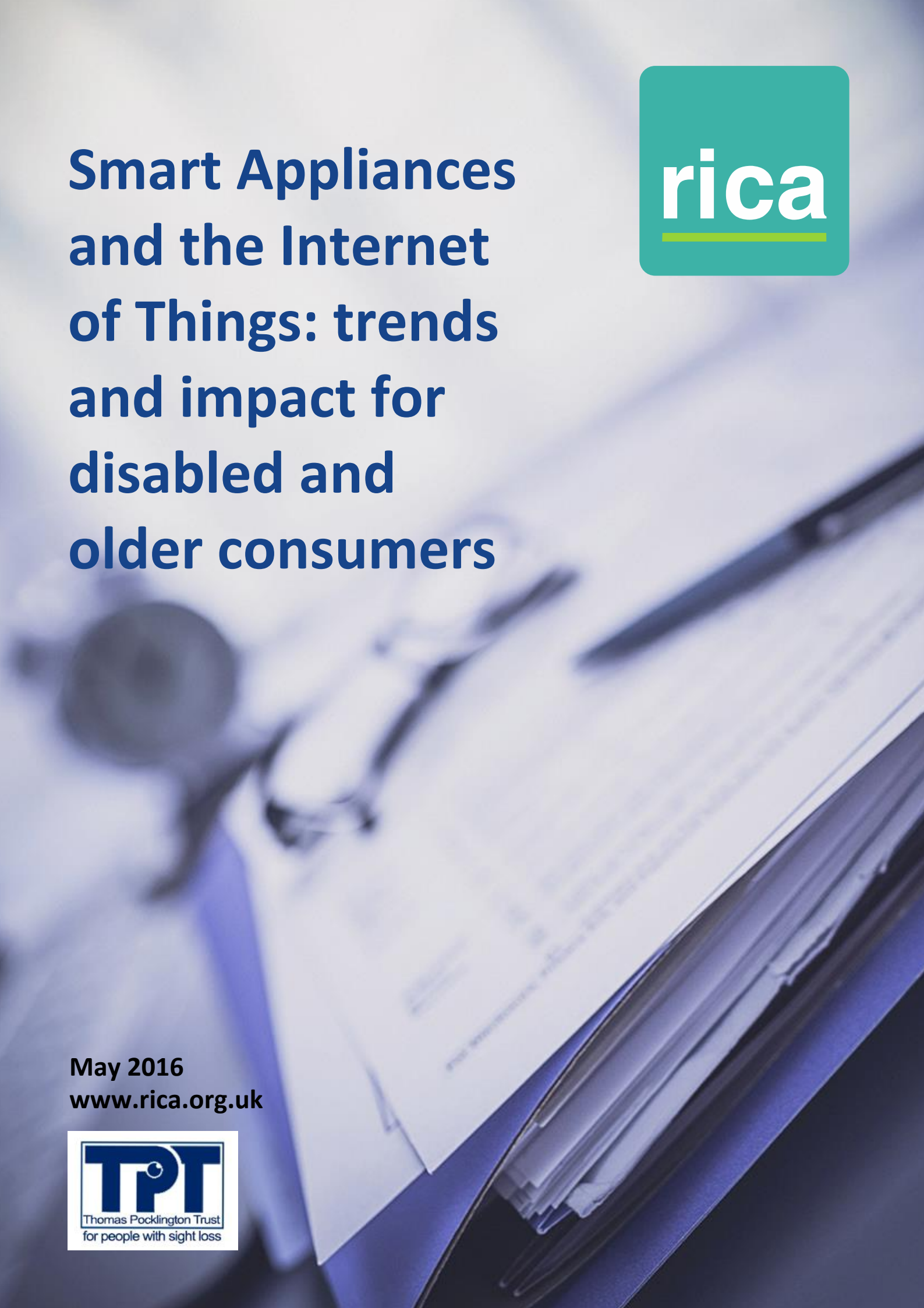
Smart Appliances and the Internet of Things: trends and impact for disabled and older consumers



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for people with sight loss

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Executive Summary

This report provides the findings of interviews with experts in the field of design and manufacturing and desktop research to identify the impact of the growth in new smart appliance in the home. The growth in these technologies growth reflects that of the broader Internet of Things (IoT) market for connected end-point devices.

A selection of IoT appliances currently available and in development are identified and described, together with use scenarios. The report discusses emerging issues including the need for common communication protocols that allow greater connectivity across different types of product and brands. The importance of aligning products to identified consumer need, rather than just offering technology solutions, is also discussed.

The study concludes that there is opportunity for new and emerging IoT appliances and service solutions to be of real benefit to disabled people. This opportunity comes from the control interface of many appliances being accessed from apps on an accessible smartphone or tablet. The challenge for disabled people however is in getting their needs and wants recognised by the builders of the appliances and solutions that make up the IoT. It is recommended that this occurs through the involvement of disabled people in manufacturers' design processes and through consumer and expert consultation panels.

Acknowledgement

With funding from the Thomas Pocklington Trust, Rica has published another report Inclusive Design: manufacturing, design and retail expert views, available at www.rica.org.uk.

Rica

Rica (Research Institute for Consumer Affairs) specialises in consumer research with older and disabled consumers. Founded through Consumers Association, publishers of Which?, Rica became independent in 1991.

It has its own Consumer Panel – the RicaWatch panel – of over 600 people and is a disability led organisation. Seven of the charity's nine Trustees have a disability.

Rica carries out commissioned research work with industry, other charities, service providers and policy makers to improve products and services. With grant funding it also publishes free consumer reports based on independent research.

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Introduction

The role and scope of Smart Appliances in the home (Washer, Dryer, Refrigerator, Dishwasher, Fridge, Freezer, Air Conditioner, Vacuum Cleaner and so on) is on the increase with the market being estimated to have a year on year compound growth of slightly over 15% (1). By the year 2020 the global value of this market is projected to be over 37 billion USD. This growth is reflected in the broader Internet of Things (IoT) market which predicts that by the year 2020 there will be just under 30 billion connected end-point devices, from cars through to toasters.

We interviewed experts in the field of design and manufacturing and supported these conversations with desktop research to uncover what the impact of these new technologies might be. In particular we asked what the home in the near future might look like for people with disabilities. This report is part of a broader investigation into inclusive design and was carried out by Rica and funded by The Thomas Pocklington Trust.

Background to the IoT

The Internet of Things (IoT) was envisioned in Mark Weisner's seminal paper on ubiquitous computing in 1991, "The computer of the 21st Century" (2). However the term "The Internet of Things" wasn't used until 1999 by Kevin Ashton (3) who was working on networked Radio Frequency Identification (RFID) devices. Since then developments in communications and networking technology have fuelled an exponential growth in this area with IoT forecasted to soon become the largest global market sector (4).

Whilst there is concern over data security and intrusion into people's daily routines (5), these connected appliances offer many potentially helpful services, such as food management in the kitchen, remote heating control and health monitoring. Additionally there is an opportunity to improve the accessibility of household appliances by interacting with them through a connected smart phone, tablet or computer. These connections to computers allow the user to be informed of the status of the appliance while also providing a way to remotely control them. This networked interface with appliances offers much potential to make inaccessible appliances accessible to disabled people, especially to blind or partially sighted people.

The development of IoT appliances

The potential of the IoT has not been unnoticed by kitchen appliance and heating controls manufacturers who have been investing time and money in developing infrastructures for their products to communicate over. The following is a brief explanation of some of the technology that underpins the IoT and gives an insight to how the IoT might develop in the near future.

Islands of technology

Connecting everyday objects[1] to the internet is an essential element of the IoT. Some appliance suppliers use a low power wireless network to communicate over, such as Bluetooth, whilst others utilise the existing higher powered Wi-Fi network used for tablet or computer wireless connectivity. Once a network is in place objects can populate the home environment and communicate with the user and with each other.

The ability of an object to respond to remote commands and change its behaviour makes it an active device, such as the new Hive heating thermostat or a Sky+ box. Where the remote object has no ability to respond to remote control requests then it is considered passive, as with some fixed cameras, microphones or temperature sensors.

This distinction is worth noting because an output from a connected passive object such as a camera can be used with some intelligence to control an active object such as a connected cooker. These more complex systems are currently being researched and developed for so-called smart homes in the near future. This is discussed more in the section 'Tomorrow', see below.

Talking the same language

Although the physical communications layer between objects and the internet has largely been agreed to be a low powered wireless network, it is not exclusively so, with at least two of the large appliance manufactures (LG Electronics and General Electric) utilising the more common Wi-Fi network standard used in laptops, tablets and smartphones.

[1] For the purpose of this report when discussing the IoT, the "things" or "objects" we refer to are kitchen appliances and heating thermostats.

There is still much disagreement between developers about what protocols to use at the network and applications layers. The two competing camps in the network layer are, on the one side, the established ZigBee Alliance, and on the other Google/Nest. The picture is even more confused in the applications layer with many companies working in one or more camps and trying to show leadership. Currently the ZigBee home automation cluster library is the most advanced, although Apple Home Kit, Intel OIC, Nest Thread and others are all still present.

This all adds up to a potential war in the home with appliances being locked into networks established by one set of protocols or another, rather than having products openly competing against each other and able to connect on any network. It is reasonable to assume that convergence to a common set of standards will happen over time. Until then, there is keen competition between companies to establish proprietary networks in the home to secure market share.

Apps and the IoT

Mobile computing has been at the forefront of providing the means by which a user can interact with their IoT appliances. This interaction is typically mediated by an app on the mobile device which is provided by the appliance supplier, as with British Gas and their Hive app. These apps become a focal point for the user to receive information about, and control of, the IoT appliance. With the use of voice input, tactile feedback, audio output, screen readers and sensitive design, these mobile devices can become a powerful agent for accessibility.

There is another element to the development of the IoT that apps can serve. Service design can have a role in broadening the utility of connected appliances; for example, providing recipe suggestions made from food available in the fridge or turning the heating back on after a holiday once the aircraft touches down. These collections of devices and information are often referred to as ‘system ecologies’.

Where and when

The long-held notion of the Asian electronics industry as developing technologies which are seen in Europe two or three years later is not so apparent in the IoT market. This is possibly because of the internet shrinking global markets, or Europe having a strong presence in software development.

A key factor needed to facilitate the presence and growth of IoT is a healthy broadband infrastructure. Without a mature internet many services which support the IoT will not be possible, leaving appliances as islands of technologies.

Although it is reasonable to expect IoT technologies to be available in any country that can afford them, the transition from the high end luxury to mainstream markets will be driven by customers recognising the utility of appliances and services offered.

Today

Appendix A contains a table of some IoT appliances either currently available or in development. A broad categorisation is applied to each of the appliances. This is not meant to be an exhaustive list of IoT products but more an indication of the range of appliances that are beginning to reach our retailers. A further exploration of appliances in the home is seen in the "Assistive and inclusive home technology for people with visual impairment" report for Thomas Pocklington in 2015 (5).

What is most apparent when looking at this list is the questionable utility of many of these appliances. To be able to remotely switch on the kettle, or to be informed of the freshness and quantity of eggs in your fridge, or to know how many cartons of orange juice have been thrown in to the bin, all might be seen to be of marginal value for the mainstream consumer. Many of the products cited in Appendix A are funded through crowd sourcing investment sites and have a strong design focus to capture the public imagination. Often the promotional material and product design is a triumph of form over function which glosses over very weak technical capability and poorly thought-out product use scenario[2].

The inability of designers to present a convincing case that demonstrates the value of many IoT products in the home suggests that, for the time being at very least, these products will remain as niche and be purchased solely by early adopters. This is reflected in market forecasts for IoT which see a slight contraction of growth expectation and are highlighted by Accenture in their 2016 digital consumer survey report (6). This work surveyed 28,000 consumers across 28 countries on their use of consumer technology and found price, security and ease of use to be the significant barriers to adoption. It also draws attention to "the lack of a compelling value proposition" as a concern to the majority of consumers.

Tomorrow

It is recognised that the IoT needs to find meaningful solutions aligned to people's needs rather than solely responding to the capability of technology. It is also said that these solutions are most likely to be found in collections of technologies, or system ecologies. This route to successful IoT product development is not new and is exemplified in the evolution of wearable fitness trackers.

[2] Use scenarios describe the greater context of a task including the conditions, motivation, and environment of the task for a particular user group. http://www.ixda.org/node/16940

The early connected fitness devices typically used sensors placed into the sole of running shoes. These were essentially pedometers that communicated with smartphones and, when coupled with phone's GPS (Global Positioning System), a record of the user's daily running patterns would be created. At the time people challenged the usefulness of such a system arguing that the runner knew where they had been, so what was its value? Over the following years the shoe sensor has been joined, and in some cases replaced, by other wearable devices such as wrist bands, heart monitoring straps, temperature probes, and galvanic skin response sensors. These additional sensors help improve the quality of personal data by sensing when the user is asleep, or in a car, or on their bike.

The scope of fitness monitoring systems is no longer being seen purely as a system to support people to exercise, they are being extended to include other aspects of a person's wellbeing such as diet, alertness and even medical conditions. These systems have matured and changed from having a gadget status to being mainstream consumer products.

It seems quite reasonable to expect IoT devices in the kitchen to follow a similar evolution as product designers better understand the needs and wants of users. Rica believes it is this conversation between designers and users that disabled people need to be engaged with, not as retrospective testers of mature designs but as early adopters of technology, shaping its development.

Inclusive Design and the Internet of Things

User-centred design methodologies are often used to help inform the design of products, services and environments. The inclusion of disabled people into this user-centred process has been at best minimal and at worst seen as tokenism (7).

There is no reason why disabled people could not be included within user-centred design methodologies, which would be to the overall benefit of the product's design. Such an approach is discussed in the paper by Schulz et al (8) where they present a case study of how Universal Design can help inform the design of prototypes and apps for smart phones and the Internet of Things. They promote the use of mixed-ability personas and user scenarios. These techniques are further supported by the use of an accessibility champion.

The practice of constructing mixed-ability user scenarios is of particular significance, especially in considering the need for the emerging IoT market to come up with convincing "value propositions". It is vital for disabled people to have a role in the development of the future IoT products and services through proactive engagement within the design process.

Conclusions

There is opportunity for new and emerging IoT appliances and service solutions to be of real benefit to disabled people. A significant element of this opportunity comes from the control interface of many appliances being accessible through a smartphone. In order to exploit the potential of the IoT to mediate the control of appliances it is crucial for smartphones and their associated apps to be accessible.

However, this is not the only place where opportunities for IoT to improve the quality of life for disabled people exist. Service designs which add context of use to clusters of appliances can also provide real benefits. Having a smartphone know the quantity and freshness of produce in the fridge or the larder is helpful to sighted people but is even more so for a partially sighted or blind person. Some examples of user scenarios of clusters of devices can be found in Appendix B.

The challenge for disabled people lies in getting their needs and wants recognised by the builders of appliances and solutions that make up the IoT.

If manufacturers are not willing to fully embrace disabled people into their design cycle for the IoT, then it could be argued that it falls to interested groups to do such work independently. This work might take the form of an expert panel of disabled people who look at IoT devices and their smartphone apps and report on them monthly. Such a panel would probably have best impact by having a narrow remit to investigate ease of use and most importantly apply user scenarios appropriate to their needs.

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Appendix A

Table of some smart appliances

Appliance (type)	Description	App Support	Wireless Connectivity	What it does
LG's Smart Oven (cooker / maker)	Oven	Yes	Wi-Fi Smart ThinQ	Allows you to control cooking remotely from a smartphone
GE (cooker / maker)	Oven	Yes	Wi-Fi Needs connect plus device	Allows you to control cooking remotely from a smartphone
Cinder (cooker / maker)	Cast iron skillet (similar to Foreman grill)	Yes	Bluetooth	Will send you a notification when your meal is ready
Crock-Pot (cooker / maker)	Slow cook pot	Yes	Wi-Fi Belkin home automation using WeMo	Adjust cooking time and temperature of Crock-Pot meals from a smartphone
Anova (cooker / maker)	Sous vide	Yes	Unsure Kickstarter project	Remotely monitors and controls water bath cooking temperature
Smarty Pans (cooker / maker)	Cooking pans	Yes	Unclear Start-up company	Allows you to monitor temperature, humidity and ingredients' weight as you cook

Appliance (type)	Description	App Support	Wireless Connectivity	What it does
Pantelligent Smart Frying Pan (cooker / maker)	Cooking pan	Yes	Bluetooth	Monitors the temperature of the pan and communicates it to a smartphone. Cooking time is adjusted using an app
Smarter wifikettle (cooker / maker)	Kettle	Yes	Wi-Fi	Remotely boil the kettle or heat the water to a specific temperature using a smartphone
Siemens Connected Coffee Maker (cooker / maker)	Coffee maker iQ700 appliance line	Yes	Wi-Fi Home connect	Remotely control the coffee maker with a smartphone
B4RM4N (cooker / maker)	Cocktail mixer	Yes	Bluetooth Start-up company	Measures quantities of cocktail mix and allows voice control of the measurements with the use of a smartphone
Somabar (cooker / maker)	Cocktail mixer	Yes	Not known Start-up	Measures quantities of cocktail mix and allows voice control of the measurements using a smartphone

PicoBrew Zymatic (cooker / maker)	Brewing machine (Beer)	Yes	Wi-Fi or Ethernet	Remotely monitor the brewing process remotely using a smartphone or tablet
Drop (measuring)	Measuring scale	Yes	Bluetooth	Coordinates with a smartphone for recipes
MixStik (measuring)	Measuring stick	Yes	Unclear Start-up company	Measures the amount of liquid placed into a container and communicates this to a smart phone
Egg Minder (container / probe)	Monitoring container	Yes	Unclear	An egg container that attempts to monitor the freshness of the eggs and communicates this to a smart phone
Vessyl (container / probe)	Monitoring container	Yes	Unclear Start-up company	Tracks the number of calories and nutritional content of what is in the container
Neo Smart Jar (container / probe)	Monitoring container	Yes	Bluetooth	Tracks how much is left in the container along with its use by date. This is communicated to a smartphone

GeniCan (stock taker)	Scanner	Yes	Unclear Start-up company	Scans barcodes and is placed by the bin to record empty items that might need restocking
Kuaisou (utensil / probe)	Chopsticks	Yes	Unclear Start-up company	Smart chopstick prototype called Kuaisou that can measure the freshness of cooking oil and the safety of water
HAPIfork (utensil / probe)	Fork	Yes	Bluetooth	Seeks to aid digestion and help weight control. The fork vibrates and lights up to remind you to slow down. Data is uploaded to a smartphone
GE (washing)	Dishwasher	Yes	Wi-Fi Needs connect plus device	Allows you to track your washer and dryer cycles and set alerts remotely to a smartphone
GE (storage)	Fridge	Yes	Wi-Fi Needs connect plus device	Allows you to receive alerts and reminders, eg filter replacement, or if door has been left open

Appendix B

Some examples of use scenarios

1. Cooking
    a. Task – blind or partially-sighted person wanting to cook, using new induction hob for safety and cleaning reasons
    b. Problems cooking with existing induction hob
        i. Controls are often touch-screen input type with visual outputs
        ii. Pan location on hob can be within an active area but there is no tactile feedback to confirm if the pan positioning is inside active area or not
        iii. Knowing if the temperature of the pan is correct for the food
    c. Solution – Smartphone connected to induction hob and cooking pan. The temperature setting on the cooker can be controlled through the use of voice output and tactile input on the smartphone. The cooking pan will monitor its cooking temperature and inform the user that the pan is fully or partially on the cooking area and what the cooking temperature is for the food. Food cooking temperature and timings can be informed through recipes accessed through smartphone.

2. Inventory
    a. Task – blind or partially sighted person wanting to know the current level of stock in the kitchen
    b. Problems
        i. Not able to readily know how full or empty storage jars are in the pantry
        ii. Not able to readily know the contents of the fridge
        iii. An easy way of remembering results of 1 and 2 above
    c. Solution – Smart containers can record the contents' name and measure the weight, which can be communicated to a smartphone. The contents of a smart-fridge can be monitored through the use of bar code readers and camera technology. This information can be integrated with the same technology placed by the waste bin or garbage chute. The fridge, smart jar and garbage information can be used to create an accurate assessment of inventory needs in the kitchen which can be managed by an App and communicated to a person's smartphone.

3. Opportunity?
    a. Task – Existing exclusion or difficulty, disability driven
    b. Problem – What makes “a.” above exist – identify barriers
    c. Solution – Create smart appliances use scenario

Further reading

With funding from the Thomas Pocklington Trust, Rica has published another report ***‘Inclusive Design: manufacturing, design and retail expert views’*** available at www.rica.org.uk.