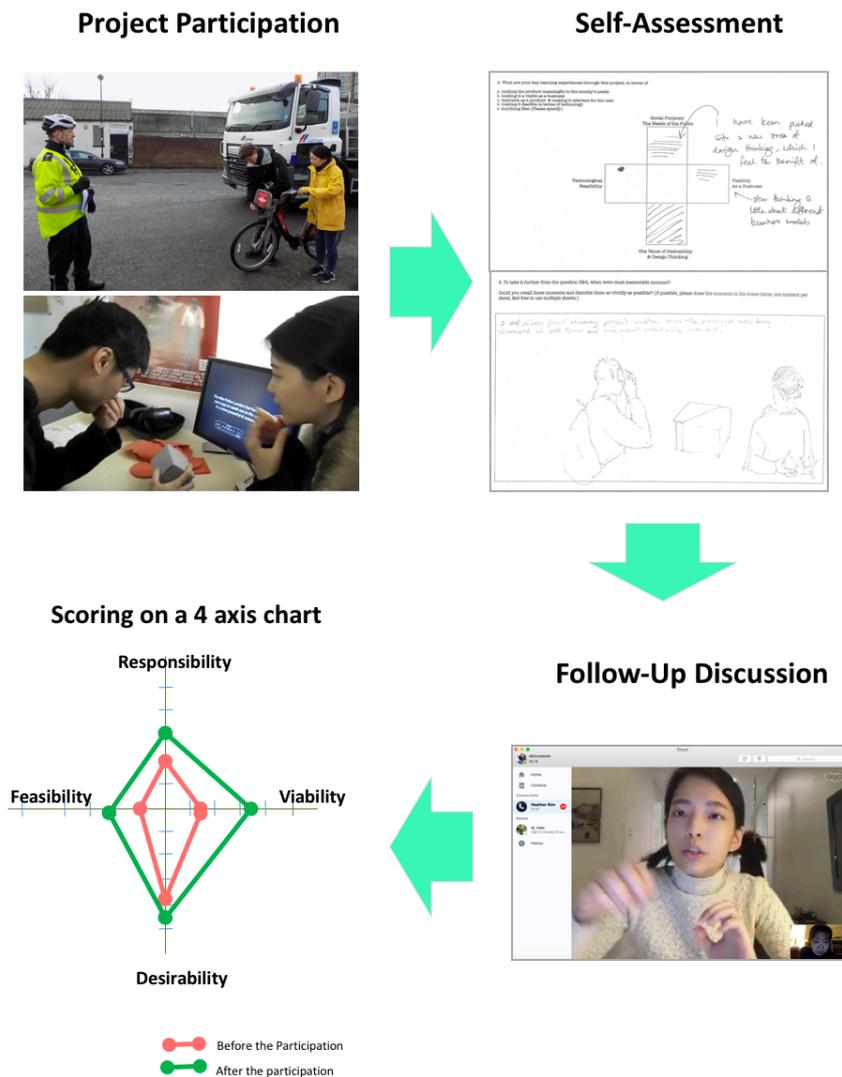


Figure 27. Methodology Used to Measure Participant Gains
Illustrated By the Design Researcher

	Group	Interviewee Details
1	Social Stakeholder	Cycle Safety Program Manager, Metropolitan Police
2	Viability Stakeholder	Program Manager, FORS (Fleet Operator Recognition Scheme)
3	Feasibility Stakeholder	Technical Assistant
		360° videographer
		VR app developer
4	Desirability Stakeholder	Industrial Designer A
		Industrial Designer B

Table 16. Participants interviewed for the post-project interview

Overview of the Interview (According to the order within the questionnaire)

- Participant’s perceived contribution to the project (Without any list of examples of contribution given)
- Participant’s biggest learning experience of the project (Without any list of examples of contribution given)
- A brief description of how the project aims to bring stakeholders of the four criteria together in a team
- Participant’s key learning experience related to the four design criteria (With the list of the four criteria given)
- Recall of the moments when Participant’s perceived differences between their own perspective and that of others
- Recall of the most frustrating moments during the project/issues and challenges/perceived solutions
- Most satisfying moments
- Most memorable moments
- Evaluation of communication with the designer-researcher-facilitator

- Suggestions for future projects
- Changes of perception/awareness in creating a technology product that would serve a social purpose

Since the post-project interviews were guided by the design researcher who also served as the central facilitator, it may have been that respondents would avoid raising dissatisfaction in an attempt to avoid remarks that might sound like a criticism. Hence the questions were structured in such a way that any potential issues of communication with the central design researcher could come up without directly addressing these, e.g. listing the modes of communication used with the design researcher. Respondents were then asked if there was any moment that suggestions made by participants were not taken on board. If this had been the case, the respondent was asked to clarify what instances were of concern, and if the reasons for their suggestions not being taken on board were communicated.

For a clear overview of the PD gains research in this study, please refer to the Figure 28: ‘How to Navigate The PD Gains Analysis In The Next Sections.’

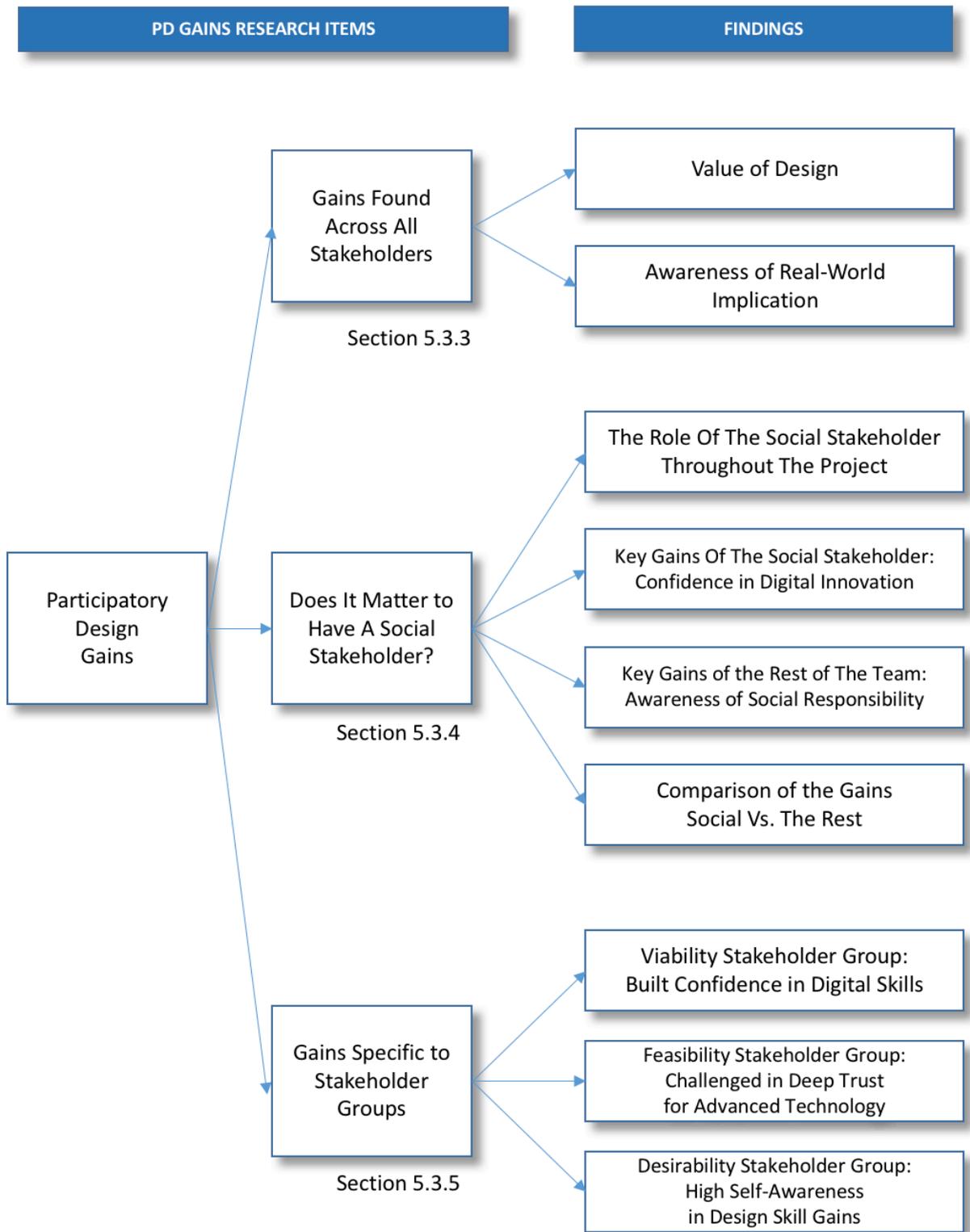


Figure 28. How to Navigate The PD Gains Analysis In This Study

5.3.3 Gains Found Across All Groups

Two gains were found across all stakeholders: enhanced awareness in the value of design; and in the requirements of the real-world.

5.3.3.1 Enhanced Awareness in the Value of Design

With an approach that was relatively open in the beginning without much assumption, it was unclear at the concept stage in which direction this project would unfold, or the project's major outcome would be. Throughout the process, however, participants gained a greater appreciation for what made the project so important and why this involved producing an outcome in the most appealing and simplest way possible.

The key social stakeholder observed the following element of the project: Even though it was part of his job to raise awareness about cycle safety, going forward he would question these messages in a new way that stemmed from his own enhanced awareness of the issues. Becoming more empathetic to those encountering messages about cycle safety was also an important gain for the key social stakeholder, which found form in our adaptation of the video to optimise its communicative potential, by changing the script and the running order, and introducing the police officer into the product. Through being part of this process the key social stakeholder felt that he learned a great deal about the importance of problem-solving skills to enhance the video's impact.

He recalled:

“I enjoyed seeing people's first experiences of VR with a film we had made, realising that the potential was greater than first imagined which were disabled people. [I am happy that we found] an unpatronising way to address adult pedestrian safety.”

The fact that feasibility does not automatically translate into usability or desirability, and that one could question existing provision and attempt to design better alternatives, is an act of optimism for design, and the outcome of the project provided evidence that this was possible. This newly gained awareness was the most important learning for all of the team members. For instance, the 360° videographer observed: ‘Often there are many steps between putting on the headset and watching the video. It was great [the design researcher] is approaching and trying to solve this issue.’

5.3.3.2 Enhanced Awareness in Requirements for the Real World

The discussion above outlines various technical, financial and logistical challenges that had to be overcome for the product to be placed in the hands of the users. While appreciating these challenges was greatest for members of the project who had very little or no previous experience with real-world implementation in particular the technical assistant and the industrial designers, appreciation was significant for all those involved.

Being a design engineering student until recently, the technical assistant had never been involved in the real-world implementation of a project. After the project she said that her participation in Clarity gave her useful concrete experience in a real-world project which in turn enhanced her confidence in job interviews, enabling her to eventually get a job in technical innovation consulting. Before the project, she had considered joining a start-up or founding her own businesses, however, after the project, she came to appreciate the complexities in bringing a real product to market, which led her to conclude that she was not ready to meet this challenge yet. This conclusion was mirrored by the desirability stakeholders. Therefore participating in Clarity gave stakeholders greater

awareness of the challenges and helped them to decide that they did not want to enter into another similar situation on their own.

For the key social stakeholder, who had more life experiences than the feasibility stakeholder also stated understanding the characteristics of digital technologies which directed the success of the real world implementation as the biggest learning curve.

5.3.4 Did It Matter to Have a Social Stakeholder? Mutual Gains: Social Versus the Rest of the Team

To know if it was meaningful to have the social stakeholder's integration into a new product development team, the role of the social stakeholder is observed, and the gains of the social stakeholder and the rest of the team is compared.

5.3.4.1 The Role of the Social Stakeholder in the Cross-Functional NPD Team

As the first line of inquiry, this research proposed that having an actual stakeholder whose priority was social responsibility in the NPD team would complement the project's other constraints, namely feasibility, viability and desirability and that it positively impact the success of new socially responsible technology products.

In section 5.1, the design researcher stated she and her team have been satisfied in the aim to validate an NPD framework which contribute to socially responsible technology products, evidenced by the quality of the design outcome the NPD framework helped produce.

Since cross-functional NPD teams usually consist of experts of all other three criteria, the uniqueness of the framework could be described as having the social stakeholder on board.

Genç and di Benedetto have investigated a similar setup, specifically with reference to the role played by an environmental specialist on an NPD team. They presented a theoretical framework and empirical evidence that examined previous cases to suggest that integrating an environmental specialist into a NPD has a positive influence on making a ‘sustainable new product development team’ a (SNPD) and improving performance beyond what an NPD team comprising traditional membership would accomplish (2015).

So did having the social stakeholder at the proverbial table for Clarity make a difference?

The answer to this question is indirectly presented in the Figure 29 showing the mutual gains between the social stakeholder and the rest of the cross-functional NPD team. While there was only one key social stakeholder who worked across all stages, the Figure 29 shows that his and other social stakeholders’ presence made the rest of the team more aware of the purpose of the project. The awareness unfolded through direct and indirect exchange via the design researcher, with the details of the social requirements have be disseminated throughout the team. Table 16 shows the details of the social stakeholder’s contribution at each design stage.

For the concept development stage, the social stakeholder’s long-term commitment to the cause and extensive knowledge of the topic greatly helped in identifying and prioritising the key issues as well as identifying core resources. His experience also helped the team to better appreciate public awareness of the issues and eventually to determine the content of the key message to be communicated, e.g. raising awareness of cyclists and pedestrians in the blind spots of HGVs. The biggest benefit of having the social stakeholder in the team was when he defended the integrity of the message communicated through the

campaign video content to other stakeholders who had other priorities, namely the communicability and attractiveness of the message (see Chapter Five: Managing Conflicts of Interests). If the social stakeholder had not been there, the team may have focused on making the video aesthetically appealing while not giving necessary attention to its purpose to inform as a public service announcement.

Being within the Metropolitan Police Service, the key social stakeholder mobilised the necessary internal resources such as the police force and the vehicle for the video shoot. He provided the research necessary to access the public in terms of trust and authority. For example, the showcases within the booth of the Metropolitan Police Service at the London Bike Show instantly opened a trustworthy channel for public. It was also thanks to the social stakeholder's crucial contribution that the team had access to a network of other organisations who might be interested in new formats of public campaigns.

Stages		Design Stage 1 (Concept Development)	Design Stage 2 (Prototype Development)	Design Stage 3 (Iteration of the Prototype)
Objectives		To test the viability of a virtual reality format for the public campaign.	- Based on the testing result of DS1, produce a desirable outcome as a virtual reality experience for the public campaign, both in terms of the video and the headset form factor.	- Based on the testing result of DS2, making the experience a more desirable VR experience to prove its viability as a stand-alone service.
The Contribution of the Social Stakeholder	For NPD Process Itself	- Helped prioritising key product attributes	- Defended the integrity of the message communicated within the campaign's video.	-
	For Networking and Resource Support	- Helped identifying the target users - Mobilised the necessary internal resources. - Gave the research the necessary access to the public in terms of trust and authority	- Introduced the NPD team to a network of other organisations that might be interested in the new format of the public campaign.	- Provided access to one of the potential target user groups for testing. - Provided media contacts who might be interested in the new initiatives of this social issue.

Table 17. The Role Of The Social Stakeholder

5.3.4.2 Key Gains of the Social Stakeholder: Enhanced Awareness & Confidence in Digital Innovation

As the social stakeholder's exposure to new technologies in his day-to-day job is relatively low, it is unsurprising that he identified an increase in confidence in when dealing with and learning about the benefits and limits of new technologies as a key outcome. Learning new technical knowledge and being able to discuss them was a central experience for this stakeholder. He also expressed a decrease in his own reluctance to engage with other forms of new technology that he might come across. Crucially, not only did the social stakeholder gain technical knowledge, he also learned to use technology as a tool for social innovation, and he learned that tool must be designed in appropriate ways to ensure their mass adoption, a key element that constitutes a digital innovation.

Regarding the commercial viability of Clarity, he assessed this gain was minimal for him because as a social stakeholder representing the police, he felt that focusing on the project's potential profitability did not align with the interests of his organisation.

Increase in confidence dealing with digital technologies seemed also to have directly or indirectly affected the social stakeholder's career path. As a next career step, he is considering continuing his studies in a part-time master's programme in transport administration and is looking into autonomous driving as his major study topic.

It is also noteworthy that the project seemed to have provided learning similar to that offered by so-called 'reverse-mentoring' projects which have become a training trend within traditionally manufacturing businesses relying on offline retail channels. Reverse mentoring is especially popular amongst those more

established in their career and can include, for instance, executives being trained in social media services that cater to millennials (Frearson, 2017).

5.3.4.3 For the Rest of the Team: Enhanced Sense of Social Responsibility

The project provided an opportunity for those involved to think of the ways to serve society by using their creative skills. The majority said they were aware of this possibility but they had not considered specifically how they might make a contribution. This aspect of learning was stronger among the desirability and the feasibility stakeholders.

One industrial designer observed the following:

“I was really interested in virtual reality/ augmented reality in terms of conceptual space, what’s going to be available in the future. But this project made me reconsider what’s available today, and how it can actually be useful, like, tomorrow, for someone, for safety reasons, [that’s not something I] would have pushed myself to go. The value I got from it was absolutely worthwhile.”

To paraphrase the other industrial designer, she spoke about waking up to the possibilities of how design might be used for social good. She observed the same regarding technology, noting the potential of a customised approach.

The 360° videographer mentioned that while he has extensive experience in 360° projects, Clarity’s VR format for public education regarding the lorry’s blind spot was the best use case he has ever worked on.

The VR developer said that this project gave him an opportunity to give something back to the society, which he had been interested in doing but had not been able to find the right opportunity until now.

5.3.4.4 Comparing Mutual Gains: Social Versus The Rest of the Team

For the analysis of the data from participant's self-completion and the design researcher's reflections, she assigned a score for gain per each criteria domain with a five-point score scale and placed on a 4 axis format chart with one starting from the inside of the chart.

The score was given based on the index below.

Social responsibility:

1 = Not aware 2 = A little aware 3 = Somewhat aware and interested
4 = Very interested to contributed 5 = Confident about the issue and know how to contribute

Technical feasibility:

1 = Poor knowledge and no interests 2 = Very little knowledge and a little interested 3 = Some level of understanding and problem-solving 4 = Expert-level of knowledge and problem solving 5 = Very competent as an expert

Desirability and Usability:

1 = Not aware 2 = Have some understanding of the importance 3 = Somewhat aware of the importance and have skills how to improve 4 = Confident and competent in improving desirability and usability of a product 5 = Very confident and competent in improving desirability and usability of a product

Viability as a commercial project:

1 = No or hardly any commercial potential at all 2 = Might be a commercial opportunity, but uncertain 3 = There is a certain path of commercial 4 = There is a commercial opportunity with a customer 5 = A commercial opportunity worth investing

The Figure 29 compares the gains of the social stakeholder against those of the rest of the team, which include stakeholders of feasibility, viability and

desirability. Dimension A shows the social stakeholders' original skillsets, and dimension B shows moderate but substantial gains on all three value fronts.

In Figure 29, The dimensions represented by C and D are gains made by the rest of the team.

It is not surprising that the team's skillsets are evenly distributed, given that the team was cross-functional. While the gains took place in all aspects, it is worth noting that the gains in the social responsibility aspect is considerable, while there was just one key social stakeholder who was committed from the beginning to the end of the project.

Participant Gains:
Social Stakeholder versus Rest Of the Team

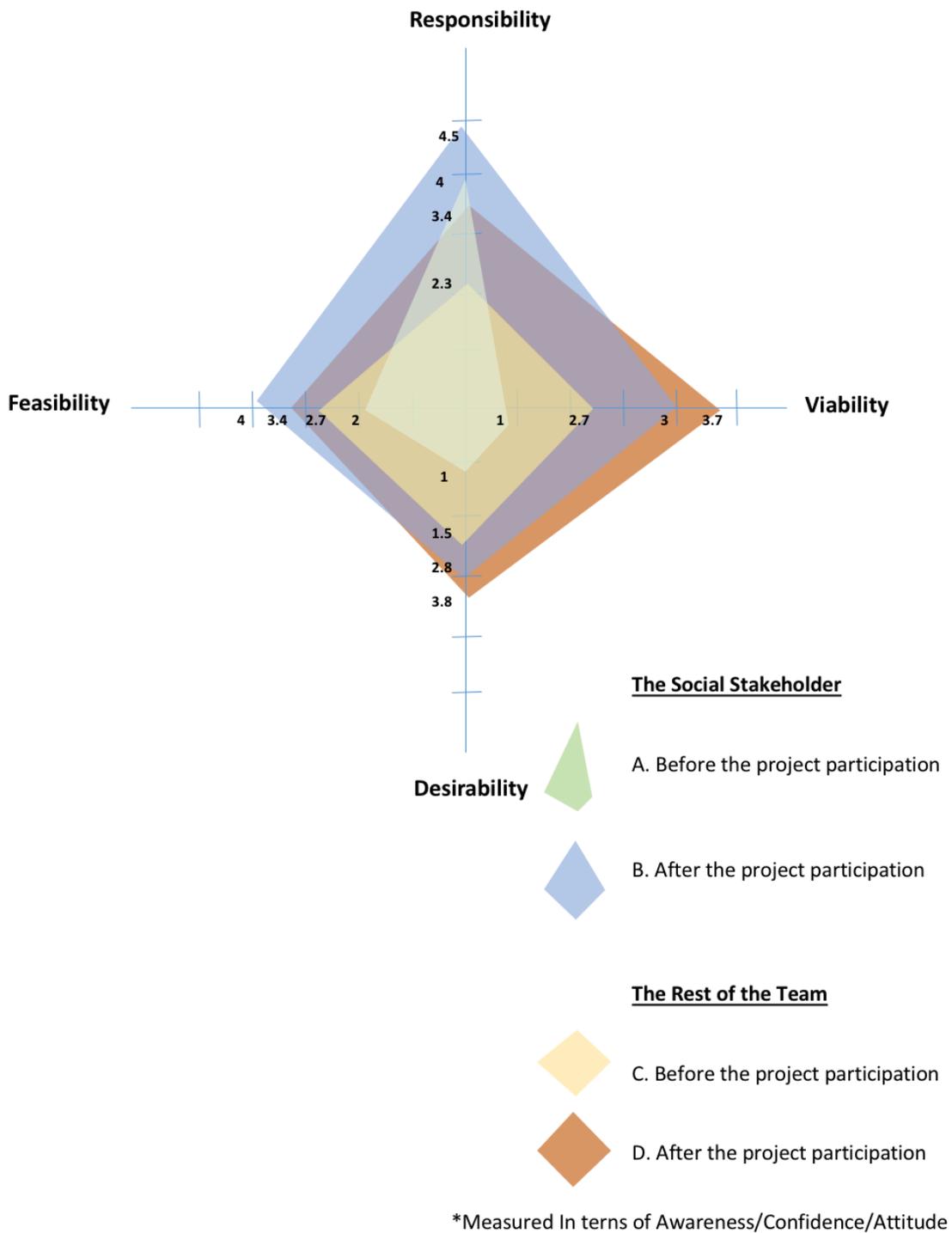


Figure 29. Confidence, Attitude and Awareness Gains – Social Stakeholder versus The Rest of the Team (Stakeholders of Feasibility, Desirability, Viability)

5.3.5 Gains specific to stakeholder group

As the common gains across the groups are covered, this section will discuss gains that are found specific to the group. The key social stakeholder's gain has been extensively mentioned in section 5.3.1 and 5.3.2., so will not be discussed further in this section.

5.3.5.1 The Viability Stakeholder Group

Built Confidence in Digital Tool Usage

The viability stakeholder group comprises a program manager for Fleet Operator Recognition Scheme (FORS) (an industrial association for road safety), and two marketing managers from a haulage vehicle manufacturer. Among the viability stakeholders, only one who was committed throughout the project was interviewed who will be referred as the key viability stakeholder. He self-assessed that he was deeply interested in both the project's business viability and its social responsibility, as part of the mission of his organisation (Company A) is to promote public safety through consulting projects. His background in policing work likely influenced his dual interest.

The key viability stakeholder had stated his disinterest in the project's technological details, giving his age as a reason (he is approaching retirement). He was sometimes unfamiliar with how to watch different formats of the video that were shared with him. He also struggled to access shared resources stored on Google Drive and web video channels, such as YouTube. He also struggled to use different settings to watch the files properly, such as 'full-screen view'. During the final stage of the project, he seemed much more keen to understand the project progress status and the technicalities, and became more confident when discussing different media formats, and digital platforms where the video could be distributed. This shift indicated his growing familiarity with the technology at stake.

5.3.5.2 The Feasibility Stakeholder Group

Challenged To Their Deep Trust in Technology Advancement

The feasibility stakeholder group consisted of three individuals, the 360° videographer, the VR app developer and an assistant who helped to oversee technical issues throughout the project. They felt they had handled a high level of technicalities well, and they were confident in their skills to look for solutions. All of them showed following characteristic that might seem self-evident, but that is considered to be common to people in similar professions: A deep trust in technologically to provide more advanced solutions;

The feasibility stakeholders' main learning curve during Clarity came from the orientation toward more technical specification and the awareness of the gap between the technical feasibility and desirability. For example, the 360° film maker believed a video with higher resolution could inherently create a better product for the user. Such propensity toward technicality is illustrated in the email discussion dated 6 January 2017 below.

Design Researcher: "The Met Police themselves still don't have a budget for this (maybe in 2 years when everybody is doing this) and my customer is happy with going ahead whichever I suggest and offer, they care mainly about getting the message across, as long as we close the story loop (for example having the cyclist visible in the mirror) they are happy with 4K resolution, as any highest spec will be quickly outdated as technology advances anyway."

360° Videographer: "Sorry but this does not make sense to me,: "As any highest spec will be quickly outdated as technology advances anyway."

Surely to accommodate advances in tech you would want to be shooting as

high definition as possible? Especially as the video will be viewed on a headset? Also, it is not 2 years until people are doing this, it is right now. “

Design Researcher: “Thanks again so much. Yes, I know many companies are doing this, what I meant by they might have a budget for this in 2 years was that as a very conservative public organisation relatively behind private sector, they might only move in terms of budget in 2 years. :). You are absolutely right one would want as high def as possible, but I do think with as technology advances so quickly, the comparison of 4K or 8K will not be as meaningful even in the short future ahead than to focus on closing the story loop. But yes, the story will have higher integrity with the cyclist in the mirror and if using GoPro will help this issue it would be really cool.”

While the 360° videographer was experienced with this technology, he had not considered prior to this project how one could improve the user’s experience of 360° footage. The difficulty in navigating the interface was especially relevant in relation to user experience. The videographer stated that through the project he came to appreciate the importance of not taking any steps of user experience for granted and of seeking improvements through enhanced design.

As discussed previously, the VR developer already had his own the VR viewer app on Google Play, which is what led the design researcher to get in touch with him about this project. Although his app is free and not for profit, it also is one of the highest performers, scoring 4.5 out of 5 on Google Play user reviews. To keep the visibility of the app afloat in the competition, he is well aware of the competitor landscape and continues to update his app user experience. He carefully examined the new design ideas such as old film look – and the toggle button to see if the new user experience would justified, and

commented that it was ‘refreshing to see new approaches to make the user experience better’.

5.3.5.3 The Desirability Stakeholder Group

Highly Self-Aware in Design Gains, But Not In Others

The two key desirability stakeholders both had commercial experience, having previously taken products to market. They self-assessed as the least aware, confident and knowledgeable of Clarity’s technical feasibility. Although they researched the current offerings of headsets in the market and both decided to use Google Cardboard as a reference for their design structure, but other than that their involvement in terms of technicalities of the project was minimal.

However, due to their main priority being on designing the VR headsets, and with limited time, the industrial designers did not have a chance to actively participate in technical discussions.

Before the project, the desirability stakeholders spoke about the project being an opportunity for them to deepen their knowledge of VR but in practice their exposure to other aspects of the project, such as the video’s production and post production and the app’s development, proved limited due to the limited time and focus. As a consequence, the designers did not gain more confidence in using VR, though they did observe that they became more aware of the benefits of collaboration.

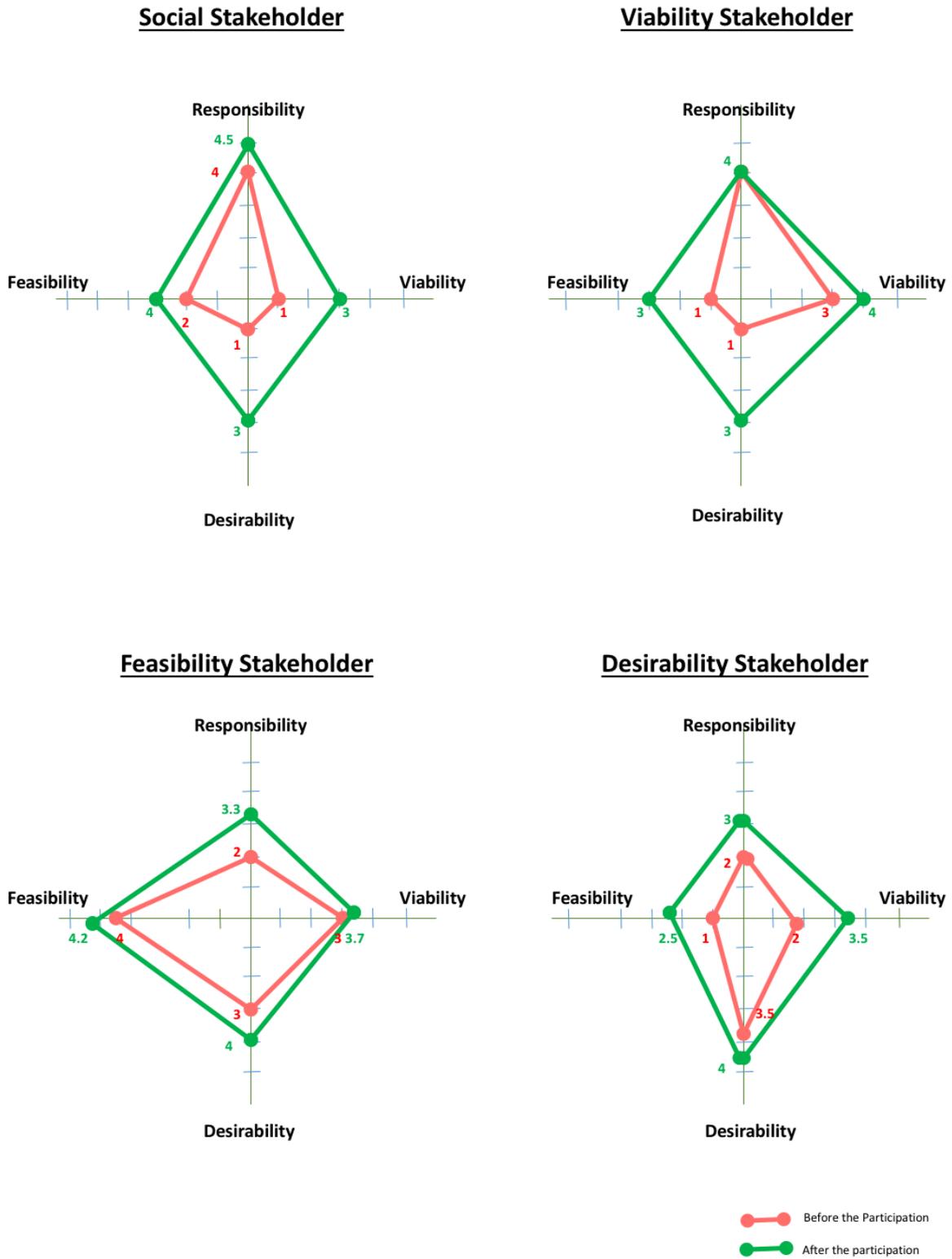
The other notable pattern was that they were aware they gained most in industrial design. One of the industrial designers described in detail how her knowledge of origami-folding techniques had improved; she also spoke about gaining insight into how the textiles in question behaved. The other industrial designer specified

that new learning in user research methodologies was the biggest gain as a result of her participation in the project.

It is the design researcher's view that a possible reason why the designers' self-observation gaining further knowledge in pre-existing areas of expertise was the most vivid and considered as the most valuable is that it was built on a strong knowledge base and therefore the learning was more easily recognisable.

Drawing from the design researcher's observations of her team member's attitudes and behaviours, she concluded that they gained significantly in the viability aspect but that they didn't seem to recall this until they were prompted.

Participant Gains: Before & After



*Measured In terms of Awareness/Confidence/Attitude

Figure 30. Participant Gains by stakeholder group

5.4 Limitations of the Methodologies

5.4.1 Self-Completion of the Post-Project Interview

The four assessment criteria of learning during the post-project interview were self-completed by the participants. The design researcher used this data as well as her own judgment based on the changes of attitudes displayed throughout the stages of the project to determine the scores on a five-points-scale scoreboard.

5.4.2 Dependency on Self-awareness

It was notable that all respondents of the post-project interview could articulate their gains within their domains of expertise more readily than in other domains. For example, the desirability stakeholder could speak at length about what she had learned with regard to new origami skills. However she found it hard to recall any other moments of learning without being prompted. This situation was consistent with the social stakeholder who had to be prompted on reading his learning about making the message appealing, an element of the project which he extensively worked on.

5.4.3 Limited Sampling

The key viability stakeholder was exceptionally well aware of the project's social purpose, due to his background in public service. It would have been ideal to have a stakeholder from a business position within a technology firm, but thus was beyond the scope of this research project.

Also, there was clearly an age distinction between the various aspects of the group – design and technology participants were relatively young (in their 20s) while the social and viability stakeholders were older (in their 40s). This could represent a general trend in industry, and may have contributed to the participants different degrees of technological literacy.

5.4.4 Causalities

Other researchers on PD gains, such as Bossen et al. (2011), have taken into consideration a time period of seven years after the project completion. Bossen et al. note the difficulty in finding the cause-effect relationship between the project and their participants' development most likely attributable due to the change in life circumstances of many participants. While project Clarity had only a month-long gap between the completion of the project and the post-project interviews. While this delay likely impacted the interviewees' responses, the challenge in finding causalities between the cause factor that took place during the project, and the effects which are gains of the participants, is difficult to account for.

CHAPTER 6: CONCLUSION

6.1 Research Context

Feasibility, desirability and viability are important criteria for success when it comes to today's products. A typical NPD team incorporates cross-functional members to effectively meet these criteria (Ernst et al., 2010) and the process for technology products are no exception. However, while new technologies such as artificial intelligence or autonomous driving are expected to bring disruptive changes to consumers' everyday lives in the not-so-distant future, ethical consensus have not been formed for these new technology products. In this regard, there is more at stake for society to be involved in NPD process for technology products have products that are socially responsible and to even be a part of the decision-making process.

Since the call from Papanek (1983) for designers to be aware of their social responsibility, there have been many attempts to incorporate sustainability into tangible products. While the focus of the experience shifts toward highly technology-oriented intangible products, such as digital products and services, however, there have been no studies on how to incorporate ethics into technology products.

Further, there have been no visible attempt in the industry of technology and internet companies to include a stakeholder who represents a social purpose on NPD teams. The closest research that has been carried out to date is by Ebru Genç & C. Anthony di Benedetto, who looked into the impact of having an environmental specialist on a cross-functional NPD team. (2015).

Additionally, to the best of the design researcher's knowledge, no studies have been carried out investigating the learning impact on the stakeholder participants of such an experiment. The studies most similar in purpose have been carried out by Claus Bossen et al. (2010, 2012), which primarily investigated end-user gains of participating in design projects developing technology products.

The lack of studies combined with the needs for a framework of socially responsible technology products arising points to why a new NPD framework that is based on a cross-functional team and integrates a social stakeholder could be valuable.

6.2 Research Opportunities

Based on the research context and the literature review, the research opportunities surfaced around a new framework that incorporates a social stakeholder in a cross-functional NPD team that enable a systematic approach in achieving a socially responsible technology product, one that incorporates a social stakeholder in a cross-functional NPD team, in ways that supplement its existing commitments to feasibility, viability, and desirability by answering specifically the four questions as:

- A) Does this NPD framework have viability as an NPD practice?
- B) What are the essential elements and the challenges and for the successful execution of this NPD framework for socially responsible technology?
- C) What are the impacts of this new NPD framework for socially responsible technology on the participants of the cross-functional NPD team that carried out the project?
- D) What is the role and contribution of the social stakeholder throughout the NPD process within a cross-functional team?

6.3 Original Contribution to Knowledge

The thesis contributes to knowledge by exploring the potential of a new product development (NPD) framework for socially responsible technology, following the ground work laid out by others.

First, does this NPD framework have viability as an NPD practice?

This question has been answered by evaluating the quality of the final product output through the results of the user testing. The user testing results at the end of each stage showed an improvement of the quality on four given criteria which correspond to social responsibility in addition to the three well-established criteria of the new product development framework: feasibility, viability, and desirability. The public adoption and the commercial potential of the final outcome showed that the proposed NPD framework could be useful for a production of socially responsible products of technology.

Second, what are the essential elements and the challenges for the successful execution of this NPD framework for socially responsible technology?

Through reflecting on the key issues that arose throughout the practice, five building blocks were identified for the successful execution of an impact technology practice: managing uncertainties; brokering knowledge; locating knowledge and talent; managing conflicts of interest; and raising awareness in digital technologies. Of these, managing uncertainties and locating knowledge and talent involved working on a relatively unknown technology. Two elements, managing conflicts of interest and brokering knowledge were challenges involved in handling cross-functional stakeholders. Brokering knowledge is a key activity also associated with NPD processes. Raising awareness in digital technologies

has proven particularly challenging when the partner organisations are not familiar with the benefit and limits of new technologies.

Possible ways to mitigate these challenges were discussed, ranging from disseminating across the NPD successful case studies of digital initiatives; setting midterm timelines; seeking funding early on; policymakers or large-scale technology buyers to boost the ecosystem by investing in a skill/knowledge exchange platform for those with technical and design skills.

Third, what are the impacts of this new NPD framework for socially responsible technology on the participants of the cross-functional NPD team that carried out the project?

As a practice-based research, this research adds first-hand insights into challenges related to a high-tech multiple stakeholder NPD process, following the footsteps of the ground work laid out by others, most prominently, Bradfield and Gao (2007), Jasawalla and Sashittal (1998) and Madhavan and Grover (1998).

A response to this question was found in the result of the qualitative evaluation of mutual gains based on the participants' post-project self-assessment. Between the social stakeholder and the rest of the NPD team, participants' awareness of the value and challenges was raised as a result of their experience working on the project.

There have been mutual learnings throughout the process. For the key social stakeholder in particular, he enjoyed significant gains, such as increased confidence in the use and understanding of new technologies; developing creative skillsets, such as storytelling; and an understanding of real-world product development.

Most of other cross-functional members of the NPD team gained greater awareness of the possibilities of making products that contribute to society, which many participants found the effort to be rewarding. Such gains would ideally be

widely replicated by public and private initiatives through providing a platform where social stakeholders and NPD professionals could converge on a common purpose to solve social issues of mutual concern.

On the role of the social stakeholder within a cross-functional NPD team, this thesis contributes to knowledge by investigating the role of a social stakeholder in an NPD process for a consumer technology offering, following the ground work laid out by others, most prominently, by Genç and Di Benedetto.

Fourth, what is the role and contribution of the social stakeholder throughout the NPD process within a cross-functional team?

The answer to this question is a qualitative, practice-based response to one provided by Genç and di Benedetto (2015) who looked at the contribution of an environmental specialist to a NPD team and provided empirical and quantitative evidences. In the case of project Clarity, the key social stakeholder helped the team to identify the key issue as well as to prioritise resources. He also defended the relevance of the product for creating social change, when there was a conflict of interest between this commitment and other factors of the project, specifically relating to its cost and appeal.

This research explores the domain of participatory design gains most prominently researched by Bossen, Dindler and Iversen and brings it forward to look into the gains of the stakeholder in terms of proposing a systematic evaluation method of participatory design gains with an objective to better understand the complexities and challenges other stakeholders face.

6.4 Limitations of the Research

Knowledge-brokering and managing conflicts of interest could be heavily influenced by the interpersonal dynamics of a team and a different team setup could result in a very different picture. Another consideration of the limitations of the research concerns the participants' gains. This data depended on self-reporting and so was subject to bias. However the interpretation has been supplemented by the design researcher's observations throughout the process, which may have provided a corrective of sorts. Moreover, asking respondents to provide retrospective evaluations was found to be useful insofar as it helped them to appreciate how they had extended their existing knowledge. However, this appreciation did not extend to new domains, where they seemed less able to articulate how they had developed over the course of the research.

6.5 Opportunities for Further Research

Understanding the results of this project would clearly benefit from future research into engaging with an NPD team from an existing large-scale consumer technology manufacturer or platform provider.

This practice has been done using action research and immersive qualitative research techniques, which identified key elements of such a project. Of course, a larger-scale research enquiry in the future, one that involved different projects, for example one that involved running a set of sample projects by many teams concurrently, would help to quantitatively validate the findings of this research.

An opportunity for design research, discovered through the findings of this research could be a communication platform for collaborative projects, that more effectively adapts to the teammates' preferred communication. For a more

collaborative ecosystem, a community platform which discusses social issues and where a possible skill could be shared, is an interesting avenue for further action research.

APPENDIX 1. A Project Overview of Design Stages

	Concept Development	Product Development	
	Design Stage 1	Design Stage 2	Design Stage 3
Conducted throughout	Jan '16 – Sept '16	Sept '16 – Jan '17	Jan '17 – Apr '17
Objectives	- Test the viability of the VR format for the public campaign	- Based on the test results of DS1, produce a desirable outcome as a virtual reality experience for a public campaign as a video and the headset form factor	- Based on the test results of DS2, add more desirability to the virtual reality experience to prove its viability as a stand-alone service
Prototype Outputs	- A 360° video content, the first VR version of 'Exchanging Places'	- A 360° video content, titled 'Exchanging Places in Virtual Reality with the Metropolitan Police' - 2 VR headset prototypes: 'Dee' and 'Cube'	- 360° video contents titled respectively 'How to Ride & Walk Safely around HGVs' - VR interface app (incomplete)

	Concept Development	Product Development	
	Design Stage 1	Design Stage 2	Design Stage 3
Conducted throughout	Jan '16 – Sept '16	Sept '16 – Jan '17	Jan '17 – Apr '17
Workflows	<ul style="list-style-type: none"> - Brief prep on the video narrative - Video shoot using a 360° camera - Edit - User testing 	<ul style="list-style-type: none"> - A full brainstorm on the video narrative - Video shoot - Edit - Post-production involving highly technical 360° image-stitching techniques - Design meetings around the industrial design of the headset Prototyping of the headset 	<ul style="list-style-type: none"> - A modification of the video narrative - Video reshoot - Edit - Post-production involving highly technical 360° image-stitching techniques - Design meetings around the industrial design of the headset - Prototyping of the headset

	Concept Development	Product Development	
	Design Stage 1	Design Stage 2	Design Stage 3
Conducted throughout	Jan '16 – Sept '16	Sept '16 – Jan '17	Jan '17 – Apr '17
Participants	<ul style="list-style-type: none"> - The design researcher - The key social stakeholder - Two police crews at the shooting scene for security assistance 	<ul style="list-style-type: none"> - The design researcher - The key social stakeholder - Two police crews providing security assistance - The viability stakeholder - The feasibility stakeholder (1 technical assistant) - The desirability stakeholders (2 industrial designers for headset design and a service designer for the narrative) 	<ul style="list-style-type: none"> - The design researcher - The key social stakeholder - Two police crews providing security assistance - The viability stakeholder (FORS) - The feasibility stakeholders (a 360° video maker and two app developers) - The desirability stakeholder (An industrial designer)

APPENDIX 2.

Video Storyboards for Design Stages 1, 2 and 3

2.1 Design Stage 1

Scene 1. The user is on a moving bike. The bike stops on the left, about 3 meters ahead of an HGV.

Scene 2. The user is inside an HGV, positioned in the driver's seat. The viewer is directed by a voice narration to look in the mirrors on the left. The cyclist is visible for a second, then disappears from view altogether. The viewer is told that while the cyclist is still in front of the vehicle, they are completely out of sight, beyond the driver's view.

Scene 3. The user is on a moving bike. The bike stops on the left, about five meters ahead of an HGV.

Scene 4. The user is inside an HGV, positioned in the driver's seat. The viewer is directed by a voice narration to look in the mirrors on the left. The cyclist is visible for a second, then stops in front of the vehicle. The user is told it was the minimum distance as seen in Scene 3 that makes the cyclist visible in the driver's direct view.

2.2 Design Stage 2

Scene 1. A police officer is standing on the left side of the viewer, reminding this is a virtual environment. The police officer and the user go onto a bike. The bike stops on the left, about 3 meters ahead of an HGV.

Scene 2. The user is inside an HGV, positioned in the driver's seat. The police officer directs the viewer to look in the mirrors on the left. The cyclist is visible for a second, then disappears from view altogether. The viewer is told that while the cyclist is still in front of the vehicle, they are completely out of sight, beyond the driver's view.

Scene 3. The viewer and the police officer are on a moving bike. The bike stops on the left, about five meters ahead of an HGV.

Scene 4. The viewer, together with the police officer, is inside an HGV, positioned in the driver's seat. The viewer is directed by the police officer to look in the mirrors on the left. The cyclist is visible for a second, then stops in front of the vehicle. The user is told it was the minimum distance as seen in Scene 3 that makes the cyclist visible in the driver's direct view.

2.3 Design Stage 3

Scene 1

1) A police officer is standing on the left side of the viewer, reminding this is a virtual environment. The police officer and the user go onto a bike. The bike stops on the left, about 3 meters ahead of an HGV.

2) While the police officer and the viewer are still standing in front of the truck, a pedestrian walks in front and walks across the road in front of the truck, directly under the cab.

3) The pedestrian then walks back the road passing the front of the truck, this time with a distance, looking up at the truck.

Scene 2

4) The user is inside an HGV with the police officer. The user is positioned in the driver's seat. The police officer directs the viewer to look in the mirrors on the left.

5) Two cyclist, one a citizen and the other a police officer, are passing by and stops on the left. The police officer (the one inside the truck) viewer can see the other police officer who is stopping in front of the truck giving distance, while, the citizen cyclist is barely visible because she stopped to close in front of the truck inside the truck.

6) The viewer is told that while the cyclist is still in front of the vehicle, they are completely out of sight, beyond the driver's view. The user is told it was the

minimum distance as seen in Scene 3 that makes the cyclist visible in the driver's direct view.

APPENDIX 3. YouTube Links for Videos Produced

Hyperlink is not supported for a PDF file format in which this thesis will be shared, so please copy & paste the below link into a browser window to watch.

A. Project Trailer: as of May 2017

[‘A new virtual reality experience for social impact’](#) (5min)

https://youtu.be/X_8iZVFSeRo

360° Videos

To watch in 360° mode, open the links on a mobile device (Android & iPad. Some iPhone YouTube app do not support a 360° browser) and click the full screen button on the right bottom.

Design Stage 1

B. Usability Summary for Oculus navigation interface:

[‘Things that should never happen but happening anyway’](#) (2min)

<https://youtu.be/7-3qh1vGzIE>

C. [Cycle Safety video in 360° produced in Design Stage 1](#)(2min)

<https://youtu.be/eNlFePiHywo>

Design Stage 2

D. [Cycle Safety video in 360° produced Design Stage 2](#)(Approx. 4min)

https://youtu.be/ITodz0M_ROU

E. [Headset Design Plan](#)(Approx. 1min)

https://youtu.be/_sQv0tshfWk

Design Stage 3

F. [Cycle Safety video in 360° produced Design Stage 3](#) (Approx. 3min)

<https://youtu.be/iE2GXONgMpY>

APPENDIX 4. Participatory Gains Scoreboard

	Before The Project				After The Project			
	Responsibility	Feasibility	Desirability	Viability	Responsibility	Feasibility	Desirability	Viability
Social Stakeholder	4	2	1	1	4.5	4	3	3
Viability Stakeholder	4	1	1	3	4	3	3	4
Feasibility Stakeholder 1	1	5	3	4	3	4.5	4	4
Feasibility Stakeholder 2	3	4	3	1	3	4	4	3
Feasibility Stakeholder 3	2	4	3	4	4	4	4	4
Desirability Stakeholder 1	2	1	3	1	3	3	3	3
Desirability Stakeholder 2	2	1	4	3	3	2	5	4
Average Score of The Rest of the team Except The Social Stakeholder	2.3	2.7	2.8	2.7	3.4	3.4	3.8	3.7
Average Total Team Score	2.6	2.6	2.6	2.4	3.5	3.5	3.7	3.6

Appendix 5. Examples of Questionnaire Responses For The Post-Project Interview

Personal Data Protection Agreements

Your responses captured in this paper or in the video recording could be used as an illustrative example within the texts in my dissertation or as a back-up data in the appendix in my final MPhil dissertation.

In most cases I will use the role or an initial to use your verbatim or illustration but in a video recording, your face could be disclosed.

If you want your faces to be masked or your name not to be disclosed please mark here. _____

If you give me your permission to use your responses and video recording of you for my dissertation purpose (will not be used for any other purposes) please mark here.

Other Instructions

Please use a thick pen or a marker, and if possible clear, bright colours for illustrations. Please do not use a ball-point pen or pencil as they are difficult to read in scanned copies!

Feel free to use extra sheets to express your opinions or your visualisation for the responses.

Thank you very much!

1. In your opinion, what is your biggest contribution to the project?

Filming and providing 360° filming equipment. Liaising with Young to produce the 360° videos.

2. What was the biggest learning experience you've had being participated in project?
(please freely write or illustrate as detailed as possible)

I think one issue that was evident during and after the project was how best to connect the viewer to the 360°/VR experience. Often there are many steps between putting on the headset and experiencing the video. It was great to see how Young is approaching + trying to solve this issue.

3

The project tested a new format of multidisciplinary team collaboration. What's new in this new format compared to previously researched is as follows.

a. Minimum viable participating experts- 4 parties participated in this project. You are selected in this project as an expert to mainly one of the 4 categories below.

- An expert in technology/engineering domain for the technical feasibility & to make it work
- Public service to inform the needs of the public
- Designers who will make it relevant for the user & desirable
- Businesses who will advise the viability in the real world

b. The role of the 'Go-Between Designer (GED)'. Ideally, it would be great to have all participants in one place at all times, but in reality, this is not always possible (i.e. our participants are in 3 time zones and all have their daily jobs) & often unnecessary (Participants' timescale within the project are all different).

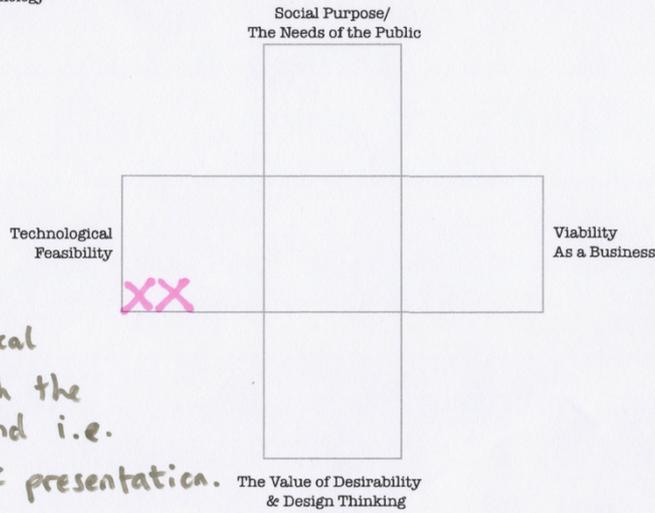
So GED's role is to centrally coordinate & communicate the requirements of the project to move forward of course, but most importantly, the GED has to successfully represent you to the 'invisible' table of the participants, and vice versa - successfully represent them to you.

From the next page, I would like to ask a few questions to evaluate how we did with the 2 unique components of this project, and so that we could make this learning experience a valuable knowledge for anyone in the innovation community, to take it further.

4

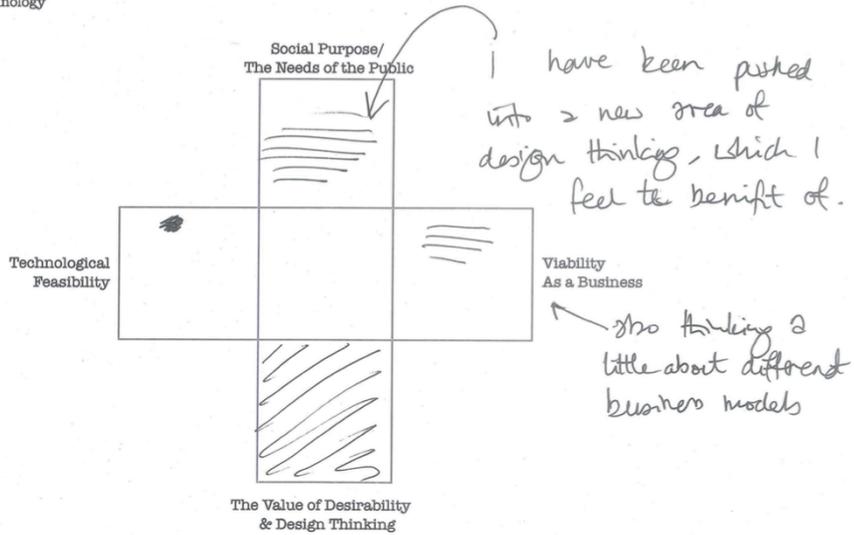
3. Where do you see your expertise mainly reside? Can you highlight it with a colour pencil or a marker? (responses can be more than one, and please highlight the space you think you have expertise in but it doesn't have to be limited into certain boxes or the line boundaries). Please feel free to write around the space next to where you marked.

- a. making the product meaningful to the user
- b. making a viable as a business
- c. desirable as a product & making it relevant for the user
- d. making it feasible in terms of technology
- e. Anything else (please specify)



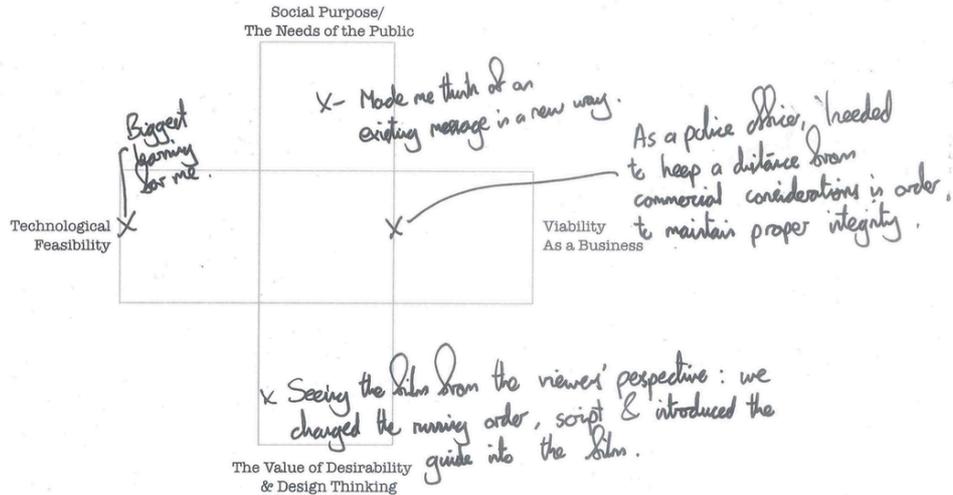
4. What are your key learning experiences through this project, in terms of

- a. making the product meaningful to the society's needs
- b. making it a viable as a business
- c. desirable as a product & making it relevant for the user
- d. making it feasible in terms of technology
- e. Anything Else (Please specify)



4. What are your key learning experiences through this project, in terms of

- a. making the product meaningful to the society's needs
- b. making it a viable as a business
- c. desirable as a product & making it relevant for the user
- d. making it feasible in terms of technology
- e. Anything Else (Please specify)



6

5. To take it further from the question 3&4, when were the moment that you realised other participants from this project with different background/function (i.e. if you are designer, think of the police, engineer, businesses if you are the police, think of designer, engineer, business) have different perspectives or have different priorities?

Could you recall these moments and describe them as vividly as possible? (if possible, please draw the moments in the boxes below, one incident per sheet, feel free to use multiple sheets.)

As the filmmaker I had to at all times be conscious of the different functions of the film. This was communicated very well by all parties and made my job much easier.

We adapted a moving shot to a still shot to show off the new truck design better. (Business)

The police had previous experience with 360/VR filming and this helped IMMENSELY. They were aware of some of the pitfalls and restrictions of 360 and needed very little direction.

7

6.1. When were the toughest/challenging moment(s) during this project?

Could you recall these moments and describe them as vividly as possible? (if possible, please draw the moments in the boxes below, one incident per sheet, feel free to use multiple sheets.)

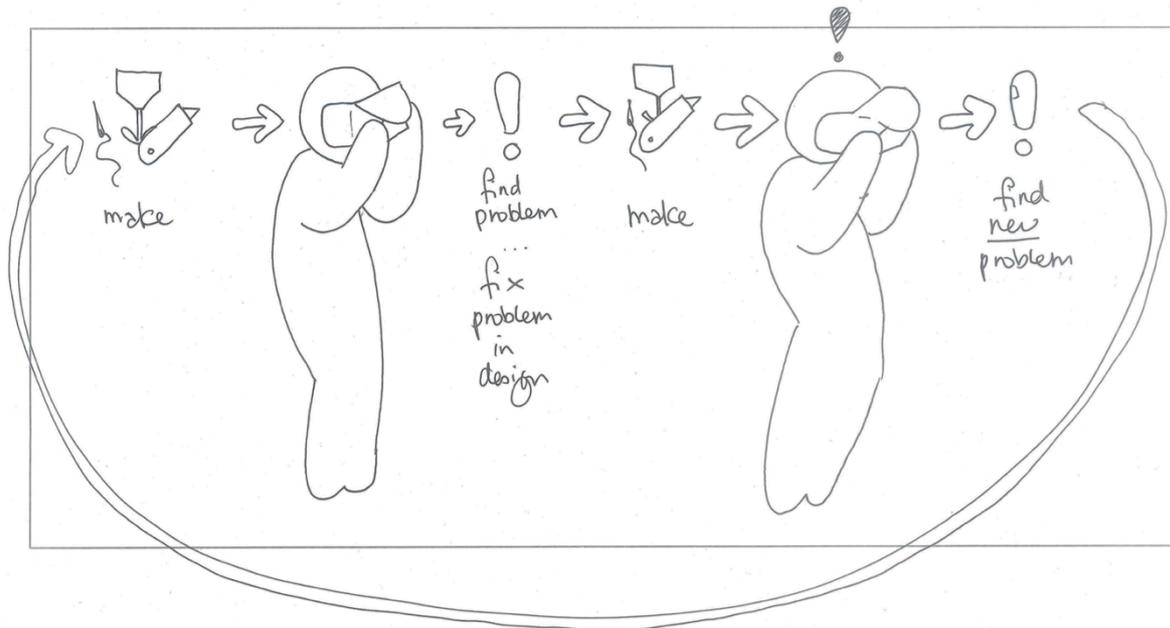
The hardest part by far was the location filming. All the usual difficulties are multiplied when filming 360°. The road at the location had heavy lorry traffic which often interrupted filming. The team was very understanding and accomodated multiple takes. Not being able to review 360 footage live meant alot of trust was placed in the police + extras who performed INCREDIBLY and their previous experience with 360 filming helped So much.

8

6.1. When were the toughest/challenging moment(s) during this project?

Could you recall these moments and describe them as vividly as possible? (if possible, please draw the moments in the boxes below, one incident per sheet, feel free to use multiple sheets.)

figuring out a new construction method meant learning as I went!



8

6.2. What kind of issues/challenges have you become aware of, about making a technology product/ experience that serve social needs?

As touched on before - accessibility. As a result, planning the production to serve those needs. This is a wider issue for 360/VR in general.

6.2.1. What would be your ideas/suggestions to solve such issues/challenges?

Young is working to provide these solutions. It is sometimes best to offer a bespoke solution to fit the purpose e.g. online/offline viewing, browser/headset file size, bitrate etc. Apps also help the flow.

9

7. To take it further from the question 3&4, when were the most enjoyable moment?

Could you recall these moments and describe them as vividly as possible? (if possible, please draw the moments in the boxes below, one incident per sheet, feel free to use multiple sheets.)

Before, during + after each take, when each member of the team would offer their thoughts. It was very much a collaboration from start to finish. The approach was always open to opinion and each member definitely made their own mark on the production. As I mentioned before, I really enjoyed working with a team very knowledgeable + passionate about 360/VR.

10

8. To take it further from the question 3&4, when were most memorable moment?

Could you recall these moments and describe them as vividly as possible? (if possible, please draw the moments in the boxes below, one incident per sheet, feel free to use multiple sheets.)

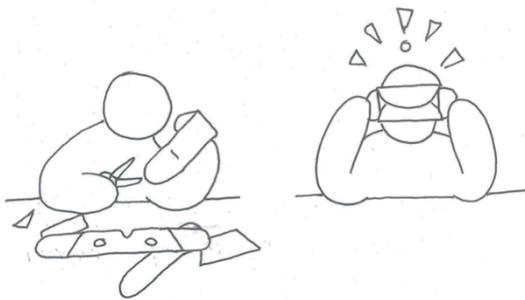
Simon (police) was able to direct himself due to his past experience of VR and our lack of live 360 stream to view the take. I felt very comfortable trusting him to make the decision on whether the take was satisfactory.

11

8. To take it further from the question 3&4, when were most memorable moment?

Could you recall these moments and describe them as vividly as possible? (if possible, please draw the moments in the boxes below, one incident per sheet, feel free to use multiple sheets.)

The first time I was able to use one of the cardboard models to enter into a 3D Virtual world using my ~~phone~~ phone was great fun!

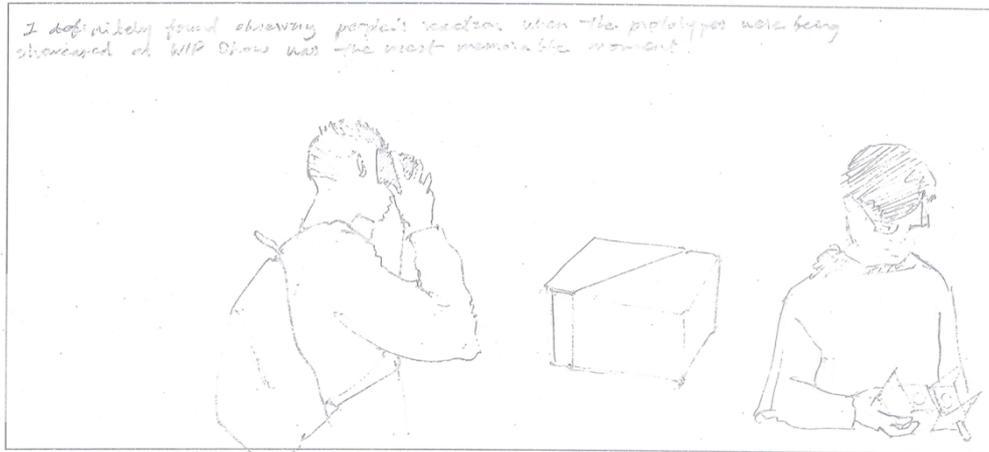


Shows how simple the idea is in a lovely way, really so little material is needed to make the holder

11

8. To take it further from the question 3&4, when were most memorable moment?

Could you recall these moments and describe them as vividly as possible? (if possible, please draw the moments in the boxes below, one incident per sheet, feel free to use multiple sheets.)



11

9. The Role of the 'Go-Between Designer'.

Through this project process, the 'Go Between Designer' acted as the central mediator to communicate with each party, and coordinated the steps to move forward. In this section, we will discuss how this interaction was to you, and how we can improve this even further.

9.1. What was your mode(s) of communication with the GBD? Was it appropriate? Why & why not?

Very thorough. Email + phone pre + post shoot.

9.2. How do you feel your opinion / feedback as a _____ reflected and accommodated throughout the process?

Very well.

9.3. Did you have moments where your feedback/ suggestions were not taken onboard?

No

9.3.1. If yes, can you describe the moments as detailed as possible?

9.3.2. Do you think the reasons/ contexts of why it was not taken onboard were communicated to you clearly by the Go Between Designer?
(Yes/No & Why)

9.4. What could we improve the communication throughout?

There was great communication throughout the project pre, during + post shoot.

12

9. 5. Clarity was an effort to build a technology experience that serves social needs, with a new approach in project management with the '4 minimum viable parties (technology, public service, business, design) and the role of the 'Go-Between Designer'. If we do a project again with a similar purpose, what would be your suggestions?

Perhaps more input from business side (truck design)
but all this was communicated through Young very well.
It was important for me as filmmaker to try to serve
the needs of all parties and all the needs were made
very clear.

13

9. 6. Do you have any suggestion to 'Go-Between Designer', for such projects in the future?

I think the project was very well executed.
I was very clear on the needs of all parties.

14

10. How did your awareness of the challenges of bringing the impact to the society through a technology product /experience change?

- In other words, what was your understanding about creating a technology experience to the public before, and how did it change?
(please freely write or illustrate as detailed as possible)

I have a huge belief in 360/VR to benefit society especially in health + safety /training films like this project. The challenge is accessibility and more widespread headset use but this will come. After reviewing the films it has only enhanced my belief of this application of 360/VR as the truck scenes especially, communicate so well the blind spots and dangers of the lorries. I would like to see a more widespread adoption of 360/VR for training /health + safety.

15

10. How did your awareness of the challenges of bringing the impact to the society through a technology product /experience change?

- In other words, what was your understanding about creating a technology experience to the public before, and how did it change?
(please freely write or illustrate as detailed as possible)

This has been a steep learning curve despite having previously engaged a professional (conventional) film company to deliver a similar message.

I had not expected this technology to be so challenging, despite its being so new.

Thank you very much

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