



Design Fiction Diegetic Prototyping: A Research Framework for Visualizing Service Innovations

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Table 1

Summary of ‘designerly’ methods

Method	Disciplinary Lenses	Definition	Description	Suggested references
Design Thinking (DT)	Design; management	Analytic and creative process through which experimentation is used to develop a prototype. Overarching term for cognitive process of designers; recently ‘stretched’ and applied within management for innovation problem solving.	A way of explaining design creativity processes; about perception in and through images; supports dialogue with ‘temporary’ representations; addresses a problem with a visualized (typically sketched) solution.	Cross, Dorst, Roozenburg (1992); Goldschmidt (1994); Plattner, Meinel, Leifer (2011)
Human centred design (HCD)	Design; management; computer science; engineering; psychology; cognitive science	A feature of DT, focussing on a solution that places the human at the centre of the problem.	Socio-cultural process (creativity <i>with</i> users); combines user knowledge and design ideas; improves user experience by incorporating usability factors in design processes; criticised because it does not adequately push boundaries to account for available or emergent technologies.	Cooley (1989); Steen (2009); Krippendorff (2011)
User experience design (UXD)	Design; behavioural psychology; ergonomics; computer science	Design approach for focussing on user experience of usability and accessibility of product/service attributes.	Focuses on interaction between human and product/service to improve usability; assumes experience/user knowledge.	Norman (1988); Hassenzahl, Diefenbach, Goritz (2010); Harte, Glynn, Rodríguezmolino, et al (2017)
Critical design (CD)	Design	Uses critical theory approach to evaluate function and form: structural, physical, psychological, social and cultural function/form.	Broadens design application to include range of practices, including potential applications (basis of speculative design); criticised for over-focus on dystopian perspectives.	Dunne (1999); Dunne & Raby (2013); Prado (2014)
Storytelling	Arts; management; marketing	Narrative approach to represent, frame, interpret something meaningful to an audience or community.	Often contains episodic information, relevant to some context, builds memory systems in audience, contributes to sensemaking in complex scenarios.	Tulving (1985); Govan et al (2009); Woodside, Sood, Miller (2008)
Videography	Arts; marketing	Videographic (e.g. film, photograph) approaches to documenting and	General field of visual data capture; reflects aesthetic intention of researcher; often aligned with multiple	Rokka, Hietanen & Brownlie (2018); Belk,

		describing happenings, events and artefacts; the process of capturing image – production and post-production.	methods; supports narrative through interpretation.	Caldwell, Devinney, Eckhardt, Henry, Kozinets, Plakoyiannaki (2018)
Design fiction/speculative design	Design; computer science; creative practice	Extrapolates plausible futures	Visually rich future scenarios incorporating a form of narrative evaluation; positions futurism in a cultural context; can include audio, visual and textual design approaches.	Bleeker (2009); Lindley et al (2017)

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Abstract

Purpose:

This paper presents a design fiction diegetic prototyping methodology and research framework for investigating service innovations that reflect future uses of new and emerging technologies.

Design/methodology/approach:

Drawing on speculative fiction, we propose a methodology that positions service innovations within a six-stage research development framework. We begin by reviewing and critiquing designerly approaches that have traditionally been associated with service innovations and futures literature. In presenting our framework, we provide an example of its application to the Internet of Things (IoT), illustrating the central tenets proposed and key issues identified.

Findings:

The research framework advances a methodology for visualizing future experiential service innovations, considering how realism may be integrated into a designerly approach.

Research limitations/implications:

Design fiction diegetic prototyping enables researchers to express a range of ‘what if’ or ‘what can it be’ research questions within service innovation contexts. However, the process encompasses degrees of subjectivity and relies on knowledge, judgment and projection.

Practical implications:

The paper presents an approach to devising future service scenarios incorporating new and emergent technologies in service contexts. The proposed framework may be used as part of a range of research designs, including qualitative, quantitative and mixed method investigations.

Originality:

Operationalizing an approach that generates and visualizes service futures from an experiential perspective contributes to the advancement of techniques that enables the exploration of new possibilities for service innovation research.

Key Words: Design fiction diegetic prototyping; Service innovation; Internet of Things (IoT);

Type: Methodological

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Introduction

Service innovation is increasingly recognized as a critical organizational capability that achieves competitive advantage and enhances financial performance (e.g. Dotzel *et al.*, 2013; Lee *et al.*, 2009). However, much research in this area is still significantly influenced by '*simple frameworks borrowed from the new product literature*' that focus primarily at the product level within social vacuums (Ordanini *et al.*, 2014:134; Dotzel *et al.*, 2013). Recognizing the experientially focussed and holistic nature of service innovations, research in this field is increasingly attempting to evaluate social practices whilst simultaneously reflecting emerging macro social trends (e.g. Gatignon and Xuereb, 1997). Such approaches reflect not only a focus on the individual (e.g. behavioral and attitudinal) but also meso and macro factors (e.g. institutional, social, and organizational) that are considered to be fundamental to predicting service transformations (e.g. Storbacka *et al.*, 2016). Understanding customer attitudes and behaviors towards service innovations whilst simultaneously considering '*real world complexity, dynamism and context at the holistic level*' (Gummesson *et al.*, 2014) is especially challenging. Central to any future vision of a service innovation is the significant influence of new and emergent technologies (e.g. Westwood, 2000; Kunz *et al.*, 2019). Crucial to this are accompanying changes in individual and societal value systems, attitudes and behaviors (Ratcliffe and Krawczyk, 2011). Consequently, a more transformative path is increasingly advocated using approaches that reflect multidisciplinary perspectives to frame service innovations research (e.g. Bitner *et al.*, 2015; Ozanne *et al.*, 2011).

In striving to devise more experiential evocations of service innovations, methodological practices are beginning to generate a rich body of work that encompasses and integrates ideas and influences from other disciplines, including arts, technology and sciences. This encompasses design, science fiction writing, fine and performance arts, video games, filmmaking and photography. However, as Beverland (2005) highlights, in doing so tensions may emanate from value-based conflicts between different disciplinary perspectives. For example, the creative motive of designers is often seen to conflict with the profit motive of marketers (e.g. Ostrom *et al.*, 2015). Whilst breaking-down disciplinary silo perspectives is increasingly essential for the optimization of service innovations (Larson, 2016), research is in its infancy primarily because there is a paucity of operationalizable guidelines on how to undertake research that examines service innovations combining multiple disciplines (e.g. Anton and Breidbach, 2018).

This paper attempts to address this gap by advancing a methodology for investigating service innovations: design fiction diegetic prototyping. Specifically, the paper proposes a framework for envisioning, developing and exploring service innovations. We next outline the multidisciplinary foundations of the methodology before presenting the research framework using a case example of the Internet of Things (IoT) to illustrate its application.

Perspectives in Design Fiction Diegetic Prototyping

We review three bodies of literature that have informed the development of the research framework. These represent different disciplinary approaches that underpin research practice which, in turn, generates useful visualizations. A summary overview of different design-based approaches to envisioning service innovations is included in Table 1. We also examine the interrelationships between these ‘designerly’ methods.

Human-Computer Interaction (HCI) design

Human-computer interaction (HCI) is a multidisciplinary field of study that focuses on computer technology and its interaction with humans to address the challenges of adoption and usability of new technologies (e.g. Pierce *et al.*, 2015). With roots in engineering, science and technology, researchers have begun to ask how they can align product development with design research (for summaries see Li *et al.*, 2016; Lalaounis, 2018), framing ‘critical design’ as a means to reflect HCI problems through a ‘designerly’ lens. Drawing on Dunne and Raby’s (2002; 2013) influential work, this emergent field provokes a type of creative practice that enables the development of ‘design proposals’ that oppose current orthodoxy (see e.g. Auger, 2013). Although it has been criticized because it often leads to concepts that challenge traditional human-centred design (it pushes the human user’s needs, competences and capabilities to the side of design problems), the approach enables researchers to speculate around questions of ‘what could it be’ (e.g. DiSalvo *et al.*, 2014; Lindley and Sharma, 2015). Extending this, some HCI design researchers have turned towards science fiction media, which is argued to be an inspirational source of information on technological futures (e.g. Mubin *et al.*, 2016) leading to innovative developments such as gesture-based interfaces (by way of example, think interactive retail windows in the film *Minority Report*). The conflation of HCI design with science fiction (Bleeker, 2009; Sterling, 2009) therefore enables novel technology representations to be devised but has so far been under-developed as a research methodology.

Visual elicitation

Within the marketing discipline, visual elicitation methods have been used in service innovations research for a number of years. It is predicated on the premise that valid scientific insight can be acquired by ‘*observing, analyzing and theorizing visual manifestations: behavior of people and material products of culture*’ (Pauwels, 2011:3). Typically qualitative in its application, visual elicitation methods include a vast array of techniques such as photography, film, video, painting, drawing, collage, sculpture, artwork, graffiti, advertising and cartoons (e.g. Glaw *et al.*, 2017). Such methods may also be incorporated within mixed research design approaches and used as a tool to support understanding, interpretation and to capture the richness of phenomena (e.g. Pain, 2012). Reflecting cognitive processes, visual stimuli may evoke deep emotional responses within research participants (e.g. Harper, 2002) especially where they may have limited experience or difficulty in verbalizing their responses to the focal phenomenon (Glaw *et al.*, 2017).

Within consumer contexts, the visual nature of consumer culture has already been acknowledged as a methodology for research and has been particularly effective at visceral evocation (Belk and Kozinets, 2005; Schembri and Boyle, 2013; Petr *et al.*, 2016). The uptake of multidisciplinary approaches incorporating the arts in an exploratory context has, however, been slow to gain acceptance. Recent forays have

focussed on consumer culture theories (see e.g. Seregina, 2017; Belk *et al.*, 2018; Rokka and Heitanen, 2018). Collectively, this work highlights the value and roles that videographic methodological approaches bring to generating insight into consumer behaviour whilst calling for greater engagement with research audiences through novel creative and interactive means, such as through storytelling. Despite receiving little mainstream attention, videography has been posited as being useful in documenting and describing happenings, events and artefacts that disclose experiences for analysis (Belk and Kozinets, 2005, 2017; Kozinets and Belk, 2006; Sayre, 2001, 2006). This provides a method of cultural immersion (Schembri, 2009) that explicates a '*contextual reading of behavioral patterns*' (Schembri and Boyle, 2013) with generative potential. As Belk *et al.* (2017) emphasize, however, the role of film in consumer research is still very much one of experimenting with different genres, viewpoints and techniques.

Design Fiction

Within media, art and design, by using experiential scenarios, performative storytelling and diegetic props, future possibilities are being explored (e.g. Candy and Dunagan, 2017) using 'speculative design' or 'design fiction' methods that draw on creative practice. Techniques used seek to extrapolate plausible near (or far) future possibilities of new technologies that have potential for use within and across a wide range of disciplines (see e.g. Turney, 2013). However, within service innovations research, the approach lacks a clear structure for operationalization as a methodology that would render it as a useful method for explorative investigation.

The term 'design fiction' was coined in the early 2000s with reference to prototyping within story-based worlds (Bleecker, 2009). Examples of this include novel modes of interaction with an innovative service communicated through a medium such as a film, poster, advertisement or game (e.g. Coulton and Lindley, 2017). Design fiction has been used to prototype technologies that do not yet exist but may be useful for evaluating potential applications and related service innovations. The approach uses data gathered from a breadth of commercial and scientific research sources in order to construct a prototype and then to consider the innovation's impact on lifestyles. Diegesis (originating from Greek, meaning 'to narrate') is a word that describes a fictional representation often told through story narratives, whereas a 'diegetic prototype' is a design-led portrayal of the aesthetic interface that encompasses intended use and purpose (Kirby, 2010). Design fiction diegetic prototyping therefore encompasses the scientific-design representations of a service innovation and the interactions between service users and emerging technologies, which is accompanied by or embedded with a story narrative (Auger, 2013; Heibeck *et al.*, 2014).

Design fiction diegetic prototyping has potential to respond well to the call for immersion techniques involving potential users (e.g. Franke *et al.*, 2006) by presenting ideas without attempting to convey unnecessary underlying technicalities or details of the specific technology that could confuse rather than inform (e.g. Lindley *et al.*, 2017). Hales (2013) states that it is not simply an ideological perspective of some futuristic context but it is about revealing '*intentional practices in the present time*' (e.g. Gonzatto *et al.*, 2013). Thus, whereas narrative stories alone do not yield a visualized new or emergent technology-in-use, its visual representation through a prototype enables possible new insights to emerge in narrative (storytelling) processes. This may encompass tacit knowledge related to potential 'slice-of-life' service scenarios because the technique depicts complex service innovations (Gummeson *et al.*, 2014; Yu and

Sangiorgi, 2018). Crucially, it merges different disciplinary perspectives including design, computer science, marketing and futurism, to facilitate insights into the adoption of new and emerging technologies in some service innovation context (Candy and Dunagan, 2017; Coulton *et al.*, 2018). This can be rendered usable through multisensory interfaces including visual design approaches that may incorporate a physical object, film, story narrative, interactive game, etc.

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Insert Table 1 about here

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This review highlights a trajectory of designerly techniques that converge on visualizations of service innovations from different disciplinary perspectives. In attempting to synthesize these practices and extend the field to propose our methodological framework, we draw upon Pauwles (2011) who argues that visual methodology should encompass three key aspects: the origin and nature of visuals; an outline of the research focus and design; and, the format and purpose of the investigation. We adopt a ‘mixing and re-mixing’ (Candy and Dunagan, 2017) of multidisciplinary approaches that attempts to balance visually rich and analytically robust potential future service scenarios at an experiential level while providing valuable insights into consumer attitudes and behaviors related to service innovations.

Thus, this paper next provides operational guidelines for a designerly methodology that enables investigation into experiential research for service innovations. Specifically, we present a design fiction diegetic prototyping research method as a technique that sets out near and potentially far futures which may evoke vibrancy and visually engaging insights into consumer reactions to future service scenarios with new and emerging technologies. The next section outlines the methodology and its operationalization using an illustrative example. In so doing, we attempt to address the shortcomings of the designerly methods outlined above and summarized in Table 1.

Methodology

We propose a six-stage research framework summarized in Figure 1. We first describe each stage of the methodology and subsequently present an applied example based on research undertaken that focused on the IoT within each stage.

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Insert Figure 1 about here

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Stage 1: Research Context Development

Design fiction diegetic prototypes stimulate consumer discussion and reactions to new and emerging technologies about which they have no prior knowledge and limited experience (e.g. Auger, 2013). It therefore assists consumers to envision service innovations as the approach links service design and service innovation to consumer experiences in such a way that consumer responses may be assessed at the point of conceptualization (e.g. Anton and Breidbach, 2018; Patricio *et al.*, 2018). The approach provides a means to create visualizations of potential uses of new technologies. A key

challenge is, however, demonstrating how speculation is realized and how the fictional accounts of the designed context are explicated through the aesthetics, technologies, interaction and behaviour of consumers. Predictions of the evolution of technologies can be reminiscent of many notions of futures portrayed in popular press and science fiction but often such predictions tend to concentrate on binary positions between utopian and dystopian futures (e.g. Westwood, 2000; Prado, 2014). Hence, the primary aim for a ‘rendered’ experience using a design fiction diegetic prototype approach is to build a perceptual bridge between the future concept to be explored and its potential *realistic* values to users disjunct of utopian or dystopian contexts. Speculation is therefore not trivial – it is beyond conjecture and grounded in evaluative extrapolation using ‘what if’ questions around the intended service applications of the emerging technology. This initial stage therefore involves exploring an area of research interest and determining the scope of the technological context that may then be used to devise a design fiction by capturing and exploring the breadth of ‘what if’ scenarios. This may then be developed into a diegetic prototype.

Applying this stage to an illustrative example, we highlight an area of research investigation that lends itself to adopting the proposed methodology: the IoT comprises assemblages of small devices that operate at machine-to-machine levels, rendering ‘smart’ services through interconnections albeit, despite their potential impact on service innovations, the devices themselves are largely invisible to consumers and end users. The proposed methodology may therefore facilitate understanding of how the IoT devices interrelate and the ways in which the technology assemblages create new connected services (see e.g. Coulton *et al.*, 2018).

Review and evaluation of literature on IoT highlights it is an umbrella concept covering a number of digital technologies that communicate with each other through geo-located devices such as the internet, smartphones and wearable devices. Current predictions suggest the IoT will consist of billions of ‘things’ that have potential to seamlessly connect, interact and share information with each other about themselves and their environment resulting in a range of potential services for consumers (e.g. Eloff *et al.*, 2009; Greengard, 2015). In its current rudimentary state of development, the IoT is predominantly a collection of fragmented networks and objects (Ng and Wakenshaw, 2017). Devices and objects will increasingly merge into a series of momentary experiences that provide holistic consumer-oriented services (e.g. Ng and Smith, 2012). Physical devices will morph from static products into ‘*fluid, dynamically reconfigurable, engaging service offerings*’ resulting in assemblages of socio-cyber-physical offerings (Ng and Wakenshaw, 2017; Hoffman and Novak, 2017). Through ongoing interactions between actors, new capacities and unanticipated services and associated experiences will emerge (Coulton *et al.*, 2018).

A justification for application of the design fiction diegetic prototyping methodology is the rapidity of the emergence of IoT, its novelty, scale and diversity of applications that highlight research challenges in anticipating potential user attitudes and behaviors and consequential impacts on businesses and society as a whole. The need to engage more robustly with future IoT scenarios and accompanying customer journeys from both a normative and adaptive perspective is crucial given the predicted and potential proliferation and permeation of the IoT in every aspect of consumer life (Karuri-Sebina *et al.*, 2016). As Bolger (2014) observes, ‘*These technologies will be some of the most intimate we have ever used and which we will be installing on ourselves and throughout our living spaces*’. However, potential benefits of the IoT may be mitigated if consumers ‘*withdraw their involvement out of fear or obscure their own data in protest*’

potentially culminating in a global deterioration in confidence in the emergent technologies and their applications (Ng and Wakenshaw, 2017:11). Furthermore, potentially complex research questions that transcend networked relationships and involve many actors, with varying levels of agency and degrees of 'intelligence', are yet to be addressed.

Thus, visualizing the complexity of potential IoT assemblages and service innovations is challenging given the multi-layered interactions between actors and objects which is likely to extend beyond the imagination of most potential users (Coulton *et al.*, 2018). These complexities are exacerbated by the all-pervasive but inconspicuous nature of the technologies and data generated, including how the flow and control of information may be based on computational intelligence (e.g. Fritsch *et al.*, 2012). The imperative is to capture and communicate the synergistic nature of assemblages rather than focus on individual devices or objects (e.g. Ng and Wakenshaw, 2017). Methods that inquire into the nature of user behaviour within such service contexts are inappropriate in framing questions because respondents lack a clear sense of the innovative assemblages. As Ng and Wakenshaw (2017) observe, *'It is clear that research stakeholders in the IoT space are sensing the need to transform traditional [research] approaches into innovative ones... the most relevant questions would be inclined towards research at the interface between marketing and at least one other discipline'* (2017:17).

Stage 2: Perceptual Bridge Tenets

Since the 'what if' scenarios highlighted in stage 1 are insufficient to generate visualizations of the service innovation context, stage 2 involves a process of conjecturing about the research context. This informs development of a 'perceptual bridge' between the new technologies, likely user behaviors (e.g. Coulton *et al.*, 2018) and any material realities of change (e.g. Raford, 2012). This stage comprises evaluation of temporal and situational contexts and potential user expectations and preferences surrounding these (Miller, 2007).

During this phase, 'found images' may be collated (Pauwels, 2011) and descriptions of applications may be drawn from technological and scientific literature with potential applications identified, noting sources and potential uses. Images may be generated using key search terms and through participation in thematically related virtual communities (social media special interest groups, often comprising early adopter consumers as well as artists, scientists and technologists). The resultant image-based dataset will comprise both images and narratives related to emergent applications of the new technologies. These may then be grouped by practical applications of the technologies. The dataset may then be reduced to a single image which summarizes a representation of the technology-in-use, potentially representing an imagined future service scenario.

In completing this stage of the methodology, it is imperative to consider what Miller (2007) refers to as a 'paradoxical task' in which rigorous imagining is both scientifically grounded and intelligible. It is important that this stage is used to acquire insights when analysing materials of *'representational cultures over time and space'* (Pauwels, 2011:6). Immersion within scientific communities may enable designer-researchers to overcome a key challenge associated with the use of found images: that of being unable to contextualize the visual material presented, thus drawing on expertise of multidisciplinary perspectives. From the analysis of visual and narrative data, a series of central tenets may be formed that explicate the development of a service

innovation expressed through a design fiction diegetic prototype, as outlined in the stage 3 below.

Extending our example of application at stage 2, evaluating future technological developments for IoT requires an assessment of the impact of service innovations on the relationship between people and devices, encompassing socio-cultural, technological, institutional, demographic, ecological and economic developments (e.g. Rijkens-Klomp *et al.*, 2017). This stage of research development therefore involves identifying emergent IoT technologies and classifying them by usage and developer intentions. It is not an exhaustive process but is thematically generative in nature. Ultimately, the aim is to identify areas of themed potential application of IoT: in our example, we identify health, home-life and travel as areas of service innovation. Using a reflexive process, the following themes emerged as perceptual bridging tenets representing a near future use and application of IoT, grounded in a multidisciplinary literature review of the technologies and their intended use:

- social and connected interactions between communities of people are commonplace;
- assemblages of technologies will become ubiquitously embedded into consumer lifestyles; and
- lifestyle is a service system ‘aesthetic’ that IoT technologies may enhance.

Stage 3: Design Fiction

This stage involves developing identified contexts into design fiction storyboards that encompass fictitious but plausible future service scenarios involving service innovation applications and consumer interactions. Crucially, the design of each service scenario should ‘pull’ people into a near (or far) future with the aim of not merely describing some personal application but immersing them within a service context (Rijkens-Klomp *et al.*, 2017). The challenge is how to imagine and subsequently construct pertinent and resonating narratives about the emergent technology that may be visualized through the diegetic prototyping process. This stage is therefore divided into two steps: scoping the scenarios and scripting the stories to create a verisimilitude perspective, blending consumers’ current experiences and expectations (Coulton *et al.*, 2018). To visualize this, we adopted a diegetic prototyping technique that makes use of ‘machinima’ (machine-animation-cinema) filmmaking. This visualization technique has unique properties that render it particularly useful for service innovation storytelling and is further elaborated on below.

(i) Scoping the scenarios

Using the research themes and tenets identified in stage 2 in order to convert service innovations into storyboards with visualized scenarios, a series of design ‘features’ may be expressed. These are necessary to translate scenarios into short illustrative films that result in a series of ‘assets’ for research application. Firstly, fictional idealized character sets are required to portray everyday actions that characters (actors) may undertake when engaging with a service innovation-in-use – this may include classifying features such as gender, age, lifestyle, etc. Secondly, a series of consumption practice schemas and patterns are required which portray how the characters may interact with the service. Thirdly, a scene/contextual setting is devised to position the characters using a service innovation – it is important to reflect upon the level of detail required within the scenario and how this may influence perceptions of service users. Fourthly, defining

a temporal dimension to the scenario provides a sense of usability and intentionality for the service innovation.

In our example, to represent IoT service innovations, four central characters and interconnections between them are identified. The scenario is visualized with a schematic drawing (Figure 2). Characterizations are two related couples: one older and one younger; sets represent one couple living an urban lifestyle and the other a suburban or rural lifestyle. All characters have differing degrees of fitness, health and wellbeing issues forming the interactive patterns of exchanges between them. A temporal dimension is incorporated into the ‘slice of life’ description for each character, condensed into a short narrative focussing on each character’s management of their interpersonal relationships.

(ii) Scripting the stories

The process of scripting story narratives results in a portrayal of interactions between actors within a service system. The stage builds upon the central perceptual tenets (Stage 2 above) by developing a series of activities that characters may engage in. This process should elicit representational practices as cultural expressions from visual materials, including form and style, processes of consumption and their potential verbal reactions to the stimuli. As Pauwels (2011) argues, such an approach influences the process of conceptualizing, gathering and communicating ideas related to potential service innovations. Scripting essentially connects the scoped scenario ‘assets’ from the preliminary stage to a story through a narrative building exercise.

In the example, narratives, envisaged as voiceovers, describe what could not easily be articulated through an aesthetic form. Narratives comprise scripts that embed assemblages of devices for fitness tracking, planning a trip, food ordering, daily scheduling, information sharing and social time (see Appendix 1). Narratives connect the central perceptual tenets of the IoT technologies-in-use and the scenarios resulting in the design fiction diegetic prototype.

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Insert Figure 2 about here

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Stage 4: Quality Standards

In an attempt to address what Burnam-Fink (2015) refers to as ‘content credibility’, Stage 4 comprises the quality standards applied to the design fiction diegetic prototype. Ethics in the context of the application of the proposed research framework is rooted in speculative realism, a philosophical lens that works through the complex process of generalizing from particular topics, of imaginatively schematizing the generalizations, and finally by renewed comparison of the imagined scheme with the direct experience to which it should apply. Reflecting the ethical stance of this philosophical approach, there is a need to recognize the opacity, complexity and the specificity of things (Morton, 2013; Banu, 2015). Within the scoped scenarios, objects render envisioned usefulness to humans through assemblages that are imagined and created. An ethical stance therefore requires ‘*considered and logical associations that retain the dense and autonomous existence of each thing... [for example] by noting the breadth of conditions that culminate in a single thing*’ (Banu, 2015:72-74) such as a moment, experience or object. Flexibility of the representations is contingent upon instrumental facts related

to the technologies and the imaginative fiction of the service innovations they render. It is the fictional aspects that provide the detail to the scenarios that fact cannot.

The design process is subjective insofar as it is dependent upon the researcher's ability to know, judge and project future possible experiences into potentially veridical fictional representations. Veridicality relates to both the rigour of the extrapolation of instrumental facts about the technologies (credibility and authenticity) and the consistency with which results are viewed by others (transferability and persuasiveness) (e.g. Geertz, 1973; Noblit and Hare, 1988). Credibility and authenticity are related to each stage of the research design process described in this framework. Transferability and persuasiveness are to be incorporated into the development process by pre-testing the devised scenarios to evaluate their relevance and realism to potential service innovation users. Focus group discussions may be particularly useful especially when different disciplinary perspectives are integrated into the evaluation process. The aim is to explore any unintended interpretations of the representational practices and characters within the storyboards and scripts constructed. Feedback may be incorporated into amendments to scenarios and scripts in order to more tightly define the projected service innovations-in-use. The process is analogous with the use of multidisciplinary teams of experts in the creation of science fiction plots. In this way, trustworthiness as a form of face validity is assimilated into the designerly research development process.

In our example, an ethical stance towards the philosophical approach taken to create the design fiction, the opacity, complexity and the specificity of things are recognized in the scenarios and stories (Morton, 2013; Banu, 2015; Hoffman and Novak, 2017) by illustrating the 'usefulness' of objects to characters. Banu (2015) argues the nature of speculation involves fantasy and chance, since the full range of possibilities that objects might perform cannot be known. An ethical stance therefore requires '*considered and logical associations that retain the dense and autonomous existence of each thing... by noting the breadth of conditions that culminate in a single thing*' (2015:72-74) such as a moment, experience or object. Flexibility of the representations is contingent upon instrumental facts related to the technologies and the imaginative fiction of the services they illustrate. In our envisaged IoT service innovations, it is the fictional aspects represented through the research process that provide the detail to the scenarios that fact related to the emergent technology cannot. The process of creation involves what some have described as 'counterfactual reasoning' and 'mental prospection' that enables development of hypothetical possibilities using 'what if' questioning (see e.g. de Smeldt and de Cruz, 2015). The ethical dimension the research framework explores therefore highlights the characteristics, features, atmosphere, processes, influences, context, interactions, and networks of all things (objects and humans). Thus, we avoid the representation of IoT objects as 'things awaiting command' but attempt to represent them as embedded components of a service ecosystem that may be perceived by the characterized human actors. In this way scenarios become transparent because content may be interpreted in many ways. It is the interpretations that are worthy of investigation in the application of the research framework and indeed, in our example, it is fundamental to the data collection strategy (see Stage 6 below).

In interpreting potential users' perception of realism during the development of scenarios into filmic artefacts, we undertook focus groups involving researchers and industry participants with different disciplinary expertise (science, technology, arts, and consumer research) and different levels of knowledge and experience with IoT developments and applications. Feedback resulted in minor amendments to storyboard

scripts to make intended applications of IoT technologies-in-use clearer to research participants. Through this process, perceived realism is therefore considered robust.

Stage 5: Artefact Development

Visual materials may be converted into a filmic (videographic) format, virtual, 'story' or game worlds which may usefully connect central tenets to scenario characteristics and helpfully explore research questions (e.g. Duggan *et al.*, 2017). The production of a videographic artefact, however, aligns with the design stages outlined by Pauwels (2011), Cayla and Arnould (2013), Candy and Duncan (2017) and Miller (2007). The process of diegetic prototyping (e.g. Kirby, 2010) using a machinima filmmaking technique may assist in depersonalizing characters rather than using, say, real actors. Machinima (machine-animation-cinema) filmmaking is a form of animated visuals which has lower production costs than might otherwise be achieved with keyframe, green screen and CGI techniques – it uses 3D computer video games' graphic engines to make high definition animations. This is significantly different to the use of design fiction by film directors with large production budgets (e.g. Spielberg). The non-commercial use of computer game environments for machinima is a recognized practice (see, e.g. Marino, 2004). The creation of machinima by researchers removes copyright issues associated with the re-purposing content such as characters, scenes, sets and artefacts. Some game environments actively enable filmmakers to generate their own creative content, build sets, perform actions, etc. (e.g. Boellstorf, 2008; Bryant and Akerman, 2009). One such virtual environment commonly used for machinima is Sansar® (formerly Second Life®). Whilst this environment for artefact development assimilates many natural world physical properties, its minimalist aesthetic properties (for example, lack of detailed facial expression on avatars/characters) is particularly useful because it enables potential consumers to project their own meaning into characters and scenes during data collection phases (Sayre, 2006).

In addition, an essential part of the filmmaking process is using an appropriately experienced film producer/director to translate research scenarios and stories into the visualized artefact. Part of this requires passing responsibility to the producer/director to recruit actors, interpret scenarios and then oversee design and build of sets, followed by directing, editing and production of the films themselves. This is challenging from both a designer and research perspective: maintaining involvement in the film development processes, for example by evaluating set designs, characters and enacted scenarios, including the interplay between and hierarchy of elements within a film, enables researchers to critically reflect on research intentions and the interpretations of others involved in the production process. In translating research scenarios to character-led visualizations, for example, it may not be possible to visually communicate service innovation intentions and so decisions need to be made about how to progress a design fiction diegetic prototype whilst in production. One device that may assist in overcoming visualization challenges is the use of voiceover to describe characterizations, scenes and actions but this may ultimately imbalance a visualization and detract from the overall intention of a service innovation's design aesthetic – it 'tells' rather than 'embeds' a sense of use albeit that, depending on researcher intent, either and/or both may be perfectly acceptable. Such decisions require a reflexiveness between the researcher and participants during this creative process stage of the method.

In our example, a professional filmmaker is formally briefed and regular review meetings are planned to address arising aesthetic decisions. For example, in a story component that relates to the representation of character illness and cancer treatment (see Appendix 1: Script 4), a turban similar to something that someone undergoing chemotherapy might use was selected as a representative depiction. In discussion, this device is easier to differentiate as a diegetic cue for the illness than a representation of a hairpiece. In translating scenarios to character-led visualizations, some IoT technologies cannot easily be visually communicated and so are therefore excluded from final films, for example, embodied health tracking devices. To partially overcome challenges of aesthetic representation, the diegetic mechanism of voiceover is used to describe actions and a musical score is added as a creative device implying speed of interaction, pace of life and general outlook of characters visualized. Screenshots of scenario themes visualized in our example may be seen in Figure 3.

Insert Figure 3 about here

Stage 6: Data Collection Strategy

Once the design fiction diegetic prototype (as a film artefact) has been produced, it may then be incorporated into any mixed method research process that is appropriate to the phenomenon under investigation. The selection of specific data collection methods depends on the nature of the research questions. Use of the artefact may be as a projective tool or intervention for an experimental design. At this stage, reflecting the researcher intentions, it important to incorporate questions into a research design that also evaluates participants' perceptions of the realism of the design fiction diegetic prototype. This should evaluate each of the components included such as the characterization, sets, behavioural and verbal response patterns, temporal dimension of service innovation-in-use, as well as the actual visualization of the new technology incorporated. Outcomes of this evaluation should of course be balanced against findings of any specific research questions related to the new or emergent technology application.

In our example, research questions focussed on the issues identified for consumers adopting the IoT service innovations. Film artefacts are used as a projective tool incorporated into a survey and films are uploaded to a video-sharing platform to facilitate this (see [XXX Vimeo link here]). This stage reflects more traditional approaches to research design, including developing a sampling frame and survey instrument. Drawing on themes developed from a systematic analysis of the literature (Stage 1), research questions relate to ways in which consumers may assess trust, risk, privacy and security of IoT service innovations. Whilst a detailed description of the research questions themselves, including the instrument development and findings, is beyond the scope of the focus of this paper (two journal papers focussing on IoT services have thus far been published, see [XXX references to be provided on acceptance of paper]), we instead focus our comments here in relation to the application of the research framework. Participants' responses are sought on perceptions of realism of the service innovations presented in four films. Based on a representative target sample of 1,200 respondents, 88.2% of respondents considered an introductory film to be 'realistic' or 'very realistic'; 88.5% of assigned respondents (n=400) considered the Household Management System scenario to be 'realistic' or 'very realistic'; 67.5% of

assigned respondents (n=400) considered the Travel Management System scenario to be ‘realistic’ or ‘very realistic’; and, 75% of assigned respondents considered the Treatment Management System scenario to be ‘realistic’ or ‘very realistic’ (n=400). The design fiction diegetic prototyping methodology, incorporating the aesthetic design, technology representation, social interaction, consumer behaviour and temporal dimension, is therefore determined to be of an acceptable verisimilitudinal standard for quantitative evaluation to take place that addresses the specific research questions on perceptions of the emergent technology service innovations devised.

Discussion

In this paper we have proposed a design fiction diegetic prototyping methodology for visualizing service innovations. The designerly approach results in aesthetic material, generally labelled as a form of visual elicitation, that may be used to examine specific consumer reactions to emergent technologies and their application (Heisley and Levy, 1991; Sayre, 2006). The research framework is intended to facilitate visualizations that examine future possibilities of service innovations-in-use by overcoming abstract verbal descriptions of new technologies that may be difficult to interpret, comprehend or imagine (Marion and Crowder, 2013). Specifically, design fiction diegetic prototyping methodology enables researchers to reflexively envisage a spectrum of ‘what if’ scenarios that may then be explored using a range of research questions and incorporated into research designs such as focus groups, interviews and surveys. We summarize the key considerations for others using each stage of the research framework in Table 2.

Insert Table 2 about here

Important to the implementation of the research framework is the development of perceptual bridging tenets (Stage 2) which connect the scientific foundations of some technological advancement (Stage 1) and service innovation, to stories of their potential application (Stage 3). The framework operationalizes the design fiction diegetic prototyping methodology making the service innovation explicit and thereby transparent, hence addressing a major criticism of designerly tools for exploring service innovations (Anton and Breidbach, 2018). The perceptual tenets articulate a series of assumptions made by the researchers in generating speculative fictional representations. Extant designerly approaches highlighted in the preliminary literature review tend to limit the extent of future possibilities because perspectives originate in either scientific intention or consumer expectation and preference rather than the multidisciplinary approach advocated here.

Extrapolation allows consumers to phenomenologically and *projectively* experience and interpret the richness of service innovations in whatever way is relevant to them personally. Ultimately, however, making assumptions about innovations may lead to erroneous or inaccurate interpretations of future user behavior, resulting in misrepresentation of an inventor’s true intention, scale or method of use. Whilst this is a potential weakness in the proposed methodology, the inclusion of quality standards (Stage 4) is critical (Banu, 2015) and should mitigate this: it is the rigor with which assumptions are dealt with that impacts the integrity of the research outcome at Stage 6. Whilst inherently speculative in nature, the process draws on contingent scientific

understanding of new technologies and likely future uses in service contexts: the methodology requires researchers, through the creative processes employed, to imagine (visualize) innovations-in-use.

It is the fusion of science with art and design within the proposed research framework that has potential to overcome weaknesses identified by selecting applications that address perceptual bridging tenets. In turn, this may result in transformative possibilities (Coulton *et al.*, 2018). Drawing on multidisciplinary perspectives, design fiction diegetic prototyping methodology may explore aesthetic and interface designs and consequential consumer behaviors and interactions. Historically, taking a multidisciplinary approach to research processes has remained elusive (Nicolescu, 2002) primarily because aligning different disciplinary perspectives to realize a creative outcome is difficult to do in practice (Anton and Breidbach, 2018). The research framework operationalized in this paper, however, suggests one approach to synthesizing perspectives which may provide a realistic view of future service innovations. With further advancement of the methodology, it will be important to understand how evaluations emanating from its use, including the incorporation of contingencies, may be integrated with organizational practices to make the fictional accounts of the technologies-in-use a reality.

Consumer perspectives are often avoided until a physical prototype is built and, by implication, in which considerable investment has already been sunk thereby focusing on the *now* rather than *future* use (see e.g. Bitner *et al.*, 2015; Yu and Sangiorgi, 2018; Baron *et al.*, 2018). Realism as a contingent outcome in the application of this research framework is, therefore, an area that needs to be further explored to improve the quality of the methodology. The research framework allows for a multitude of designed artefacts to be devised (Stage 5) and data collection methods to be applied (Stage 6) but it is the central tenets (Stage 2) that underpin the development of research questions, which in turn provide scope for visualizing innovations. Furthermore, it is the ability to envision '*life as it may be apprehended, felt, embedded and embodied*' that gives scope to reflexively evaluate commercial viability (Yu and Sangiorgi, 2018; Kunz *et al.*, 2019).

Our example is a case in point: IoT is a popular topic with considerable policy-backed funding into its development, yet remains largely a technology that has not as yet been scaled for use (Royal Society, 2017). Studies are difficult to devise when consumers have no prior experience of the technology-enabled service innovations. Approaches that visualize innovations provide a method for critical evaluation of how value may be derived. Furthermore, when major disruptions by service innovations are likely, investment in understanding the scope and nature of consumer behavior is justifiable. The example in this paper incorporates modes of consumer interactions with more than 20 different IoT enabled devices, resulting in a series of service assemblages – devices represented include biometric trackers; embedded health trackers; interactive virtual games; kitchen, household and portable program managers; smart freezers, refrigerators, stoves and washing machines; thermostats; drones; and, private and public methods of transport connected through smart technologies. What is important, however, is how the various IoT technologies represented in the artefacts generated create value from the visualized assemblages (Hoffman and Novak, 2017).

Conclusion

This paper proposes a methodology that operationalizes a multidisciplinary approach to researching service innovations. The framework enables researchers to ask speculative ‘what if’ type questions built around central tenets drawn from a research context. Through the design fiction diegetic prototyping methodology, principles of design are used to interrogate service innovations.

A number of decisions on which researchers need to reflect are highlighted as areas of contribution to a new understanding of the multidisciplinary methodology. Firstly, the nature and role of the central perceptual tenets make explicit the premise on which service innovations are designed and this feeds into the development of projective artefacts. The extent to which the explication of central perceptual tenets represents a near or far future perspective on an emergent technology-in-use is a matter for the researcher to determine, based on a systematic review of multidisciplinary literature. For example, our illustrative example connects consumer experience to emergent technologies (IoT) to devise service innovations, which in turn inform the development of research questions (see XXX [papers]). Hence, the proposed research framework is demonstrated to be useful for service innovation contexts rather than technology product developments more generally. The visualizations produced illustrate a realistic understanding of the interfaces between the technologies and services, how they may be used, and how they may interact with each other in a social context. Secondly, where speculation is an abstraction of likely engagement, it may be advantageous to allow consumers a greater or lesser control over their ability to project personal emotions on to the service innovation. Storytelling is one mechanism through which this may be achieved and, in our example, we use voiceover (narrative) as a means to augment visualized stories combined with an animation that minimalizes character representation. This thereby gives research participants scope to project. Thirdly, the role of quality standards and how they are applied to develop the designerly approach. We refer to the speculative nature of scientific contingencies and how realism is ‘designed in’ to the creative processes employed.

From a researcher perspective, the research framework provides a means to operationalize research that explores service innovations reflecting consumers potential experiences. Timms *et al.* (2014) highlight how such ‘visioning’ is frequently reduced to numerical targets, such as reductions in carbon emissions or energy usage in the transportation sector. As a result, potential social and phenomenological consequences related to values derived by consumers and target users are often neglected (e.g. Vargo and Lusch, 2008). Timms *et al.* (2014) describe how research that explores important issues related to the future may become a ‘bureaucratic exercise’ insofar as self-selected experts typically devise means to achieve government-specified targets without considering the attitudes and opinions of ‘ordinary’ consumers and intermediaries whose adoption or rejection of particular behaviors may ultimately be instrumental in delivering the targets. Furthermore, Ozanne *et al.* (2011) and Patricio *et al.* (2018), from different disciplinary perspectives, suggest the interface between disciplines remains poorly understood for service development (design) and outcome (innovation) because they draw on different epistemological bases and lack research methods that visualize service innovation. Thus, our research framework contributes to extant literature by linking designerly methods to consumer centric service innovation methods.

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Table 2

Design Fiction Diegetic Prototype Considerations

Stage	Aim	Considerations
Stage 1 Context	Conceptualize designerly research context	Do not trivialize speculation but consider the different epistemological stances of multiple disciplines on which the innovation is based and consider how each informs conceptualization of the context – how are different disciplinary perspectives aligned and dealt with? Identify and evaluate binary perspectives and consider ways in which utopian and dystopian views influence the context. Explore a range of ‘what if’ and ‘what can it be’ questions in the evaluation of the context at the outset and consider how these develop as the application of the framework progresses.
Stage 2 Perceptual bridge tenets	Underpin the concept with precepts that bridge the innovation with its intended application; develop a series of statements that capture the tenets and inform the designer-researcher in devising the visualization	Refine the ‘what if’ questions – consider situation and temporal dimensions of the innovation in use; create a database of annotated ‘found images’ that may be used a concept board to align with ‘what if’ questions, ensuring that detail of source and intended use by source is captured; use content analysis systematically to theme datasets; apply a single image to each theme – this may be reflexively revised, but keep a record of the ways in which it is revised in order to track the evolution of the visualization; become immersed in different disciplinary perspectives of the innovation – critically reflect on the ways in which the narratives of the innovation emerge and how they relate to the imagined product or service, as well as user interaction.
Stage 3 Design fiction	Scope scenarios and build stories	Create characters, sets, patterns of interaction and narratives related to service innovation in use; use visuals to map interrelationships between characters and products/services; storyboard narratives and test their validity with multidisciplinary participant/stakeholders; explore diegetic properties of creating the visualization – detail versus minimalistic representation, etc.
Stage 4 Quality standards	Rigor and transparency in designerly approach; statement of ethics	Recognize the nature of speculative realism incorporated into the visualization process; state the nature of facts and extrapolations projected into the design at each stage of the framework; evaluate critically with participant/stakeholders.
Stage 5 Artefact development	Material artefact	Use professional filmmaker (visualizer) to convert content generated into a usable artefact for Stage 6; be mindful of nature of diegetic prototype and evaluate the intended versus articulated artefact; examine conversion process (remain involved throughout the conversion process) and consider the ways in which challenges during the process resulted in modifications to the finished aesthetic design.
Stage 6 Data collection strategy	Research design	Consider the role of the material artefact in the research design – projection vs experimental; explore respondent evaluation of artefact within methodology and moderate findings based on perceptions of realism of innovation in use rather than usability per se.

Figure 1: Design Fiction Diegetic Prototype Framework

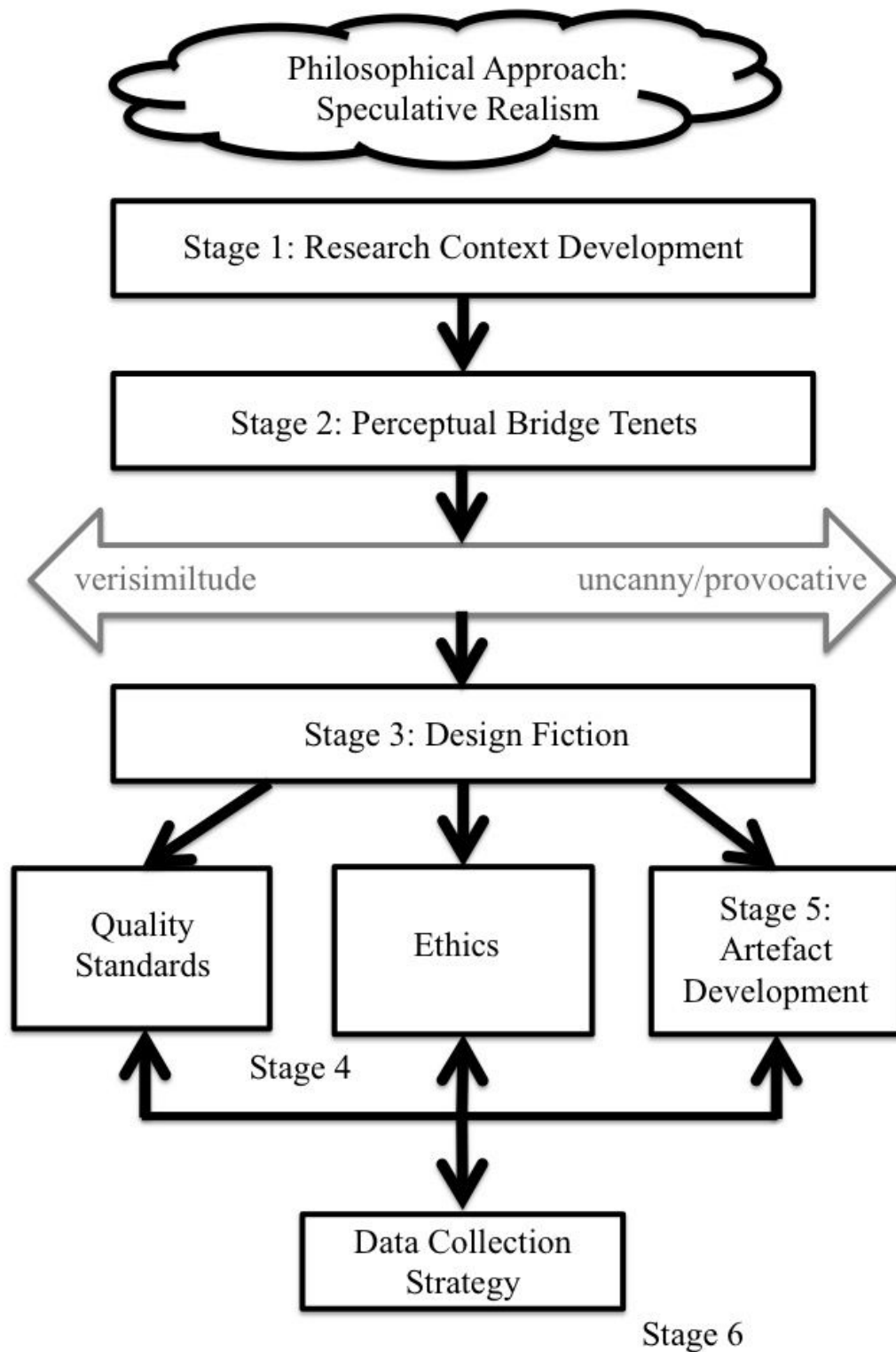


Figure 2: Example of Potential Consumption Practice Schema

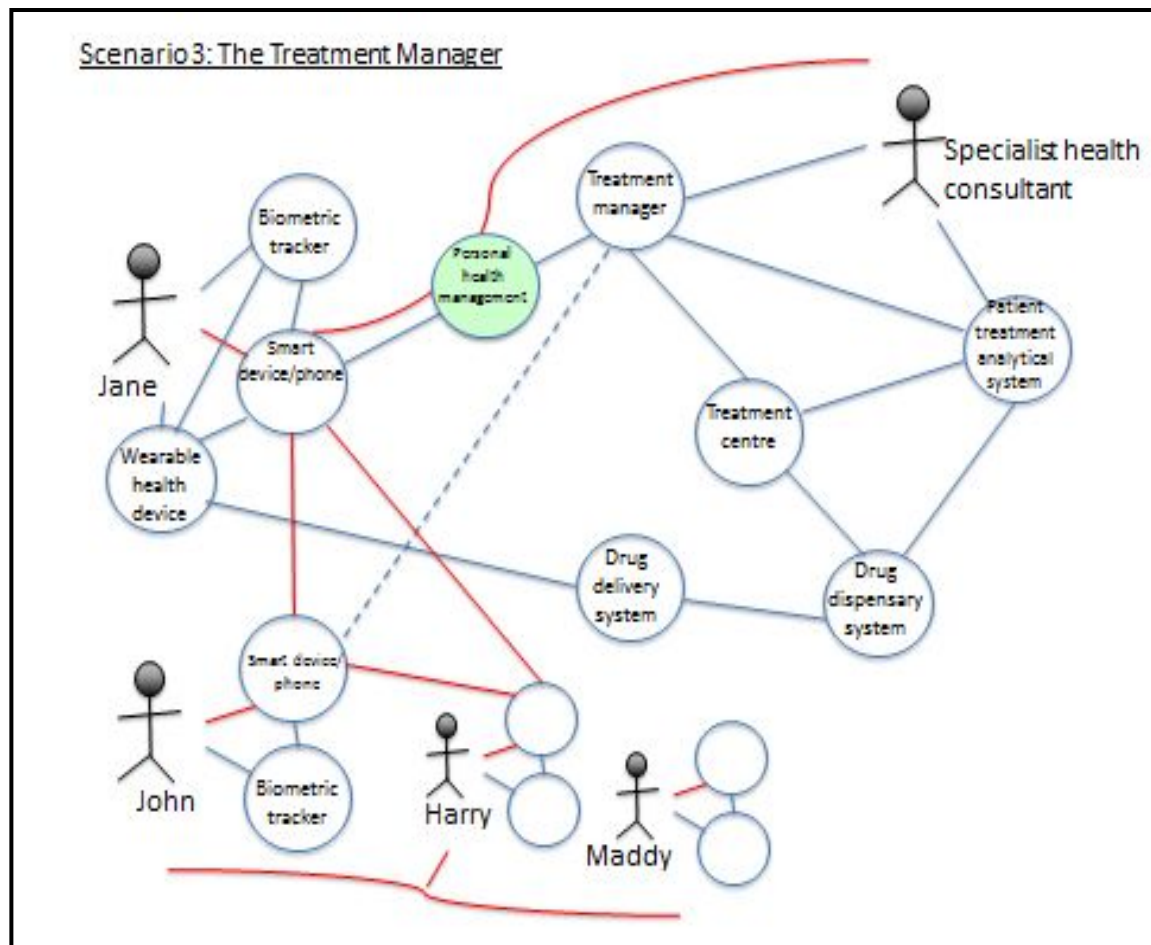


Figure 3: Screenscaps –Walker Family Visualizations

Mealtime



Fitness tracking



Travel



Appendix 1: Scripting the Stories (voiceover narratives)

Script 1: Introduction to the Walker Family

Two couples, John and Jane and Harry and Maddy, are part of a connected family network. John and Jane are in their mid-50s, and parents of Harry, who is cohabiting with Maddy, both in their mid-20s and beginning their busy careers in the city. John and Jane live in a rural environment, over an hour away from Harry and Maddy by public transport. Jane has recently undergone surgery for breast cancer and is recovering well, following an ongoing programme of treatment. John is a keen runner, and with their son, Harry, regularly participates in marathons. Maddy has a broad social network of friends with whom she likes to keep in touch with via social networks and participation in virtual games. All four are wearing biometric trackers that capture data about their individual health, wellbeing and whereabouts status. The data is shared and used in conjunction with a range of people, devices and environments.

Script 2: The Treatment Manager System

Jane's tracker monitors her responses to her cancer treatments and feeds back data to a centralised treatment manager. The treatment manager is based on a large network of data collected from thousands of patients and best practice in the management of similar treatments from around the world. In turn, the manager remotely adjusts

Jane's treatment programme to ensure that drug levels are optimized, also deployed through a discreet wearable device. She is sent status updates and messages about her condition regularly via her smartphone, and periodically receives a personal call from a specialist consultant who discusses her progress and has oversight of the treatment manager.

Jane has the option to attend a local treatment centre to top up her drugs as needed, or the device may trigger a delivery direct to her home, depending on her family and social plans. John, Harry and Maddy use their smart devices to keep in touch with the progress updates that Jane chooses to share with each of them, individually and as a family, and this also helps them to plan their family activities together, such as best days to go out, what to eat, etc.

Script 3: The Household Manager System

Harry and Maddy have very busy work and home lives. They both participate in sport three nights a week and spend some time over their weekend also in sports activities, although this tends to be more social and together. During the week, Harry and Maddy like to plan their meals so they can focus on their activities, both are health conscious and like to ensure they have nutritious meals according to their lifestyle. Harry is in preparation for a marathon and is following a strict diet to maximize his performance according to his training regime. Maddy also enjoys cooking although has little time to spend planning exotic meals. Using the parameters of their respective fitness and health programmes as well as social plans, they select and upload meal ideas each week to their kitchen programme manager. The programme manager evaluates the data and ensures the appropriate foods are available for meals. This involves the freezer and refrigerator coordinating which items are defrosted and when; appropriate stock levels in the store cupboards for dried, tinned and fresh produce are maintained; and the oven heated to the correct

temperature at the best time, ready for when food will be cooked. The programme manager is connected to the couple's favourite grocery retailers and automatically coordinates orders to make use of retailer offers and optimized deliveries, which it dovetails to the availability at home of either Harry or Maddy. After meals, crockery and utensils are put into the dishwasher ready for switching on in alignment with the energy consumption target the couple has set for their home. The washing machine along with other automated household equipment, such as the robotic cleaner, also align with this target, typically overnight whilst they sleep, or are out at work during the day.

Script 4: The Travel Manager System

At least once a month Harry and Maddy visit John and Jane. Neither of them drive, living and working in a city there is no need, but getting to Harry's parent's home in the country can be challenging. They use a travel management programme to help them plan their visit. The final 10 minutes of their journey has to be on foot as there is no public transport at that end, but at least the programme manager tells them about the weather forecast so they can plan what to wear. They enter the time they would like to arrive at their destination, and the programme manager coordinates their itinerary based on fastest travel time and best value for money, to optimize their scarce resources. In this instance, it selects a shared car service with a bus that connects to a train and an automated minicab, taking just less than an hour overall. The programme manager monitors their journey and updates as delays occur en route. They receive notifications via their smartphones. If necessary, it changes their itinerary to ensure their route continues to be optimized in real time. Where the delays are likely to impact on their arrival plans, it sends status updates to John and Jane, so they can make adjustments to their plans accordingly.