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Designing *In* With Black Box Technologies and PD

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Building on prior work we examine design research challenges posed by working with new technological applications of Blockchain within multidisciplinary research. Drawing from recent design research of others, we articulate the value – and associated challenges – of Participatory Design creative approaches involving co-design of similar 'black box' technologies. We go on to report on three workshops, including one in which we invited technologists and designers to work together to talk through and materially represent their tacit understandings of how two Blockchain applications – BITNATION and Trust Stamp – work. We demonstrate how creative methods are useful in enabling critical reflection and knowledge exchange providing a useful bridge between radically different disciplines; to counter emerging technologies' 'unconscious image' as magic; and to valuably inform on future oriented design implications.

participatory design, emerging technology, blockchain, 'black box' technology

1 Introduction

The role of the designer within the expansive field of digital technology has become increasingly significant. In 2006 John Maeda noted how designers should not only understand human factors to iteratively improve their design, but should also understand how the technology worked, including where appropriate, how to write code. More than a decade later; how much do we, as design researchers, need to know about the complex workings behind opaque data technologies within our multidisciplinary enquiries? Digital designers may use increasingly sophisticated enabling technologies such as 'app builders', avoiding the necessity to understand 'under the bonnet' code. Should interaction design researchers similarly design for and contribute to building complex 'black box' products and services without understanding their precise workings, or potential impact? Norman and Stappers (2015) argue that designers' input should not stop at the design stage, but involve implementation of "complex socio technical systems" (p.84).

In this paper we demonstrate our explorative Participatory Design (PD) approach in research that is developing TAPESTRY, a browser-based (in the first instance) service that aims to enable people, businesses and digital services to connect more safely online through exploitation of the complex

digital footprint left behind by individuals' everyday digital interactions. In designing and building what aims to be a private, secure and trustworthy online service, we are using PD to support understanding and connect different perspectives of designers, psychologists, computer scientists and the potential users and beneficiaries of the service. Grounded in this study, we go on to discuss design implications relating to researching and developing black box systems, and touch on wider societal values such as personal privacy and safety; and the recently growing area of policy regulation that aims to control the potential negative impact of online risks and threats towards enabling democratic online citizenry (see Pasquale, 2015).

2 Background: Designing Tools to Support Trust and Privacy Online

This study forms an early part of the larger research project which aims to enable safer online connectivity through the design of a browser-based tool that helps someone establish the authenticity and 'trustworthiness' of the interactor or organisation an individual is about to disclose personal information to. The research focuses on three use-cases of online dating, e-commerce and e-health; all domains where verifying the real person behind a pseudonymised online identity might help to minimise risk and support trust-related decision-making. The research team is building the TAPESTRY tool with the aim of supporting lower level digital literacy users – who have limited skills and experience of making judgements online. Our selected use-cases pose particular and heightened risks when making investments/online purchases; building rapport and trust online towards developing intimacy and meeting offline or; seeking to self-diagnose an illness or condition and administer an 'alternative' treatment. In all these cases the authenticity of the interactor's digital identity is vital in being able to establish someone or something's legitimacy.

2.1 Recognised Risks and Threats

There are much-increased incidences of serious sexual assault in the UK during the first face-to-face meeting following relationships that are established through online dating (NCA, 2016). Online, would-be daters disclose personally sensitive information and build perceived trust and intimacy more quickly than those who initially meet offline, due to the anonymous nature of their online interaction. Our wider contextual research shows that, amongst other things, men lie about their marital status and relationship goals, and women their weight and age (see Jones & Moncur, 2018). A combination of misdirected expectations and misrepresented online identities is believed to have directly led to a significant increase in reported and, it is thought unreported, sexual assault (NCA, 2016). In seeking to solicit money, crowdfunding fraudsters are known to manipulate social identities, including by constructing fake social media accounts to generate followers and increased pledges (Jones & Moncur, 2018), or in charity crowdfunding – appeal to people's sympathy. Our discussions with a crowdfunding executive suggest that fundraisers have suffered reputational damage from negative comments posted to live campaigns by competitors posing as disgruntled investors. And in e-heath forums, anonymity makes it difficult to assess medical credibility if someone for example endorses an unusual remedy (ibid.). Again, online trust building processes can lead to premature or over-disclosure of personal information, leaving those with a medical condition vulnerable to identity theft and personal safety when location details were shared (Blythe, Sillence & Briggs, 2017, p.122).

2.2 How TAPESTRY works

The proposed TAPESTRY service aims to support people's judgement about the authenticity of the interactor behind a particular online persona. It does *not* aim to make people's trust related decisions *for them*, but rather, communicate whether a digital pseudonym matches the person or company claiming to be behind it. TAPESTRY aims to make it more difficult to fake or hijack another's digital identity, including through 'fraping', where someone uses another's computer or online profile maliciously (see Moncur, Orzech & Neville, 2016).

The technology behind the opt-in service will collect shared details about individuals' digital footprints (social media use, browsing and purchasing habits etc.), encrypt, and store relevant data

in a Blockchain. A browser plug-in will then facilitate cross-checks and visually communicate the level to which this conforms to the digital identity. These operations will happen in real time; during use, the relevant crowdfunding platform, e-health or dating website will enable those with the plug-in to cross-refer to the TAPESTRY third party service.

3 The Multidisciplinary Context of Emergent Designed Technologies

'Emergent technologies' bring radically novel and potentially prominent technological change, if also ambiguous wider impact and uncertainty (Rotolo, Hicks & Martin, 2015). Societal impact clearly implicates the interaction designer and design researcher. Nanotechnology, Artificial Intelligence (AI), Blockchain, and so on, are the subjects of much debate in the media, academic research and policy and regulation discourses. Some of these discussions concern futuristic envisioning or near-future horizon scanning of potential threats, whether to individual or national security, with a view to managing control. Perceived benefits in the application of such technologies are often apparent to the technical experts, whose understandings elude or raise questions for the wider research team; whether around practical operations, the ways in which the technologies could be beneficially exploited, or wider social implications. In our research, our collaborating computer scientists describe the inherent trustworthy functionality of Blockchain – the decentralised nature of the distributed ledger, immutability of transactions and inherent need to use private and public keys to securely store and share personal data (see Elsden, Manohar, Briggs, Harding, Speed & Vines, 2018). Meanwhile the wider research partners and co-investigators grapple with and try to build up mental models of understanding (Johnson-Laird, 1980) while also identifying potential flaws from their own domain.

3.1 Gaps in Knowing

In the absence of informed understanding, folk theories are often constructed as a way to orientate towards enabling future action (Rip, 2005). Folk theories around emerging technologies and wider science (Rip mentions folk physics, folk chemistry etc.) are necessary to understand the current situation and how a science/technology can segue into the future, as well as provide opportunity for further inter- and multidisciplinary interactions with other disciplines (ibid.). These understandings help researchers to decide what characteristics of an emerging technology to avoid developing, and what to take forward in future designs (see Muller & Lia, 2017).

3.2 Making Sense of Blockchain

Blockchain is an infrastructural technology that is proposed to fundamentally transform the ways in which people transact, trust, collaborate, organise and identify themselves (Elsden et al., 2018). We have explored design issues relating to Blockchain (and DLT, the underpinning technology) and its increasing popularity due to its speed, security and reputation as a trusted mode for online interaction (ibid.). While Blockchain through crypto-currencies are especially prominent in financial domains, there are several well recognised societally relevant applications, including providing transparency in empowering people from developing countries with recognised identity, asset ownership and financial inclusion (Underwood, 2016). Yet there is currently little guidance or published research on how to approach developing shared understandings within multidisciplinary design of emerging technologies. This is especially timely as data-related policy and regulation – including the imminent EU General Data Protection Regulation (GDPR) which includes the 'right to be forgotten' – are placing designers in view of policy makers who task them with designing *in* functions that aim to support online privacy and safety. This paper then, contributes to methodological discussions around the abstract black box nature of digital design and how emerging personal data technologies might be approached as a (co)design material. We start by outlining relevant literature before examining how uncertainties can be addressed more holistically by adopting a PD creative approach.

3.3 Designing in Flux

Crucially, there is an increasing number of real-world applications of emerging technologies where the design of functions that aim to protect the user are 'bolted on' retrospectively, without adequate consideration for the end user or overall design. Considering implications for multidisciplinary research, legal data experts Diver and Schafer (2017) claim that companies prefer data privacy and protection to be managed by policy rather than designed *in* to a system. Here, the onus is on the user to give a company e.g. a social media platform consent to harvest and use personal information. However, most complex back box technologies are beyond most users' comprehension, making any policy tokenistic (ibid.). Luger, Moran and Rodden (2013) working within the Human Computer Interaction field also critique the notion of informed consent around personal online data, saying that platforms and other ubiquitous technology companies construct unreadably complex terms and conditions with dubious legal legitimacy. British journalist Nicole Kobie says "the best way to ensure that security is considered by designers is for them to understand the basics of security and authentication" (2016, p.1). Increasingly, governments are putting pressure on companies to design *in* personal data privacy and security functions. Diver and Schafer (2017) propose a holistic approach 'by design' stating:

> *By enabling the deep integration of regulatory norms early on in the design process, we can balance … the need to retain a democratic connection between the creation of regulation and the locus of its operation, and … the desire to invent and develop new digital products and services. (p.40)*

Of particular relevance is the authors' advocacy for computing-legal collaborations that necessarily 'bridge' disciplines enabling a more interdisciplinary approach to sharing heterogeneous understandings from technologists and, in their case, legal experts towards societal benefit.

3.3.1 Designing With/For Black Box Technologies

Emerging technologies are often appropriately discussed as futuristic as their real-world applications are still being developed and discovered. Such technologies go through a "process of shifting application domains and rapid subsequent growth in the new domain" according to Adner and Levinthal (2002, p.63). During this process the user base is very small, unstable and in flux.

In preparatory work with colleagues we surveyed Blockchain applications to gain better understanding of this still-developing technology (Elsden et al., 2018). Within the many hundreds of examples are Crowd Jury, Cambridge Blockchain, BitNation and Trust Stamp. We were constantly reminded that by their nature, some Blockchain services exist only as concepts, or early prototypes in beta under development by start-ups or activist groups. This still-emergent quality amplifies challenges of deployment and testing to identify and understand users and their needs and potential input, or evaluate and iterate designed experiences – as the technologies do not yet fully exist. We addressed the design space around these technologies still-emergent nature with groups of designers and technologists through a PD approach.

3.3.2 History of Terminology

> *(M)ore and more products in everyday life have become what engineers call 'black boxes'— we know what goes in and what comes out, but not what goes on inside. This has reinforced the unconscious image of technology as magic. (Dumas, 2010, p.5)*

The idea of black box technology seems to originate from the Second World War where the term was used to refer to the gun sight carried on Flying Fortresses, which incorporated hidden components that corrected for environmental variables (Tenner, 2003). Whilst the crew probably knew little of how the device worked they certainly knew how to use it and were critically aware that it may be crucial to survival. Possibly, the term was borrowed from E.M. Forster's science fiction work *The Machine Stops* (1909), in which the whole world is a black box that functions through input, an unknown process, and an abstracted output, from which human beings are disconnected

from direct experience. Building on this, Bruno Latour (1999) used the term to question the science in action i.e. how can the plane fly, or how does the theory of relativity work?

> *Scientific and technical work is made invisible by its own success. When a machine runs efficiently, when a matter of fact is settled, one need focus only on its inputs and outputs and not on its internal complexity. Thus, paradoxically, the more science and technology succeed, the more opaque and obscure they become. (Latour, 1999, p.304)*

Recently, the term is applied to algorithmic data science.

> *Hardly a day goes by without a story in the media involving machine learning, whether it's… Google's AlphaGo beating the human Go champion; US retailer Target finding out a teenager is pregnant before her parents do; or the US National Security Agency (NSA) looking for dots to connect. But in each case the learning algorithm driving the story is a black box. (Domingos, 2016, p.xv)*

To return to our research, Diver and Schafer (2017) advocate for individuals' control of personal data to be designed and built *in* to the digital technologies that gather and process these data to balance on-going development of new digital products and services. As legal experts they are writing in anticipation of imminent GDPR; the aim of which is to make companies liable to provide users with both clear explanation for decisions that automated systems reach and also control over their data, including the right to be forgotten (see Luger, Moran & Rodden, 2013). Just how much should you trust an Artificial Intelligence's decision, for example on approving your request for a loan, diagnosing an illness or selecting someone for promotion in a job? When technologists lack full understanding on how these decisions are made from within their black boxes, Pasquale (2015) amongst others calls for the workings of the mathematic models and algorithms to be made more transparent, comprehensible and accountable. According to Knight (2017), access to these models may help promote general understanding about the reasons behind automated decision-making. For a recent stark warning of how data systems reinforce socio-economic polarisation see Eubank (2018). Bryson and Winfield (2017) advocate that better understanding around how Artificial Intelligence's deep learning and machine learning works, can help designers, technologists and users to recognise why certain applications fail. So can we, as design researchers help to make these workings more explicit and comprehensible?

3.4 Overview of Comparative Design Research

Blockchain has been an apparent answer to extremely centralised models of finance, governance, notary, utilities etc., challenging the status quo through its disintermediated ubiquitous systems that we can use day-to-day. The significant feature of Blockchain is the complex network that builds up through a distributed database, the peer-to-peer transmission formed through transactions, and the irreversibility (or mutability) of records. Groups of transactions are blocked together and a 'fingerprint' of each is added to the next block, creating the growing network, or *chain*, irreversibly (Government Offices of Sciences, 2016, p.56). Blockchain is the recent object of investigation within smart cities design research – towards enabling "liveable, sustainable and sociable urban futures" through citizen-centred approaches (Speed, 2016b, p.1). It is also proposed to extend digital humanities into new forms of storytelling and narrative (Maxwell, Speed & Campbell, 2015) and provide alternative forms of (non-monetary) value exchange (Nissen, Symons, Tallyn, Speed, Maxwell & Vines 2017). These explorative investigations aimed to make Blockchain more accessible to designer researchers and publics through familiar props and materials.

Chris Speed with Debbie Maxwell and Dug Campbell (2016a) used Lego bricks in a workshop with design students to further understanding on the principles of Blockchain (see Figure 1). Their stated aim was to demonstrate the distributed nature of the technology and something of its 'complexity', but not *illustrate* the network (chain) within Blockchain. The workshop was a catalyst for conversations to identify research challenges rather than creating accurate representations (ibid.).

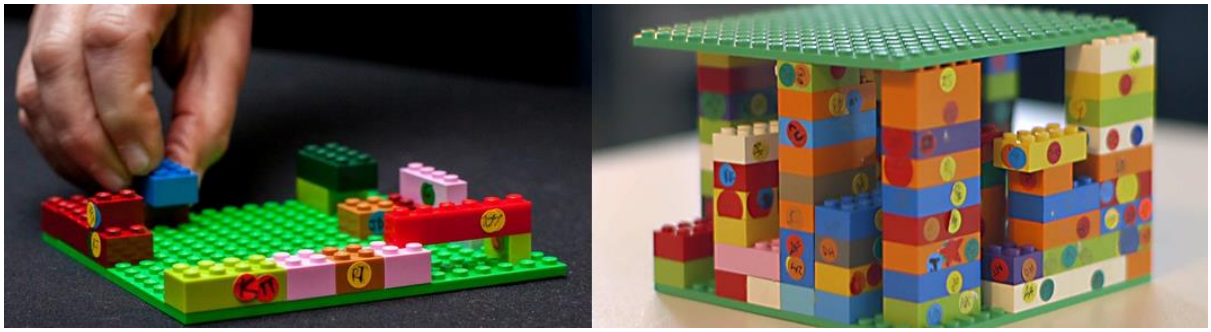

Figure 1: Speed's workshop use of Lego bricks to represent Blockchain. ©Chris Speed reproduced with permission.

Maxwell, Speed and Campbell (2015) in associated work explored the applicability of Blockchain to adaptive storytelling. They addressed ways in which stories may be read, written and shared through DLT, drawing novel comparisons between story narratives and cryptocurrencies using the creative approaches of 'physical modelling' and 'Lego based activity'. Whereas Speed (2016a) focused on identifying interesting research questions, Maxwell and colleagues speculated on and mobilised Blockchain's creative possibilities for new applications (2015). Our workshops reported below aimed to both explore and enable multidisciplinary knowledge across participating researchers (workshop 3) as well as familiarise us with the everyday digital practices of groups of researchers and those who attended a drop-in IT help session at the local library (workshops 1&2).

4 The Workshops

We ran three workshops between July and October 2017. The first two aimed to broadly scope the level of understandings and digital 'competency' of our design and computer science colleagues and a target user group, to provide initial insights into their attitudes to and breadth of practices around online safety in the context of the research. The two earlier workshops involved an icebreaker and use of a 'conversation tool' based on Covey's (2004) three concentric circles, used to indicate areas of online life over which our workshop attendees felt they commanded total control, some influence, or which concerned them but about which they felt powerless (see Figures 2&3). We provided 15 scenario cards (see Table 2, later); in turn each person was asked to read out and discuss a response to one of the scenarios and place the card appropriately in the circle as marked 'safe', 'unsafe' and 'not sure'. These sessions were audio recorded and where practical and decipherable, the audio files were transcribed. All names have been changed.

4.1 Workshop 1 and 2: Structure

Workshop 1: 'Scoping' workshop of 90 minutes with academic researchers (3 men and 2 women) from design and computer science. Following a short icebreaker the group was split into 2 groups for the Conversation Tool (Figure 2)

Workshop 2: The following day we ran a 50-minute Conversational Tool session directly after the city library's Computer Coffee Morning which offers tailored volunteer expert help to novice users on 'how to use your new digital device': 9 Computer Coffee Morning attendees, their 6 digital skills volunteers and session organiser Lauren were present (Figure 3). We observed in the session people being shown how to move photos from a smartphone to a laptop, and adding urls to 'favourites'.

Figure 2 (left): Conversation Tool with designers and technologists. Figure 3 (right): Conversation Tool discussion with attendees, volunteers and organiser of the city library Computer Coffee Morning.

4.2 Workshop 3 (Blockchain)

Following an icebreaker, this 2-hour session was focused on materialising the understandings of Blockchain and its applications with designer-researcher and computer scientist researcher colleagues recruited from two collaborating labs (3 men, 4 women). We appropriated aspects of creative methods: Anderson's Magic Machine (2013); Nissen and Bowers approaches to materialising data within design making practices (2015); and Playful Triggers (Clarke, Briggs, Armstrong, Macdonald, Vines, Salt & Flynn, n.d., after Akama & Ivanka, 2010) as means of engagement and to invite dialogue around the Blockchain technology and its application. We provided a collection of familiar household objects, toys and novel materials such as Playform, plastic cups, small plastic balls, and human and animal figurines. The overall aim was to gather insights into others' conceptualisations and perhaps folk theories around how Blockchain and its applications work, using visualisation and material making.

We introduced the TAPESTRY project and described the workshop structure before posing an icebreaker question, for which the group were given 10 minutes to construct individual responses on paper, before sharing. The first author then gave an overview of Blockchain introducing general definitions including from pioneer Nakamoto (2008). He describes the technology as a combination of i) *distributed ledger*, a database shared between multiple actors who are all allocated read and write permissions; ii) *immutable storage*, where changes to the ledger, or transactions, are stored in 'blocks' and where each copy of the database retains every block in the 'chain' as an immutable history; and iii) *consensus algorithms*, which are protocols for trustless actors in the network to verify the transactions made on the Blockchain and achieve a secure shared consensus about the state of the database. For more on this in layman's speak see Thomson (2016). Then, in two groups (3 designers and 1 computer scientist in each), our workshop attendees were invited to visualise and map their understanding of the Blockchain applications Trust Stamp and BITNATION. The brief included information from the respective websites (Table 1 shows text provided) to minimise purely subjective interpretation.

Table 1 Website Definitions of the Two Blockchain Applications Used in Workshop 3

Trust Stamp uses social media and other publicly available data to verify your identity and provide a unique FICO-like trust score of your score are private and under your control, you can easily share your trust score on any platform. (Trust Stamp, 2017)
BITNATION is the World's First Virtual Nation – A Blockchain Jurisdiction. The Internet has radically interconnected our world and Blockchain technology – a cryptographically secured public ledger that is distributed amongst all of its users – allows us to choose to govern ourselves for the way we want to live now: peer-to-peer, more locally and globally. (BITNATION, 2017)

Both applications facilitate identity services with distinct features; BITNATION is presented as a virtual nation while Trust Stamp offers identity verification services through publically available social media and wider personal data.

The two groups, who worked in separate rooms and without facilitation, were invited to use the range of physical props and materials that had been laid out. Our aim over this 40-minute activity was to solicit responses both in terms of materialising specific application functionality, and then to promote general discussion across the two groups. Ultimately, we aimed to investigate opportunities for knowledge exchange and ways of bridging the gap between technical and design – and in the case of the library workshop – user domains. Could such workshops help technologists and designers communicate? And; build better applications?

5 Findings Workshops

5.1 Workshops 1&2

The researchers were unanimous in their assessment that 'receiving an email from a stranger' is safe; Computer Coffee Morning (CCM) attendees on the other hand were less sure (see Table 2). Yet

CCMs reported feeling safe 'Sending money using online banking' and 'Storing [their] email password' whereas the researchers were ambivalent. Two thirds (6/9) of the CCM attendees classified 'Sharing photos on the cloud' as safe (compared to 2/5 of researchers) and they were unanimous that 'Sending money in online banking' was also safe (compared to 3/5 researchers). This apparent confidence probably stemmed from the topic having recently been covered by the CCM group: "*You have to come to my other course, you will learn all about that, all about security. Online banking is really safe to do"* Lauren had told the researchers in the workshop.

While limited in their findings, the two workshops were a useful early sense check about the level and range of experience of TAPESTRY's target users. 'Booking a room through AirBnB' and 'Giving your credit card details on online gambling websites' were outside of all the group's — including Lauren's and the volunteer experts'— experience. ('Exchanging personal information in online gaming' unsurprisingly perhaps, proved similarly unfamiliar, though the second author asked a woman who'd discussed playing iPad chess with her friend if that was 'online gaming'.) The sessions then revealed issues relating to our terminology, and different generational interests and values. Online dating, gambling and gaming were perhaps outside of the CCM group's experience. And there was some ambiguity around whether a volunteer's answers reflected their 'lived' or more 'imagined' experiences around their discussions on Tinder and making in-app purchases; and discussions seemed to conflate online- and potential for offline risks.

Table 2 Conversation Tool scenario cards and categorisation in workshops 1 (Researchers) & 2 (CCM)– broadly listed from more common practices to niche. The researchers worked through all the cards but the CCM attendees had relatively lower numbers of responses (marked) due to some having no experience.*

Questions	Wrksp	Safe	Unsafe	Not Sure	Questions	Wrksp	Safe	Unsafe	Not Sure
Receiving an email from a stranger	1	5	0	0	Sharing photos on the cloud	1	2	1	2
	2	4	1	4		2	6	2	1
Creating a Facebook profile	1	3	2	0	Shopping online on Amazon	1	4	0	1
	2	3	1	1		2	6	2	1
Sending money using online banking	1	3	2	0	Downloading an App on an iPhone	1	2	3	0
	2	6	0	0		2	3	0	0
Storing your email password	1	2	2	1	Messaging a stranger on a dating platform like Tinder	1	3	2	0
	2	4	2	2		2*	0	1	0
Using Skype to call your family	1	5	0	0	Making an in-app purchase on an online gaming platform	1	3	0	2
	2	4	1	0		2*	2	0	0
Facetime call with your friend	1	5	0	0	Giving your credit card details on online gambling websites	1	1	1	2
	2*	2	0	0		2*	0	0	0
Sharing your location on Facebook	1	4	0	0	Giving personal information online gaming	1	1	4	0
	2	2	2	0		2*	1	1	0
Sharing photos on WhatsApp	1	2	0	2	Booking a room through AirBnB	1	2	2	1
	2	3	2	1		2*	0	0	0

Overall the relatively more experienced researchers revealed varied perceptions of what was 'safe', which broadly reflected their multi-generational range. The more mature technologist was very distrustful overall, commenting on how their trust in Facebook had diminished over 6-7 years of use; a younger Design researcher, while finding social media "*pointless and unnecessary*" expressed no concerns about sharing their location on Facebook.

5.2 Blockchain Workshop

5.2.1 Icebreaker

An icebreaker question asked "Is there a need for users, technologists and designers to understand how digital technologies work and why? Digital designer Alice expressed "*a categorical 'Yes!'*" due to "*implications of use*". Programmer John said, that while it was important to recognise the limitations of technology, technologists didn't "*get a say in how [the technologies they create] affects general interactions,*" somewhat abdicating technologists' ethical responsibility. Cara stated that *all the groups* need *"an idea of the ethical, moral and social impact it might have on one's life*", referencing Einstein's support of the atomic bomb project. Kris said users didn't *need* to understand, but on reflection stated: "*if I am using something or designing something or engineering it. Sometimes I am doing all three*", recognising his mutable position. Another programmer said: "*I want to be more 'no' than the others*" this time referencing Leonardo's flying machine as an example of how innovation can thrive without technical feasibility. He likened this to algorithms: "*We don't understand what is happening in deep learning, 10 to the power 9 or something. We can't pretend we know…we can't visualise it*" (Alex). Designer Peter said promoting a product through use increases its influence and power. He advocated for historical critique, concerned that people were losing technological know-how: "*technology is built upon technology...without a roadmap and a general understanding, [people] will have no means of deepening knowledge.*" Tina considered understanding unnecessary at a "*technical 'I could make this happen' level"* but she said it was "*crucial"* to ask questions to account for different perspectives and motivations as *"technology has multiple purposes and intersections of power.*" Designer Carol took more of a user's perspective: "*Technology shapes us as much as we shape it."* She suggested "*literacies…as a portable kind of skill for figuring out how things are done"* and, echoing Tina, accommodating *"different ways of knowing*."

5.2.2 Making Activity

The main workshop was loosely informed by the approaches taken to giving material form to 'prototyping' (Andersen, 2013; Nissen & Bowers, 2015; Akama & Ivanka, 2010) within open PD dialogue. We used these as means of engaging participants and prompting their discussions on the properties and workings of the Blockchain technologies. Each group was invited to consider Blockchain and its Blockchain-based application (BITNATION or Trust Stamp) separately.

5.2.3 BITNATION

The four participants used a stack of clear plastic cups to build a chain of transactions with coloured balls representing different users' data in the Blockchain (Figure 4). These data balls were incorporated in such a way that they cannot be removed – representing Blockchain's immutable character. To support understanding further they labelled this with coloured letters spelling out the word Blockchain. The group signified the BITNATION application itself with more coloured balls, placed in threes on a "*twirling*" plate, which they animated using circular card to suggest movement. Angela explained "*All the disks are turning at the same time and everyone is looking at everyone"* representing groups of individuals consenting to each other's transactions. "*It's like the tea cups that twirl in the fun parks"* Angela said, going on to explain how the chain was developing in real time.

5.2.4 Trust Stamp

Group 2 visualised the Trust Stamp application (Figure 5) using figurines and other material props, literally and metaphorically– again selecting the coloured balls, which clearly suggested their use as personal data. Human figurines stood in as Trust Stamp users, and a 'sea' of blue beads signalled the shoreline-threshold between digital and physical worlds. This representation incorporated the functional Blockchain and its Trust Stamp application as one technology – prompting higher level narrative overviews which perhaps belied clear understanding of how the technologies functioned. Overall, the more metaphorical whimsical approach was reminiscent of some of sociologist David Gauntlett's (2008) work describing creative methods for making material understandings of social experience and identities, the results of which require explanation and interpretation (ibid.). This

group's activity facilitated wider thinking about the technology's application and implications for design and use, including regulation. The group used the uniformed figurine as an authority to oversee the verification process.

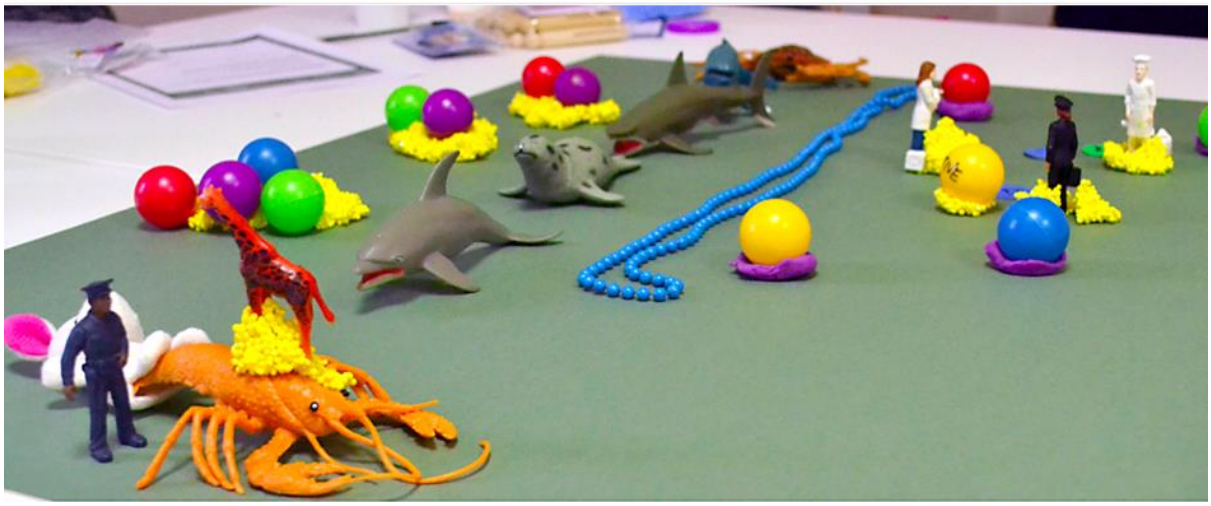

Figure 4 (top) Visualisation of BITNATION; Figure 5 (bottom) Visualision of Trust Stamp.

6 Discussion

Both the groups were able to clearly show the *immutable* characteristics of the Blockchain technology. Kris, who'd locked the coloured data balls into the chain of plastic cups made a nice analogy; "*Thinking about materials, thinking about stuff that that could go one way but not the other, like burning a match…or making a cake.*" Both groups struggled to show the *distributed* nature of the system. This was possibly due to finite materials and time: "*how do you show the*

distributed ledger system? We need an entirely new [material]!" declared Tina, who was probably the most knowledgeable of all the participants on Blockchain and its uses.

The workshop process did provide valuable insights into the complicated workings of the technology for those contributing: "*It makes people understand the individual steps*" said Tina on how the physical build invited 'conceptual deconstruction' of the Blockchain process. This in turn provided critical insight: *"…you realise Trust Stamp really doesn't need Blockchain. Then, why are these people going through Trust Stamp and trusting them as a verification body?*" she asked. Carol agreed; the making exercise enabled better understanding and comprised "*… an easy way to cut through all the marketing BS*" around new Blockchain applications.

This speaks to Melanie Swan's (2015) argument that decentralisation, agreeing to a consensus model or recording every single transaction on a public ledger is not necessary in every situation, and reinforces complaints about the level of 'hype' around Blockchain technologies. Their inherent opacity and complicated nature opens up potential for exploitative marketing – or apparent black box 'magic' (Dumas, 2015, p.5).

> *Kris stated that his position hadn't changed (since the icebreaker), but increasingly supported this with references to needing professional standards and regulation:*
>
> *Kris: "if I am in a car with my family driving on a bridge and the bridge collapses, is it my fault as a user or is it the designer's fault? […]*
>
> *Alice: "In the bridge, you may look for signs [of damage and potential collapse] but in software you cannot."*
>
> *John: "Unless you are literate."*
>
> *Alice: "Exactly. A lot of people are not and that's why it is important [to have sufficient understanding]."*

Our methods solicited insights, enabling us to better understand people's understandings of not only the 'mechanical' nature of the Blockchain applications but also how people perceived them. Alice called BITNATION "*pretty dystopian…pretty dodgy*"; although BITNATION is meant to comprise a "*borderless nation*" the Blockchain introduces a form of "*customs*" (Angela). She later said "*it is like Stasi all over again"* referring to the secret police. Peter declared: "*Trust Stamp terrifies me*." Kris was untrusting of BITNATION and its online presentation stating: "*these [Blockchain] systems are dishonest.*"

The value of material making was in making explicit and sharing their understandings of the workings of Blockchain as a prompt for inviting more tacit insights (technical and socio-trust related) into understandings and attitudes. Yet it also enables them to see through the 'magic' and 'BS'. However, we are equally aware as design researchers that such approaches could misinform and confuse; the groups were set a task and without some level of existing understanding amongst the group they struggled to develop deeper or clearer understanding, even with access to the respective websites. Obviously, there are ethical and value-related issues with research projects such as TAPESTRY around which we need to be critically aware.

7 Conclusion

There are many issues to be resolved before potential users routinely enable algorithms to capture and manage their data. Users may be expected to trust the Blockchain application system, because the data is locked with a private key. Providing discussion and insights through creative methods potentially opens up opportunities for people to understand how they think about these systems and how they and their peers respond to the 'unknown'. We propose that creative design

techniques within PD have rich purpose beyond providing interesting and thought-provoking mediation between designers, technologist and user groups.

However, such workshops have limitations. These include the availability of key participants. We worked with colleagues from a computer lab on campus, rather than our TAPESTRY Blockchain and AI computer scientists. Our participating colleagues demonstrated a generous willingness to take on abstract playful activities, and were prepared to share their varying understandings on the Blockchain technologies and personal attitudes to various digital practices. And, while the materials we provided (readily available in our studio lab from previous workshops) lent themselves to enabling broad representational work, they sometimes invited particular uses (the coloured balls as data, the figurines as controlling authorities); meanwhile, showing a 'distributed ledger' proved difficult (see Kensing & Blomberg, 1998).

We only began to scratch the surface of how applications such as BITNATION and Trust Stamp may impact on our world. Our study prompted quite dystopian negative reactions. Critics Iaconesi (2017) and Swan (2015) amongst others warn that using Blockchain tends towards quantification, with all relational, emotional and expressive interpersonal exchanges becoming 'transactions' as a form of what Swan calls *economification*.

This paper concludes that PD approaches are useful in eliciting understandings around the perceptions of the functions, value and ethics of emerging technologies within multidisciplinary Design research. Although there is much we can learn from investigating emerging technologies, it is also crucial that they are studied from multiple perspectives – not only designers' and technologists', but those of myriad potential users to best fit societal and human purposes.

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