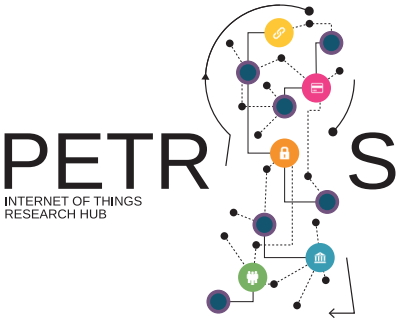
The Little Book of DESIGN FICTION for the Internet of Things

Paul Coulton, Joseph Lindley and Rachel Cooper



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Contents

What this little book tells you

This little book is about the future and the Internet of Things (IoT). We explain why it's important to understand how the IoT will shape our lives in the future and how we can use Design Fiction to explore these futures. Based on our research conducted for the Acceptability and Adoption theme of the PETRAS Cybersecurity of the Internet of Things Research Hub, this little book will explain:

- What we mean by the IoT;
- What we mean by Design Fiction;
- Why it's important to understand the future of IoT;
- How to do Design Fiction for the IoT;
- Who might do this and what they can achieve by doing it.

What is the Internet of Things?

The term *Internet of Things* (IoT) can be traced back to a presentation given by Kevin Ashton[1] in the late 1990s. Ashton explained how, by using sensors to gather data that could be shared across the company's computer network, they could streamline their supply chain. He called these data-enabled parts of the supply chain the 'Internet of Things', and the phrase caught on. What makes the IoT distinct is that, rather than people generating data, it is the 'things' themselves that generate data. Given that computers and machines are quicker and more accurate than people at data gathering, the IoT presents huge opportunities. Ashton was mainly interested in how businesses could become more efficient using the IoT in factories, manufacturing plants, and supply chains, but the usage of the term has expanded rapidly to cover a variety of areas – including factories, hospitals, homes and cars – which can be quite confusing. In this book we use the term to describe any objects or things that can be interconnected via the Internet, making them to be readable, recognizable, locatable, addressable, and controllable by computers.

[1] Ashton, Kevin. "That 'Internet of Things' Thing." The RFID Journal, 2009. http://www.rfidjournal.com/articles/view?4986.

The things themselves can be more or less anything. Later in the book we use examples such as a kettle, a door lock, an electricity meter, a toy doll, and a television, but it's important to remember that there is no limit on what could be an IoT thing. *Anything* that is connected to the Internet is arguably part of the IoT, including us.

'Things' are the visible part of the IoT but there are invisible parts that we need to be aware of such as networks and infrastructure. In figure 1 we have illustrated an IoT-enabled smart home system with internet connected devices including a thermostat, lights, a refrigerator, and a voice controller. Because these devices are part of the IoT they have some extra features compared to their non-IoT counterparts. Smartphones do much more than make or answer phone calls, and likewise smart thermostats do much more than switch a heating system on or off according to temperature. An IoT thermostat uses sensors to detect when you are in the house, it can also be controlled when you are out of the house from your phone (so it's nice and warm when you get home), or controlled using a voice command like "Alexa, turn the heating up".

However, figure 1 is not the full picture, and as we said previously, to fully understand the IoT, you must appreciate there is much more to it than just the 'things' that are visible to you; other elements exert significant influence in the IoT, and are often forgotten. In our example, although the user simply sees a physical smart thermostat, as Figure 2 illustrates, behind the scenes there is a data centre that processes all the information generated by this user's thermostat in addition to the data from all of the other smart thermostats that the company has produced. This data may be linked to 3rd parties who process the data in order to understand how people heat their homes. The data is often crucial in terms of the thermostat company's profitability, because they can generate additional revenue by monetizing the data which selling thermostats alone would not produce. The business model in turn relies on data interoperability, standards for security, and the use of algorithms to process the data to allow 3rd parties to use this data.

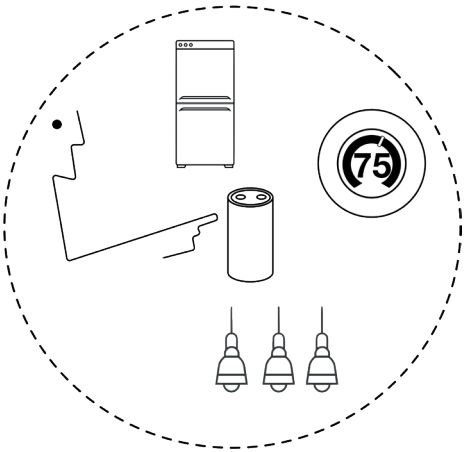


Figure 1. Visible things in an IoT enabled smart home system

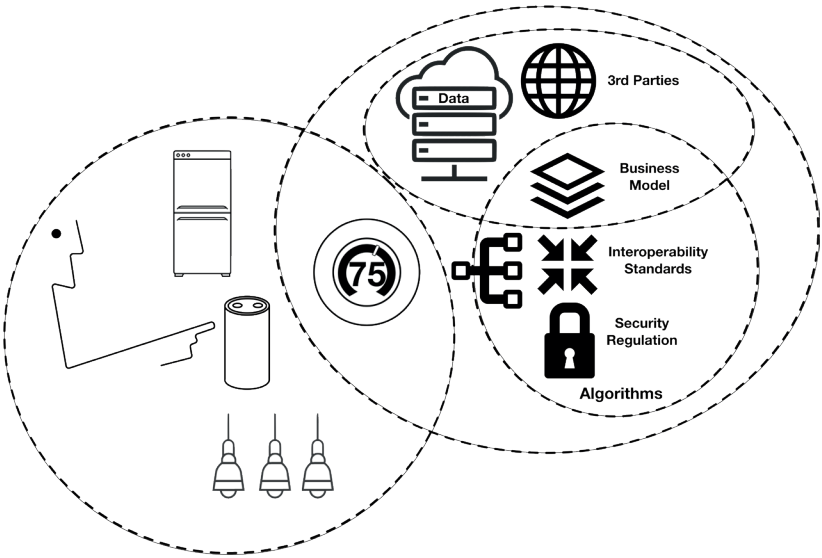


Figure 2. Visible and Invisible things in an IoT enabled smart home system

This example and the diagram does not show *all* the potential influences on any connected device, but highlights the fact that any given device is actually part of a much more expansive and complicated IoT system. Although the IoT's physical presence is all about the 'things' themselves, what the IoT really represents, and how it works, actually goes way beyond devices. We call these interrelated collections of objects (data stores, 3rd parties, business models, and so on) *IoT constellations*. IoT constellations is a design metaphor built on top of a philosophical theory called *Object Oriented Ontology*. The detail of it is explained elsewhere, but the main thing to remember is that it highlights the importance of the fact that the IoT is defined by lots of different interrelated factors, and that as different factors are more or less relevant according to who you are, and your own perspective.[2]

[2] Joseph Lindley, Paul Coulton, and Rachel Cooper. 2017. Why the Internet of Things needs Object Orientated Ontology. *The Design Journal* 20, sup1: S2846–S2857. http://doi.org/10.1080/14606925.2017.1352796

What is Design Fiction?

Design is a very general term and people who 'do' design include typographers, architects, and computer games developers. Most designers are actively trying to solve current actual problems, making things better, or producing something for sale or consumption. However, *Design Fiction* is different; it is part of a group of design practice which we call *Speculative Design*. Rather than solving existing problems, these approaches use design to ask questions.[3] They do this by creating prototypes, but instead of being created to be put into production, these prototypes are used to encourage people to think critically about issues that the design embodies. Speculative Designers, and Design Fictionists, ask how things might be in the future, *why* things might be that way, with a view to highlighting potential problems and opportunities.

Whilst the term Design Fiction has been around for only a few years, its origins can be traced back to the Radical Design movement of the 1960s and 70s. Radical Designers aimed to show that design and architecture should not just be seen as subservient to capitalism, but could engage critically with social and political matters too. In more recent times designers have embraced a resonant approach under the banner of *Critical Design*. Whilst Design Fiction shares this lineage with Radical Design and Critical Design, it also takes cues from science fiction, popular media, and the futuristic tropes publicised by Silicon Valley's tech giants.[4]

[3] Fiona Raby and Anthony Dunne. 2009. A/B. Retrieved October 27, 2014 from http://www.dunneandraby.co.uk/content/projects/476/0

[4] Paul Coulton and Joseph Lindley. 2017, Vapourworlds and Design Fiction: The Role of Intentionality, *The Design Journal*, vol 20, no. Suppl. 1, pp. S4632-s4642. DOI: 10.1080/1460692 5.2017.1352960

There is some confusion about the precise origin of the term Design Fiction, but it became popular after the publication of an essay by Julian Bleecker.[5] In the essay Bleecker explains that fact and fiction can be seen as two different 'genres' of science. These genres are sometimes deliberately knotted together, particularly in science fiction film production. When designers, rather than film producers, do this, it is in order to ask or understand questions, that practice is Design Fiction.

Bleecker and colleagues established a design studio specialising in Design Fiction, and their outputs demonstrated what could be achieved by putting the ideas in Bleecker's essay into practice which brought Design Fiction to greater prominence. Today, Design Fiction is offered commercially by studios such as Super Flux and Design Friction, and is an increasingly common academic research method taught at universities.

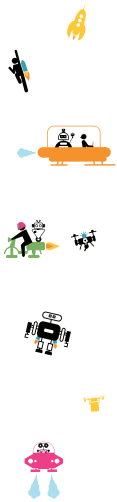
Although Design Fiction has become more common, there are still lots of competing views about the best ways to use it. Some argue that Design Fiction is a way of using science fiction in order to understand what it will be like to live with future technologies,[6] or a way of influencing popular understanding of modern issues like sustainability.[7] Others see Design Fiction as a way of building narratives that tell stories about the future, which we can use to think more carefully about the future.[8] However, the way that we use it within our practice is called *Design Fiction as World Building*, a flexible approach led by design practice, which we explain in more detail later.

[5] Bleecker, J. (2009). Design Fiction: A short essay on design, science, fact and fiction. Near Future Laboratory. Retrieved from http://blog.nearfuturelaboratory.com/2009/03/17/design-fiction-a-short-essay-on-design-science-fact-and-fiction/

[6] Joseph Lindley, Dhruv Sharma, and Robert Potts. 2014. Anticipatory Ethnography: Design fiction as an input to design ethnography. *Ethnographic Praxis in Industry Conference*.

[7] Joshua Tanenbaum, Marcel Pufal, and Karen Tanenbaum. 2017. Furious Futures and Apocalyptic Design Fictions: Popular Narratives of Sustainability. Interactions: 64–67. http://doi.org/10.1145/3022123

[8] Mark Blythe. 2017. Research Fiction: Storytelling, Plot and Design. *Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI 2017)*: 5400–5411. http://doi.org/ccv8



Why is Design Fiction for the IoT important?

Design Fiction is a really useful tool for understanding what the implications of a particular technology's adoption might be.[9] New technologies, and the services and products built using them, can have far reaching and permanent consequences for individuals and society. If we look back through history there are countless examples of technology profoundly changing the way we live and work often in unforeseen ways. For example, steam engines helped power the industrial revolution, moving the textile industry out of homes and into newly built factories. Cities grew to accommodate workers, becoming hubs of transport and manufacturing. Connecting our cities and countries with steam trains and ships revolutionised the way people and goods were moved around the world. Powered by the same steam technology, ships laid telegraphy cables that allowed instant messages to be sent around the globe for the first time in history.

Another lesson from the past shows us that the time between a technology becoming possible, and it having profound impacts, is reducing. It took 150 years from the first telegraph cables being laid in the 19th century to the point when Sir Tim Berners-Lee invented what became the World Wide Web in the 20th century. In the 25 years since then, the Internet has

[9] Lindley, JG, Coulton, P & Sturdee, M 2017, Implications for Adoption. in CHI '17 *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*. ACM, New York, CHI 2017, Denver, United States, 6-11 May. DOI: 10.1145/3025453.3025742

changed many aspects of life including how we order taxis, talk with our friends, read the news, and how our elections are won and lost to name but a few.

Historically we have always accessed the Internet via computers, and more recently through smartphones. The IoT is changing this. By connecting everyday objects, such as cars, lightbulbs, televisions, or toys, the Internet is reaching deep into every aspect of our lives.

Although the benefits of using the IoT to collect data are potentially huge, for example to help deliver preventative medicine, to reduce energy wastage, these benefits come hand in hand with and many ethical challenges, especially the right to privacy. Recognising how these challenges may impact on individuals' rights, the European Union (including the United Kingdom) have developed new legislation called the General Data Protection Regulations (GDPR). These regulations give people new rights relating to data. The GDPR gives individuals the right to be deleted from a data set, to know how their data is being used to make decisions, and to have incorrect data fixed. Design Fiction is a great tool for exploring what devices will look like and what they will be like to use. It is able to do this taking account of new laws like the GDPR, and in doing so brings the broader impact on life into focus.

One reason why it is important to use tools like Design Fiction to understand the IoT is that the way technologies become adopted is frequently not straight forward. Whilst there are many different ways to look at the process of understanding implications for adoption[9] for near future technologies, Design Fiction is arguably one of the most flexible. To illustrat this we refer to an adapted version of the *hype cycle*. The cycle, created by commercial research organisation Gartner, is a graph that maps the amount of exposure and expectation that a technology attracts against time (figure 3). We use it to help visualise the path that technologies take on their way towards widespread adoption.

The hype curve on the graph shows that technologies tend to go through a staged process. The process starts with a 'trigger' (a new technology), builds to a 'peak of inflated expectation' (everyone gets very excited), drops quickly to a 'trough of disillusionment' (people realise this technology isn't quite ready), climbs up the 'slope of enlightenment' (slowly people

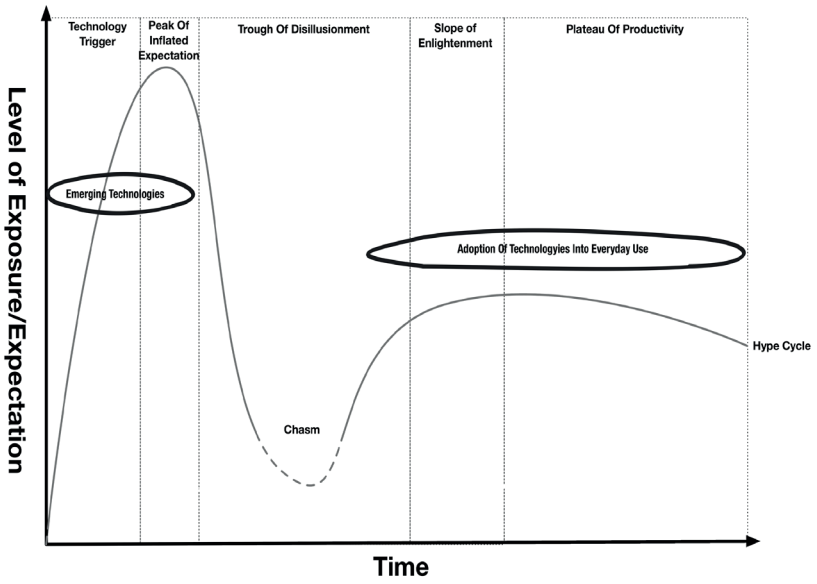


Figure 3. The hype cycle shows selected technologies on a graph of time (x-axis) against the level of expectation or 'hype' (y-axis).

realise how the technology can be useful), and arrives at the 'plateau of productivity' (everybody knows what it is, how it works, and it becomes part of everyday life).

At the bottom of the trough of disillusionment and before the slope of enlightenment there is the so-called 'chasm'. This part of the diagram represents a place where many technologies get stuck. Some technologies get stuck here permanently and will never become widely adopted. Others may go through the cycle again, but usually will have to attempt to cross the chasm for a second time. A good example of this is Virtual Reality (VR). In the 1980s and 90s VR technology attracted huge amounts of hype and was promised as the future of gaming. Quickly, interest subsided, and the technology got stuck in the chasm. But then in the 2010s interest in VR re-ignited, initially through the company Oculus Rift, and then from an array of other companies. Today, with several VR products on the market,

only time will tell whether the technology will get across the chasm and become widely adopted.

We can map specific examples of IoT technologies on the hype curve. The majority of smart home IoT products – like thermostats, kettles, and smart speakers – are near the peak of inflated expectation. We can say this because while few such IoT products have become commonplace, they *do* attract a lot of media attention and buzz. Meanwhile many niche IoT products have got caught in the chasm (for example a company called Juicero which raised $120m in funding, but shortly after releasing their IoT fruit juice machine, announced the company was closing because its business model was not sustainable).[10]

Design Fiction for the IoT is useful because it acts as a bridge across the chasm. Design Fiction can help us understand what will enable products to get across the chasm (or what will prevent them from doing so) and, even more importantly, to understand what the world might be like if those products did become widely adopted.

[10] Sam Levin. 2017. Squeezed out: widely mocked startup Juicero is shutting down | Technology | The Guardian. *The Guardian*. Retrieved November 28, 2017 from https://www.theguardian.com/technology/2017/sep/01/juicero-silicon-valley-shutting-down

How to build Design Fiction worlds for the IoT

Because Design Fiction is still quite a new idea, and similar to other practices, it has a reputation for having teenage angst – or, in other words, it is only beginning to mature and figure out what it really wants to be. *Design Fiction as World Building* was researched and developed at Imagination Lancaster, and although it cannot make the teenage angst go away, it serves as a blueprint to show how Design Fiction can be used by many people in many different areas. In this section, we introduce several examples of Design Fiction as World building, with a focus on the IoT. The examples show what the process looks like and describe how Design Fiction can help us to understand the implications of IoT in the future. They include an exploration of how the government may regulate your kettle's data protection policy, how the IoT could revolutionise the way we wash our clothes, and how coloured blobs and blurry lines are, quite literally, helping to open doors (using smart locks) with the IoT.

The Design Fiction as World Building approach was in part inspired by an

[11] Paul Coulton, Joseph Lindley, Miriam Sturdee, and Michael Stead. 2017. Design Fiction as World Building. Proceedings of the 3nd Biennial Research Through Design Conference. http://doi.org/10.6084/m9.figshare.4746964. You can view a short video introduction to Design Fiction based on World Building here: *http://www.fictionware.org/introduction-to-design-fiction/*

interview with Bruce Sterling (the person usually credited with inventing the term Design Fiction). He said, "It's not a kind of fiction. It's a kind of design. It tells worlds rather than stories".[12] Based on an interpretation of what Sterling said, the world building approach focuses on designing things which give the impression of a future world, the essence of that world then prototypes the things, and the things prototype the world. By creating this reciprocal prototyping loop, Design Fictions can ask, and answer, questions like 'what will it be like to live surrounded by the IoT'. It does this by creating a fictional version of that world that we can dip in and out of, in order to better understand it, and help shape the actual world that our technologies are creating.

The concept of *World Building* is applied in many different places, with a variety of different media, and using different tools to help create the world. For example, soap operas like *Eastenders*, alternate histories like Philip K Dick's *The Man in the High Castle*, and fantasy worlds like Tolkien's *Middle Earth* — each of these create worlds. However, the media used to create worlds in television, literary fiction, or film tend to be different to the media used to make Design Fictions. Table 1 lists several examples of World Building. It describes the media that is used to create the world, what features they have and includes the Design Fictions discussed in the rest of this book.

Nonetheless, some features are common to all these different types of world building. For example, when building a fictional world, everything stays the same unless you indicate that it has changed. If it is important that you change something, then you need to communicate it to people.

The key to building really accessible fictional worlds is to communicate the differences in a way that is accessible and intuitively makes sense in the context. In *Lord of the Rings* J.R.R Tolkien builds a world with Elves in it, complete with their own language, songs, and maps of where they live. Multiple elements combine together to communicate how this world is different from our own, but because the collection of multiple pieces all work

[12] Bruce Sterling. 2012. Bruce Sterling Explains the Intriguing New Concept of Design Fiction (Interview by Torie Bosch). *Slate.com*. Retrieved February 9, 2014 from http://www.slate.com/blogs/future_tense/2012/03/02/bruce_sterling_on_design_fictions_.html

together, the fictional world is easy to access and relate to. This is exactly what Design Fiction aims to do, but rather than trying to make Middle Earth's Elves, dragons and magic accessible and relatable, we're interested in an alternative and near-future version of *our world* where the IoT has become more widely adopted. A useful starting point for Design Fiction worlds is often asking simple 'what if?' questions.

Table 1.

World	**Media Used**	**Features**
Eastenders	Screenplay, acting	Present day. Fictional part of London called Walford. Fiction pub called the Queen Vic.
The Man in the High Castle	Novel TV adaptation	Alternative history. German invasion of USA. Different technologies prevail (e.g. rocket powered planes).
Lord of the Rings	Novel Film adaptation	Fantasy Universe. Orcs, wizards, magic, elves. Invented languages, songs, and lore.
Polly Design Fiction (page 18).	Feature prototypes Packaging Marketing materials	Near future. World's first truly smart IoT kettle. Fictional governmental IoT regulator.
Allspark Design Fiction (page 29).	Wiring diagram App design Marketing materials	Near future. IoT enabled smart energy grid. Apps and devices designed to work with smart energy grid.
Orbit Privacy Design Fiction page 37).	Privacy Orbit concept design App design Video prototype	Near future. GDPR changing user agreement interfaces.

Polly: The world's first truly smart kettle

We built a Design Fiction world around the concept of an IoT kettle. We used Design Fiction to unpack the question *what if IoT kettles became widely adopted, what sort of world would that be?* Although on the face of it a kettle seems a rather mundane thing to create a Design Fiction around, household appliances are one of the most visible types of IoT device, and by working with such a familiar product we, aimed to create an accessible and relatable Design Fiction. Another reason to use a kettle is that there are already a number of IoT kettles available to buy which exhibit the type of ethical and privacy concerns that motivated us to use Design Fiction to study the IoT in the first place. The IoT kettles on the market (as with many consumer IoT products) have not yet traversed the hype cycle's chasm, and given their high cost and dubious handling of data, it seems unlikely they will manage such a feat at least for the time being. By building a Design Fiction around a smart IoT kettle, we were able to explore a future where IoT kettles *are* widely adopted and to understand what sort of world that might be. Where Tolkien used language, songs, and maps to make Elves an intuitive part of Middle Earth, we used branding, marketing and promotional materials to begin to create a world where a smart kettle makes sense.

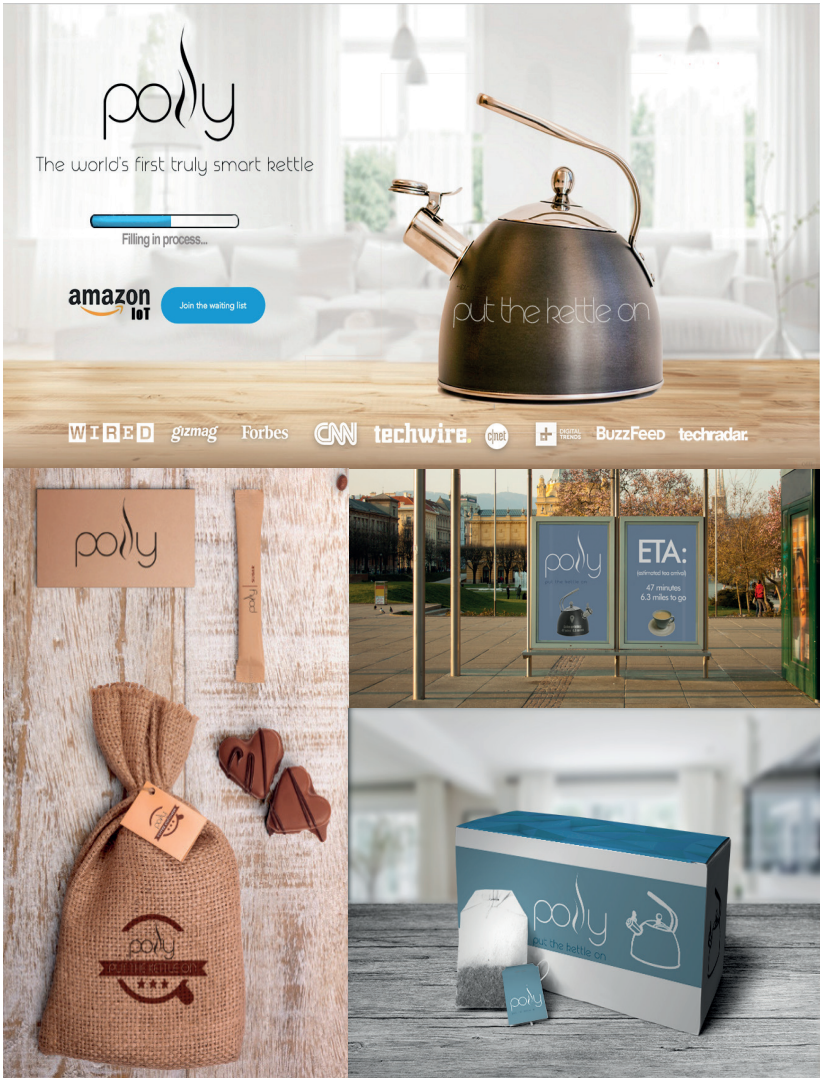


Figure 4. Marketing materials serving as entry points into Polly's world.

The first task was to decide on a name. Although we went through many ideas, the one we settled on was *Polly*. You might think choosing a name is simple, but this had to be carefully thought through to ensure it would connect with the rest of our fictional world and also to give the impression of a believable product. The name makes reference to the famous nursery rhyme that includes the line 'Polly, put the kettle on'. We envisaged that the line could be used as part of a marketing campaign as the product's tag line; furthermore the phrase would double as a voice command used to tell the kettle to boil, thus drawing parallels with the female voices used for voice assistants such as *Amazon Echo* and *Google Home*. To begin to flesh out Polly's world we created a logo and incorporated that, along with the 'put the kettle on' tag line, into various marketing materials (figure 4). These artefacts don't *immediately* try to answer our "what if?" question; instead their primary purpose is to invite you into the world, to begin to build up layers of texture. Ultimately the Design Fiction is trying to get you to accept the possibility of such a world, and to feel as if the fiction could be reality.

We also created a backstory for the Polly. In our backstory, the kettle was originally a Kickstarter (figure 5) project that gained a huge amount of attention and popularity. Inspired by the story of Oculus Rift (the VR headset company) being successfully funded on Kickstarter and then being bought by a large American technology company, we decided it was plausible that a product like Polly would be bought by a company like Amazon, pioneers in today's IoT space. This backstory is communicated through the quotes from media outlets that are shown on the Kickstarter page. By imagining how Polly would be represented in the press it helped us to better imagine the finer details of the kettle's world. For example, we used the term "IoT 2.0". Once we had used the term we had to think through what features IoT devices would have in order that media outlets would start using a term like IoT 2.0.

Today's IoT kettles are, to be frank, very poorly designed. Although they are often marketed as 'smart' kettles, their features are rarely useful and sometimes they simply don't work as they should – for example when you cannot boil the kettle because it crashed or it has lost its network connection or the wrong version of the app is used. We decided Polly would be marketed as 'The World's First *Truly* Smart Kettle', to justify the media

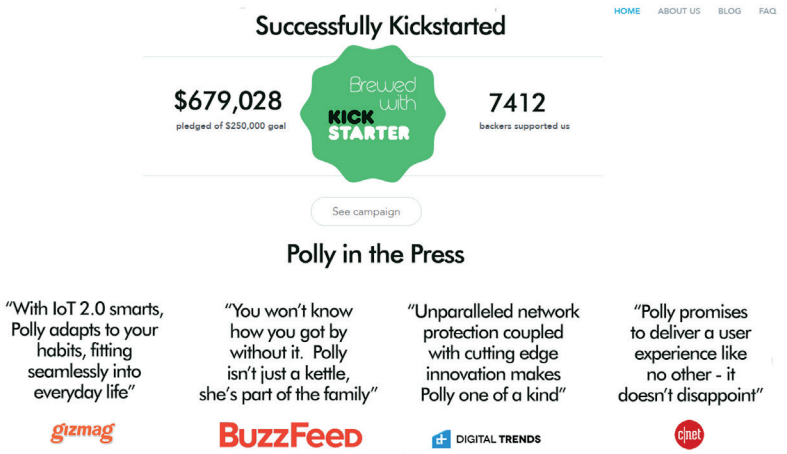


Figure 5. Fictional crowdfunding campaign for Polly, featuring quotes from various *media outlets.*

reports that Polly is an IoT 2.0 product (see figure 5).

The branding, marketing and feature demonstrations we created for Polly are all what we call 'entry points' into the Design Fiction world. Learning to use entry points carefully is one of the most important things when doing Design Fiction as World Building. Usually each artefact or thing you design is classed as an entry point, and collections of entry points should work together, feeling like they are all part of the same world. Each one gives clues about the world that has been created. Some entry points, like Polly's website and Kickstarter page, provide a kind of 'zoomed out' overview of the world that doesn't give you any detailed specifics but does help create a general feeling or aesthetic. The zoomed out entry points provide a foundation for adding in more detail. As well as the photographs of Polly's smart features (figure 6) we added other 'zoomed in' entry points (e.g. figures 7, 8 and 9) that communicate exactly what features the device has, and gives you clues about how those features work and what it might be like to use them.

In figure 7 each of the holes in the spheres is a visual metaphor for an entry point into the Design Fiction The different sizes of sphere represent how zoomed in or out each the entry points may be. Once the spheres

Figure 6.

Top left: Polly has downloadable boiling profiles that tie in with other physical products (such as speciality coffee), hence Polly is not just a kettle it is a gateway for other purchases (which fits with business model for companies such as Amazon).

Bottom left: Polly uses its adaptable display and machine learning to figure out what you usually boil it for then displays your common boils on its smart fill level display.

Top right: Automatically integrating with a connected car, Polly knows when you will be driving and knows the weather outside. If the weather is freezing and the user's calendar shows they should be going to work, Polly suggests warming water at the right time so it can be used to defrost the car.

Bottom right: combining the very social ritual of tea drinking with Facebook, Polly can detect when friends are nearby and automatically invite them for a cup of tea.

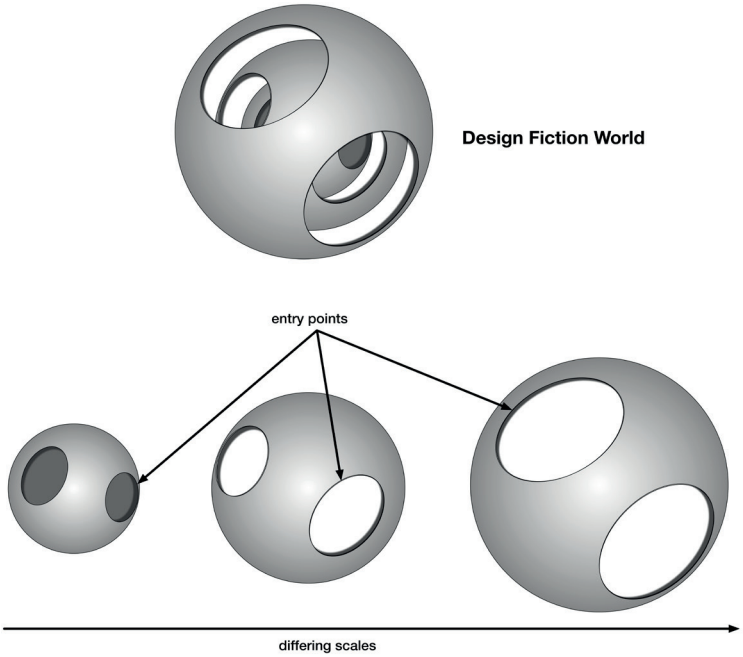


Figure 7. Visualisation of *Design Fiction as World Building*; several artefacts and their entry points come together (bottom) to form the whole view of the world (top).

are nested within each other. Try to imagine them rotating around inside each other, as the spheres are moved different aspects of the interior become visible. This represents the fact that any given Design Fiction does not give people a *specific* message about the world that's been created, but instead, by showing them different views of the world, it enables viewers to make up their own mind about the future based on their perspective.

Next, we began to think through what sort of world it would be where a smart kettle like Polly had become the generally accepted type of kettle people would buy. Of course, the smart features (figure 6) are an important part of this, but we decided to explore other, and currently less frequently considered possibilities. A big area for concern for IoT products is what personal data they gather, and how they share that across the Internet. For example, the television manufacturer Vizio created a television

that collected information about what programmes users watch, and then sold the information to other companies, which used it to market products to their owners based on their viewing habits. Although this is not an uncommon practice (most websites collect the same sort of information), when it was revealed in the press it undermined trust in Vizio because they never asked their users for permission. User agreements, where users tick a box to say they have read and agree to terms of use, are where the details of what information devices gather are usually held. However, as we know from experience and research, the majority of people never read these agreements. Opaque data policies and lack of transparency around connected products might contribute to IoT products being unable to get across the chasm. So, in Polly's world we wondered what features we could build for the kettle to help users feel secure about what data the kettle collects, why, and what it does with it.

Polly's timeline lets users view every time the kettle takes part in a data transaction. There is a simple visual key that tells the user whether the transaction involved uploading, downloading, or moving data around the local network. An accessible plain English name is given to each transaction to tell the user what it was for. In figure 8 we can see that the kettle uploads data to the cloud when the kettle is removed from its base and when the water is refilled. In contrast when the kettle gets a boil request, that information stays within the local network.

Features such as Polly's data transaction timeline would allow device makers to be transparent to their customers about what a device is really doing beyond boiling water. We subsequently decided to create another entry point to explore a more technical solution to this transparency consideration. The 'Machine Readable Data Policy' feature (figure 9) complements the timeline with a technical standard. The Internet is built upon many different standards, which are usually described in documents called 'Request for Comments' (RFC). We created a fictional RFC for something called 'Minimum Necessary Datagram Protocol' (MNDP). This standard would ensure that any device using it would have to tell the user which network it was connected to, specifically what servers it is allowed to talk to, and for what purposes. When the network's router is given this information, it can then police the network to ensure that a device is doing what it said it would. Just as your bank will check the balance of your

Figure 8. Left: In order to underscore trust in the device, Polly's timeline shows every data transaction the kettle takes place in. Right: The data volume graph helps the user to understand how much data the kettle is uploading or downloading by showing relative volumes next to each other visually.

Figure 9. Using a fictional standard called Minimum Necessary Datagram Protocol, Polly creates a machine-readable file that integrates with compatible routers. This acts as a self-imposed firewall, and ensures the kettle can send or receive only data that the user has specially agreed to.

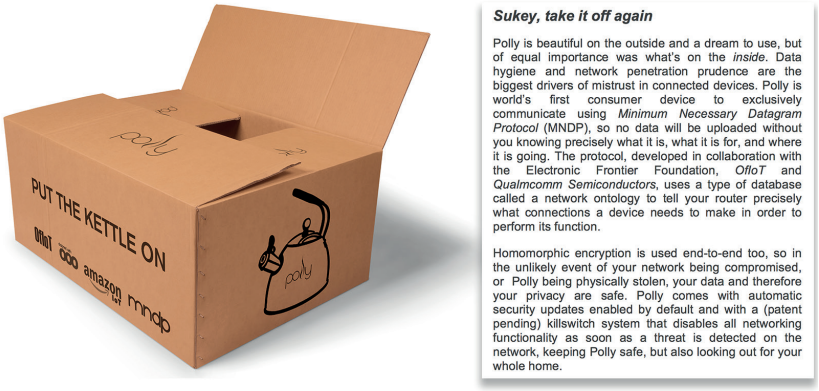
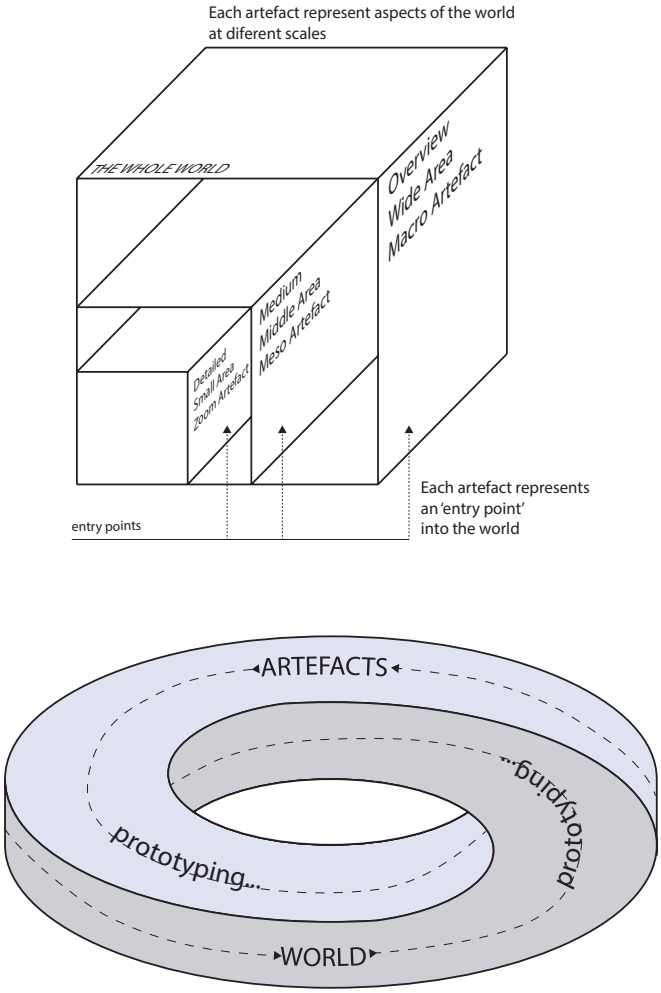


Figure 10. Packaging featuring the logo of the fictional regulator *OfIoT* and extract from a press release describing *Minimum Necessary Datagram Protocol*.

account before allowing you to spend money, an MNDP-enabled device would need to get permission to send or receive data before it actually makes a transaction.

Fictional technical standards like MNDP represent quite detailed entry points into the Fictional World. Even though they seem to make some sense to certain audiences, it's important to remember that all of the entry points need to work together, they need to fit inside each other and create a cohesive world that works seamlessly. Although it is clearly *possible* to create a standard like MNDP, we wondered how plausible it really was. Would a company such as Amazon simply decide to spend time and effort making a product that adheres to a standard like MNDP? Although it is not beyond the realms of believability, we decided to add in another zoomed out entry point that would give a clear explanation for why the MNDP would exist. To do this we created a Government run regulator for the IoT called *OfIoT*. In Polly's world OfIoT provides an accreditation scheme for IoT products, and depending on how well products meet various criteria relating to the reliability, security and privacy provisioning, products receive a rating. In figure x you can see Polly's packaging alongside an extract from a Polly press release. Both serve as entry points with multiple purposes. The packaging helps to communicate the existence of OfIoT, MNDP, as well as an Amazon IoT brand, and the press release explains

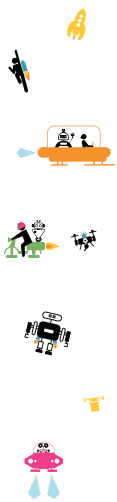


In design fiction as world building multiple artefacts come together (left) to define multiple entry points into an artificially created world. Each entry point describes that world at a different scale. The effect is a reciprocal prototyping relationship, where the world is prototyping the artefacts and the artefacts are prototyping the world (right).

Figure 11. Further visualisation of *Design Fiction as World Building;* Several artefacts come together to form the world (top) which forms a reciprocal prototyping relationship between the artefacts and the world (bottom).

how these things fit together (in order to gain OfIoT accreditation a product needs to use MNDP).

This relationship between the individual entry points and the world that they create shows how Design Fiction as World Building works around a reciprocal prototyping relationship. For example, Polly successfully bridging the chasm, makes more sense when we imagine it using a technology like MNDP, and MNDP makes more sense when it can result in accreditation by a body like OfIoT. The diagram in figure11 is a visualisation and reminder of how this works. The artefacts and the world that they create are in a prototyping loop, where both world and individual artefacts constantly test and reinforce each other. Learning to get the balance between artefacts and world just right is what helps to make plausible and compelling Design Fictions.



Allspark: Sparking the Internet of Energy

This project focused on a fictional energy company called *Allspark*. However, it came about quite differently to the kettle project. With Polly, we decided, right at the start, that we were interested in building a Design Fiction around a specific product, an IoT kettle. For this reason we can call it a *product-driven* Design Fiction. For the Allspark project we began by taking an interest in a particular technology, so it is a *technology-driven* Design Fiction. The specific technology of interest was batteries. As our global electricity generation slowly moves towards sustainable sources, temporary energy storage is becoming a very important factor in ensuring our ability to cope with varying energy demand.

Although it is quite easy to generate electricity from wind and solar energy, the supplies are intermittent because the wind doesn't always blow and the sun doesn't always shine. Companies have started selling large batteries to install in your home that can store power generated when it is windy or sunny it be used later at a time when it is needed. The same technology is starting to be introduced on an industrial scale, which means that at peak times energy companies use huge arrays of batteries, charged by spare solar and wind energy, reducing the need for polluting fossil-fuel power stations. We wanted to use Design Fiction to explore the

role the IoT might play in the future of battery technology and smart energy grids. We set out to use Design Fiction as World Building to explore the question *what if energy consumption could be optimised using batteries and the IoT, what would that world be like?*

Figure 12. The *Runner* battery entry point.

Early on in the project we did a large amount of research about electricity delivery systems and battery storage. We realised that today's electricity grid has a huge amount of wastage in it, particularly when electricity is converted from Alternating Current (AC) to Direct Current (DC). For example when power is generated by solar panels on the roof of a house, the DC generated is almost always converted to AC immediately, before either being used in the house or sent back to the grid. *That* conversion causes a loss of energy. It is also the case that many, and increasing numbers of, modern devices use DC power, even though the power is delivered to the house using AC. This conversion from AC to DC also causes a loss of energy. What if we could avoid some of the conversions? One way to do this, would be to redesign household electronic devices so that they

would get their power from small rechargeable batteries, rather than from wall sockets. So, the first entry point into our Design Fiction was a portable rechargeable battery.

In a house equipped with the Allspark energy system, users would own several batteries. Each one could be used to power a range of different devices (see figures 14 and 15). Each smaller battery would be charged directly from a much larger single larger household battery. The large batteries would usually be charged directly from solar panels on the roof of the house (and in some circumstances when there is spare capacity in the electricity grid). Because the solar panels, big batteries and small batteries, all operate using DC, there is a significant power saving when the system is configured like this. We began to imagine how these products would fit together and be marketed, naming the smaller 'utility' batteries *Runner* (figure 12) and the larger fixed batteries Director (figure 13).

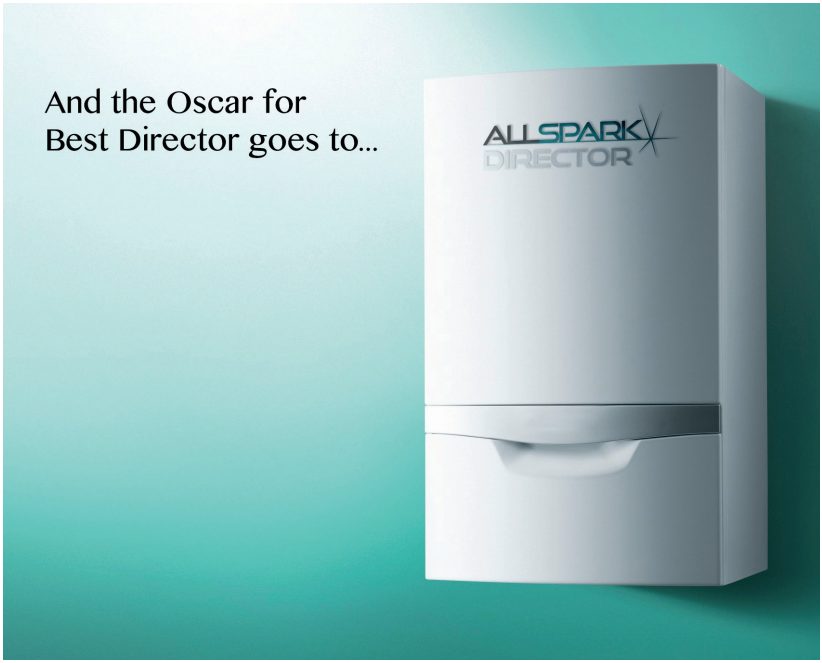


Figure 13. The *Director* battery entry point.

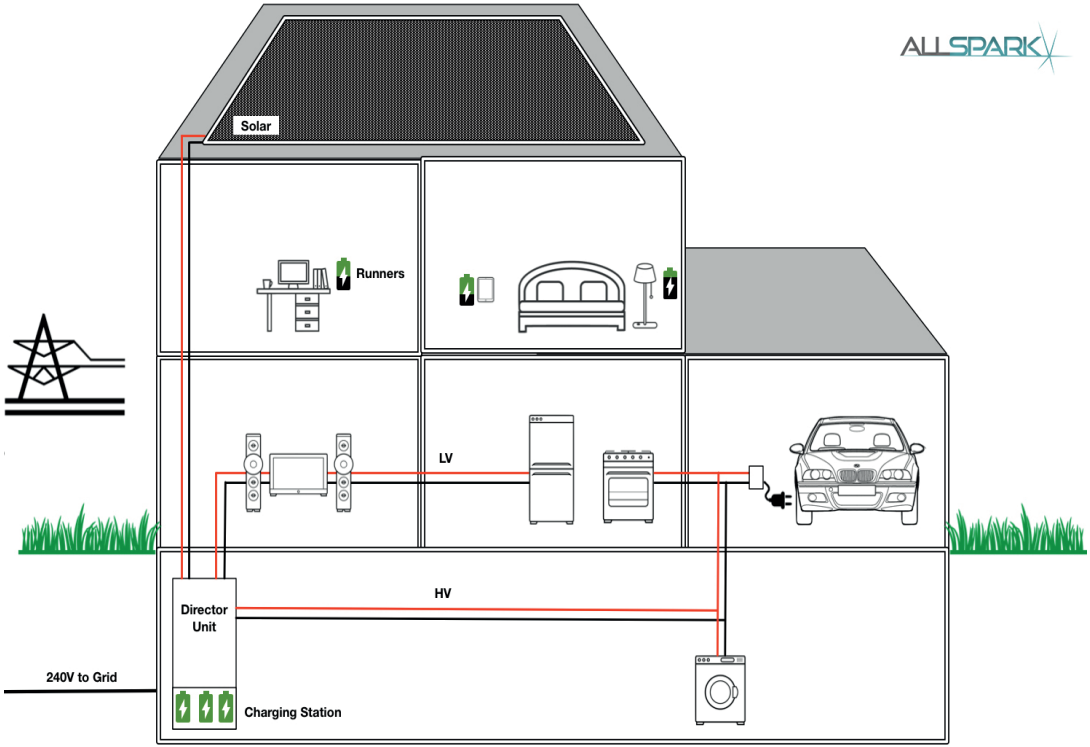


Figure 14. Diagram of the Allspark system installed in a house including a Director, several Runners, and a variety of appliances.

Figure 15. A variety of household appliances shown being powered by an Allspark Runner battery.

In order to help visualise how the system would work in a typical home and how it would integrate with the existing power distribution network, a further entry point shows a wiring schematic (Figure 14). Using the Allspark system the main electricity grid remains the same, however in houses many appliances would have to be replaced to either run off a newly installed high voltage DC circuit (e.g. the washing machine, cooker, and

electric car) or from one of the Runner batteries (e.g. the laptop, tablet, or lamp).

Further developing the 'zoomed out' entry points for this Design Fiction, we produced fictional marketing materials as a way of thinking through what products could be powered from batteries (figure 15). The entry points so far—Runner, Director, household wiring diagram, and advertising for battery-powered appliances—are all zoomed out overviews. The more detailed entry points came about when we considered the role the IoT could play in the Allspark system. Although a 'dumb' version of this system could bring efficiency to power consumption, to really optimise the system all of the elements need to be integrated. The energy grid operators need to know how much energy is currently stored across every household's Directors and Runners and they need to know as precisely as possible how much energy will be used in the coming hours. By making every single Runner and Director battery an IoT device, it would be possible to gather the information necessary to make electricity consumption far more efficient, and take significant steps towards a renewable-first grid.

In the Design Fiction world we created, Allspark would oversee internet-connected batteries across hundreds of thousands, or millions, of homes. Using the data provided by these smart batteries Allspark would be able to, very accurately, predict and potentially manage the demand on the grid. Ultimately Allspark could minimise the need for on-demand generation from fossil fuels. In a system like this it would be very likely that the operator, in this Design Fiction Allspark, would want to incentivise their customers to use devices at particular times. One way this could be achieved would be with variable pricing, depending on supply and demand. The entry point below is more zoomed in than the others, and shows a screen in the Allspark app. Householders would utilise this app in order to plan their electricity usage around the price of electricity from the grid, how sunny it is, how many daylight hours there are, and how much charge there is in their battery system.

Through a 24 hour period we can see how the market price of electricity (if it is bought or sold from the grid) changes dramatically depending on various factors. During the night time (between sun down at 5.40pm and sun up at 7.36am) market price is at a high if winds are light. The app pre-

dicts that during this period the house should use battery power. Towards the end of the night, as the price of grid electricity goes down, the battery begins to charge from the grid. The app entry point (figure 16) helps us to understand not just how the price, charge and solar factors interact, but shows how the Allspark system might try to influence customer behaviour. It includes an option to select 'Nudge Aggression', which would impact upon how many notifications users get asking them to change their behaviour (an example is shown in the top-left of figure 16, asking the user to turn off their air conditioner for 10 minutes in order to get a cost bonus of £0.50).

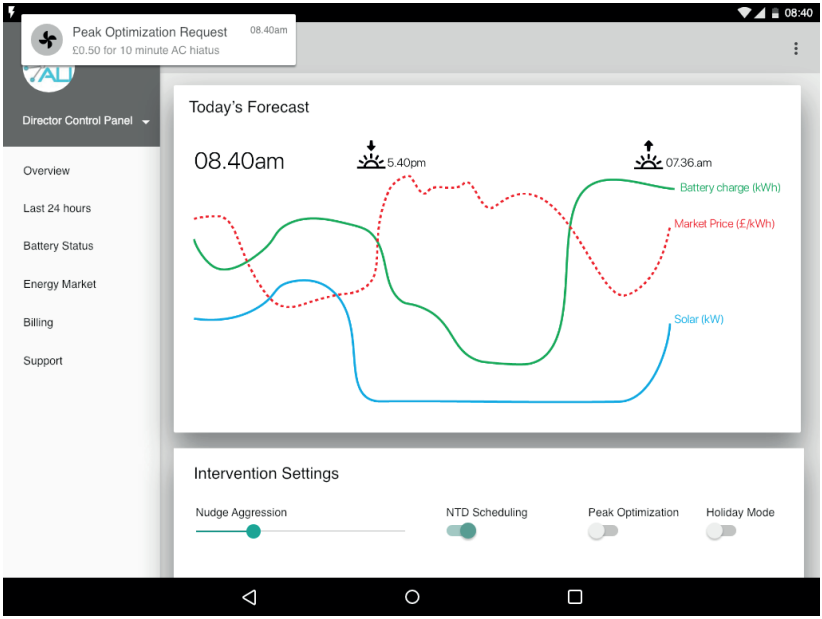


Figure 16. The *Allspark* tablet application entry point, showing the system's interface and configurable settings.

This entry point (figure 17) – an Allspark approved washing machine – shows how individual appliances would become integral parts of the whole system. Employing a basic nudge technique to try and influence

behaviour towards more efficiency, appliances like washing machines would automatically schedule so that they run at a time that maximises available energy. Rather than indicating to the user how long is left before the wash is finished, it would display the *latest possible* time for when the wash would complete. We use the term 'energy temporality' to describe the way that a smart grid would likely have a knock-on effect on how we use and interact with our electrical appliances, and it may ultimately require a change in design criteria. For example, if appliances are to be used at night, then making them quiet might be an increased priority. This sort of Design Fiction may be used by product designers to develop their understanding of how future energy distribution will impact upon their designs; alternatively it could be a useful tool for energy companies that need to refresh our energy infrastructure; lastly it may be used as a communication tool to demonstrate how the IoT will become a crucial factor in meeting medium-term emission targets, and ultimately freeing our economy from carbon-dependency.

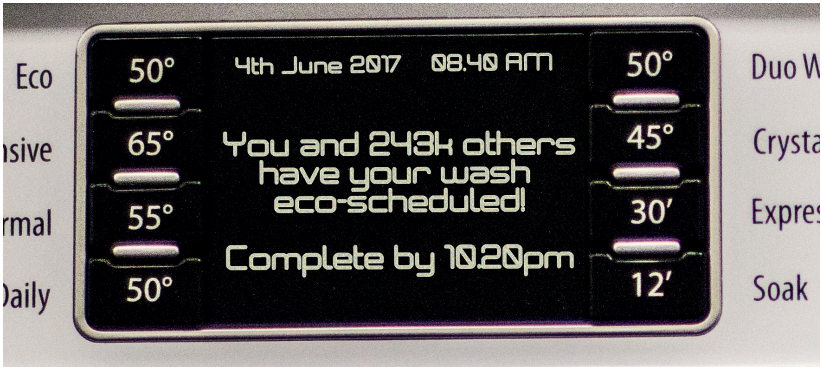
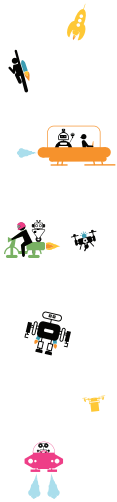


Figure 17. Entry point based on a display designed with *energy temporality* in mind, also employing nudge techniques to encourage energy efficient behaviour.



Orbit Privacy: Opening doors for the IoT

While Polly was product driven, All spark technology driven, this Design Ficiton—based around an app called Orbit—is *problem driven*. The problems we were concerned with all relate to the process of accepting the agreement necessary to use a new IoT device. Most computer-based products, whether software or hardware, will force you to accept the terms of an agreement before you can actually use them. These agreements inform users how the system works, describe what data is collected by the system, and explain what that data is used for. In reality, very few people ever read these documents, and if they do, they are often very hard to understand. In 2018 a series of new rules called GDPR will come into force throughout the European Union (GDPR will cover the United Kingdom too). GDPR puts the onus on product manufacturers to ensure that their users have *understood* the details of user agreements. If manufacturers fail to do this, they could receive hefty fines. So, to explore how GDPR could impact on the design of IoT products, we used Design Fiction to explore the question *what if there was a GDPR-friendly way of communicating user agreements, what sort of world would that be, what would it look like?*

Initially we did a lot of background research into user agreements for IoT devices that are available today, in order to try and understand what

mechanisms they were actually describing. We were particularly interested in the data that IoT systems collect, process and share across the Internet. The vast majority of IoT devices require some kind of registration. In addition, most IoT devices need to share data with the manufacturers' servers, in order to provide the service (for example the Nest thermostat uses the company's cloud servers to learn your behaviour, and to enable remote control of your heating). In many cases, however, the user agreements say that *some* of your data *may* be shared with a 3rd party, but user agreements rarely explain what the underlying nature of data sharing relationships really are. These complexities, are, in part why we use talk about IoT constellations —to represent the fact that there are multiple different perspectives on the same situation. In order to make a user agreement compliant with the GDPR, technology manufacturers must communicate all the details of how their system works in a way that is easy to understand, unambiguous, and can be verified afterwards (i.e. they have to ensure that their agreement is understood by their users).

In order to explore and shed light on these factors we began to create a Design Fiction world around a smart home environment. Although this was a problem-driven Design Fiction, we began by creating a fictional product to use as an example. We chose to work with an IoT door lock on this occasion, primarily because the lock is really very simple; it has straightforward features, integrations and requires a minimal amount of data to work. Inspired by IoT locks that are available on the market today, we gave our fictional lock the following features:

- Using a smartphone's Near Field Communication (NFC) feature to unlock instead of a key;
- Geofencing (automatically locking/unlocking the door depending on location);
- Providing guest access temporarily via a smartphone app;
- Voice activation (using a service like Amazon Echo);
- Connection to 'If This Then that' (IFTTT) to allow integration with other systems.

Although we did not actually build any artefacts that explicitly show each

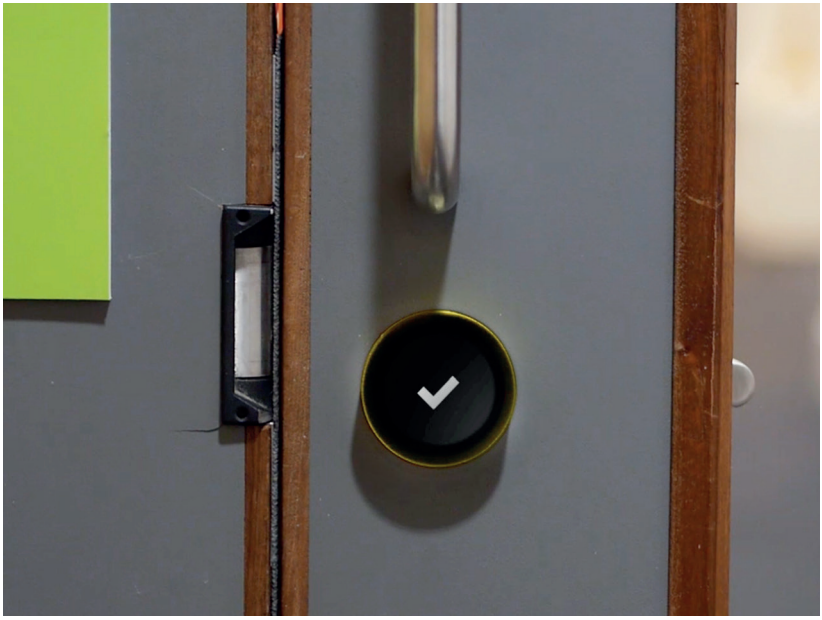


Figure 18. Image of the IoT lock mounted on a door

of the lock's features in action, they were implied in everything we did with the Design Fiction. These features also linked with the problem the Design Fiction was intended to explore—user agreements and GDPR—because each feature would require that data be shared slightly differently. Keyless opening using NFC operation only requires that data be stored *within the user's own network*; geofencing and guest access requires that data be processed by the lock company's servers; voice activation would mean some data would be shared with the relevant voice agent's servers; services such as IFTTT could lead to data being shared with any number of 3rd parties (figure 19).

To gain a user's consent to collect and share the relevant data, a user agreement would typically detail, gather, and share the data that is necessary for *all* of these features, with no regard for which ones are actually being used. For example, some users may be very happy simply to use the NFC-unlock feature, but to use that feature they might have to give their

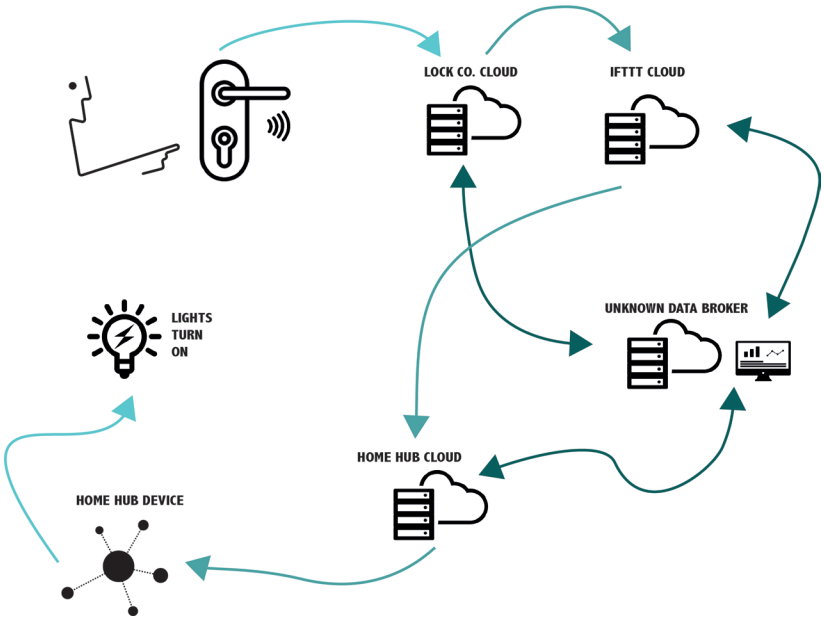


Figure 19. We used this diagram as a kind of entry point, to help us think through how data would have to be shared to enable particular features. In this example we illustrated how, in order to configure the IoT lock to automatically turn on lights when somebody opens the door, data might be shared with at least four companies.

consent in respect of all the other features. Responding to this shortcoming became a feature of our Design Fiction. We wanted to design a system that would allow users to customise what they had consented to, according to which features they really wanted to use. The design challenge with this project was to understand how we might communicate to how the extent of data sharing they would be consenting would vary according to which features they wish to use. To try and solve this problem, we developed the concept of 'Privacy Orbits'.

Orbits are circular infographics which explain, based on what data a system gathers and where it shares it, how identifiable a person might be from this data. The Orbit design uses three concentric circles, where

each circle represents data that might be used to identify you. The inner circle represents data on devices you own (like your router, smartphone, or television). The middle circle represents data on servers of companies you know, but where you have no control over the servers (like the server of the lock company, Amazon's Echo servers, or your email provider). The outer circle represents data on largely unknown 3rd party servers (this might be IFTTT or a marketing company they sold data to). It's also important to remember that being identifiable doesn't necessary mean data that has your name and address, or a picture of your face. It is very easy to identify people by combining two or more other pieces of information. For example, a postal code combined with hair colour and height would almost certainly uniquely identify each individual living on a given street.

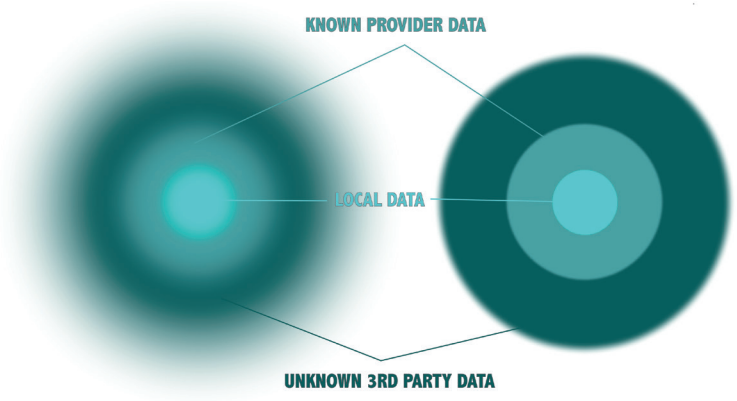


Figure 20. Conceptual design for privacy *Orbits*.

The Orbits don't just show where your data will go, but using the blurred lines between each circle they communicate how likely it is that you could be identified based on that data. In the example above (figure 20) the diagram on the left shows that it's very unlikely that the user could be identified by the data held locally, by known providers, or unknown 3rd parties. However, on the right the user can *definitely* be identified by the data held locally, almost certainly can be identified by the data held with

known providers, and there is a good chance (but not as high) that the data held by 3rd parties would identify the user. To make the concept easier to understand, we created a short Design Fiction film as an entry point that shows how it could be used to help configure our IoT lock. In the film the user installs the lock, uses an Amazon Echo to detect it, and then the Amazon Echo automatically launches the Orbit Privacy app to help them configure the system (figure 21).

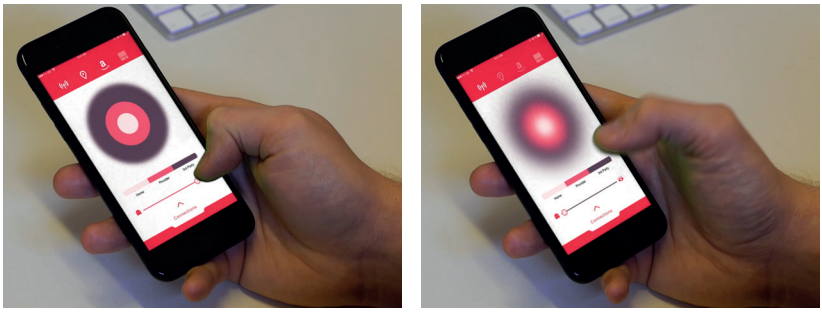


Figure 21. Privacy *Orbits* implemented in a smartphone application.

With the app loaded (figure 21) a slider at the bottom of the screen can be used to turn on/off the features (p. 38 list of features) of the IoT lock. As the user decides which features they want to use, the Orbit graphic is updated to show them the effect this will have on how identifiable they are, based on the data generated and used by the system. This Design Fiction, so far, only touches the surface of the underlying issues.

By building additional entry points it could easily be expanded to explore other factors. For example, if the Orbit system were to become a standard way of gaining a user's consent, we would need to understand how the Orbit graphs would be generated. Would researchers need to populate a database to calculate the right blurriness, or would an algorithm do it? What would the process be like?

Orbits would also have to be further developed in order to account for information over and above identifiability. For example, users might well be interested in how vulnerable their data would be to theft; whether it might

be sold; or if it could have profiling algorithms run on it. Figure 22 shows several prototype ideas the Orbit system could employ to communicate information about security and specific data points for IoT constellations.

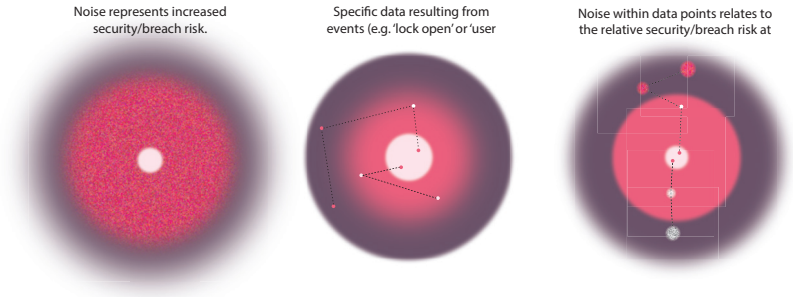


Figure 22. Explorations of how to extend the privacy *Orbits* to communicate more information.

With this Design Fiction we wanted to address the problem of making GDPR-compliant consent mechanisms, showing what the world might be like if IoT devices were more accessible and transparent in how they gain consent from their users. By using Design Fiction as World Building we have shown how novel designs such as the Privacy Orbits could do this, as well as helping to identify the pitfalls and challenges in making such a system a reality. Using Design Fiction to prototype different ways that consent can be gained in a way that is compliant with GDPR may allow IoT product developers to understand more quickly the pros and cons of different ways of preparing for GDPR, as well as communicating to users what alternatives to text-based end-user agreements could, and perhaps should, may look like.

Summary

This little book explains why the IoT is an interesting and important area to pay attention to, and explains how you can use Design Fiction to understand and help shape how the IoT will impact our lives in the future. Central to this is the idea that the IoT is much more than just products and services. The IoT also includes data, standards, business models, and a whole raft of other interrelated factors. Realising that the IoT is not simply collections of physical things, but consists of collections of constellations of things, is essential for understanding and making best use of the IoT at this time. As artificial intelligence, data science, and machine learning become more sophisticated, the power of these constellations will become increasingly apparent, impacting on all aspects of our lives. Although much of the IoT is currently on the pre-adoption side of the hype cycle's chasm, one day soon they will be on the other side – the things of the IoT won't be special any more, they will just be 'things' – it's important to understand what that will mean and what it will be like to live that way.

Design Fiction works in many different ways, but the World Building approach provides a flexible, and accessible method for using it. Our three example Design Fictions show how different media – including marketing materials, prototypes, wiring diagrams, et cetera – are used to create entry points to Design Fiction Worlds. Design Fictions can be product driven, technology driven, or problem driven. Each different flavour of Design Fiction can be of relevance to widely different groups and be used in different ways be corporations, governments and researchers. We can never truly know the future until it arrives, but by using Design Fiction we can learn how to make the most of tomorrow's future, today.

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PETRAS
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