LONDON'S GLOBAL UNIVERSITY

UCL

# Future Retail Environments

## and the Internet of Things (IoT)


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**Figure 1: UCL Pop-up Retail Shop at the Boxpark London**

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# Introduction

In 2012 retail sales in the United Kingdom totaled £311 billion, £29 billion of these sales were linked directly to online retail[1]. Retail and wholesale (2011) accounted for 11.3 % of the Gross-value added (GVA) and 15.3% (4.2 million people) of the overall employment[2]. This report notes the increasing influence of the Internet in the last couple of years, not only in terms of actual online sales, but also in terms of how online experiences inform offline buying. This increases pressure on high street retailers to adapt to these transformations and changes in behaviors of shoppers. As a result, a number of high street names have reduced the number of brick and mortar stores, where as some online retailers have started to sell their goods now in physical stores, often via pop-up shops, with the aim of diversifying their brands.

This report aims to elicit the key trends in retail and it details how Internet of Things (IoT) technologies are helping to drive and enable some of those key trends. While IoT is only one factor in the overall picture, it is deemed significant enough in this context to warrant closer inspection. The report examines best practice examples of IoT applications and relates them to wider trends in the retail sector. The report combines multiple perspectives in order to paint an overall picture of retail trends. One view is the research perspective on the future of retail, another is presented through innovative examples of IoT-based solutions that have already been rolled-out by retailers. These examples show that high street names have already started to explore this space.

Clearly retail is an important sector of the UK economy that goes through a state of accelerated transitions at this time. These transitions also provide unique opportunities for novel concepts, ideas and business models to pave the way for the successful future of retail. We are aware of the limitations of a report that focuses mainly on the application of IoT in this context. Nevertheless, we think that the ground that our document covers is substantial enough to demonstrate the relevance of IoT in retail and we envision that there will be an uptake of some of the recommendations and ideas that are put forward. Potential stakeholders and audiences include retailers, researchers, policy makers, and technologists.

**Figure 2: "Düsseldorf futuristic shopping architecture" by Retinafunk**

1 http://www.brc.org.uk/brc_stats_and_facts.asp
2 *www.parliament.uk/briefing-papers/SN06186.pdf*

# 2 Background

The Internet of Things (IoT) consists of physical networked objects that are seamlessly integrated into the information network. These networked objects may be 'smart' (i.e. embedded with some processing capability), they may be objects that have been tagged with unique object identifiers (e.g. Radio-Frequency Identification or RFID for short, smart labels) that identify and link virtual information to the physical objects via smart devices or augmented environments (e.g. iBeacons[3]). Smart environments in which these services are enabled are frequently location aware (location of people and objects). IoT services are designed with the goal to enable people to interact with these networked objects in order to provide an added value to businesses and people. It is worth noting that there is no standardised top-down design approach when it comes to IoT infrastructure. Consequently the bottom-up emergence of IoT structures leads to a couple of challenges in terms of interoperability and communication between devices and data providers[4]. However, the underlying challenges of interoperability and connecting different data providers is beyond the scope of this report. One of the authors has published with colleagues on the possibility of standardising the format of digital object memory for use in Internet of Things applications (Barthel, Kröner and Haupert, 2013) and we are aware of issues of interoperability and reuse. However, many of these challenges are not so different from those in other Internet-based environments so that a number of best practices (e.g. semantic web technologies, search and retrieval, application of widely used internet protocols, API's), and lessons learned exist that can guide the way when dealing with these challenges creatively.

Historically IoT has strong ties with the retail sector as early research focused on the use of auto IDs (e.g. RFID tags) in supply chain management (Schuster, Allen and Brock, 2007; Schneider and Kröner, 2008). The term Internet of Things originated from the Auto-ID Center at MIT, which had been established in 1999 to explore the use of Automatic Identification technologies in supply chain management in partnership with industrial sponsors including Proctor and Gamble and Gillette. Although barcodes were by then well established in stock control these generally require some form of human intervention (i.e. alignment and scanning) to be read. One of the aims of the Auto-ID Center was to explore ways of completely automating the supply chain through machine-readable RFID tags. Another important contribution to the IoT made by the Auto-ID center was the establishment of the Electronic Product Code (EPC) and the EPCGlobal Tag Data standard[5]. The EPC is a unique identifier that can potentially identify every physical object on the planet. The EPC takes the form of a URI that can be written to a tag and links to a directory service that provides specific information about that particular object.

Other areas where IoT applications have already become widespread include energy monitoring through the use of smart meters and connected sensors. IoT is also frequently applied to challenges in the area of environmental monitoring (e.g. pollution, noise). In recent years the IoT's has also seen a stronger uptake outside industrial applications so that a number of products and services that are targeted at consumers have been rolled out. Examples of consumer IoT services and products include the Nest learning thermostat[6], the networked

3 http://gigaom.com/2013/09/10/with-ibeacon-apple-is-going-to-dump-on-nfc-and-embrace-the-internet-of-things/
4 http://readwrite.com/2013/06/14/whats-holding-up-the-internet-of-things
5 http://www.gs1.org/gsmp/kc/epcglobal/tds
6 http://nest.com/

scale Withings[7], Little Printer[8], the Goodnight Lamp[9] and Penguin NAVI[10]. Consequently the interest in designing interfaces to engage with a variety of sensors, uniquely identifiable physical objects and their application in people-centered services has grown and as a result progress has been made to make IoT more accessible for mainstream audiences. A number of platforms that aim to provide infrastructures (e.g. data storage, analytics, history of people's interactions) for connected real world objects have been developed and rolled out in the market; examples include Xively[11], Evrythng[12] or ThingWorx[13]. This means that increasingly all the necessary pieces to create IoT-based services that augment retails spaces are becoming available but a number of grand challenges remain. For example, the real-time analysis of multichannel data that subsequently can be turned into relevant insight is one such challenge. Section Four of this report discusses some examples of IoT applications that are already employed in retail.

The retail sector has historically gone through a number of transformations and we would like, as a first step, to identify some of key trends and drivers of recent changes. Once we have identified some of the drivers for transformation we will discuss a number of key technologies that have emerged as potential building blocks for new IoT-driven applications in retail. In this process we provide a number of examples that show how these building blocks can be creatively applied to some of the new challenges that changes in shopping behaviors have introduced. These examples demonstrate how retailers can connect better with their customers through the smart augmentation of retail spaces.

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**7** http://www.withings.com/
**8** http://bergcloud.com/littleprinter/
**9** http://goodnightlamp.com/
**10** https://www.youtube.com/watch?v=IK4-zPD_25U
**11** https://xively.com/
**12** http://www.evrythng.com/
**13** http://www.thingworx.com/

# Drivers for Change

## 3.1 Changes in Customer Behavior and Expectations

One of the key drivers in retail is an increasing demand for a seamless experience between online, mobile and in-store shopping. Many brands understand the importance of a unified user experience and have started streamlining online and in-store shopping experiences to provide a more uniform environment. An example is the fashion house Burberry – the flagship store in London's Regent Street mirrors many of the design elements found in the online presence and vice versa. One can also experience an increase in multichannel retailing with high street brands using their physical retail stores to fulfill online orders. It has to be expected that retailers will further integrate online and high street shopping experiences in the near future. However, to increase multichannel performance retailers need not only to integrate design elements but also business processes and insights from online, mobile and in-store channels. This leads to complex requirements in terms of analyzing and evaluating this multichannel experience. It also needs an IT infrastructure that is prepared to support the data analysis that is required to gain insights from people's interactions across the different channels.


**Figure 3: "Augmented reality with LEGO" by antjeverena**

Another key driver are people's expectations about price comparisons and in-store access to information about a product. In areas such as food shopping, companies including the online supermarket Ocado offer low price promises[14]. If selected competitors provide the same product at a lower price at the time of an order then customers will automatically receive a voucher for the price difference as long as certain conditions are met. While price matching examples like the one above are not yet a common practise in many sectors they clearly set the bar concerning people's expectations about price comparisons and more importantly transparency. These new expectations when combined with the ability of most shoppers to look up prices and any product-related information in-store through the use of mobile phones and other wearable technologies, force retailers to act. Consequently they need to be open and transparent about their pricing and service quality in order to increase trustworthiness and customer loyalty. This is not to say that automatic price matching will be applicable or desirable in all sectors. However, if it is not price that is the most important criteria then it will be service or product quality, or whatever other relevant product properties/differentiators are applicable in a given situation. These criteria will be subjected to transparency checks as customers have relevant information (e.g. customer reviews, product tests, certificates) increasingly at their disposal at the point of sale through ubiquitous computing technologies.

14 http://www.ocado.com/webshop/startWebshop.do?dnr=y

Another source for transformation are people's expectations for retail to be more event-like. This trend has also been dubbed as "retailtainment"[15]. On a larger scale such retail events can be experienced in large shopping centers such as Westfield in London that organises concerts, fashion shows or ice-skating events on their premises on a regular basis. Single retail shops compliment this trend frequently through an uptake of latest technologies with the aim to increase in-store engagement and thus the dwell-time of shoppers. These technologies for in-store engagement can include anything from ambient sensors, to the use of iPads as interactive labels to in-store 3D printing facilities to enable novel forms of product customisations. These are only a few examples, Section Four of this report discusses a number of technology interventions that are linked to IoT concepts in greater detail. Hence it can be said that changes to the user experience are a strong driver in retail. A description of what encompasses the user experience in retail can be quiet complex and include many different layers. See Verhoef et al. (2009) and Petermans et al. (2013) for an in-depth explanation and examples of conceptual models of the retail experience. The perspective on user experience as presented in this report is much narrower and focused on the use of novel in-store IoT technologies. It would be a formidable task to cover a wider view on retail user experiences and technology, and it is not possible within scope and constraints of this report to explore such a broader view. However, the authors are aware that (IoT) technology is only but one part of this wider experience. Nevertheless we feel it is an important view that is worth exploring.

## 3.2 Multichannel Retail

One of the current buzzwords in retail is "me-tailing". The idea behind me-tailing is that retailers offer highly personalised interactions with customers based on information gathered in real-time through mobile, social and in-store channels, as well as any other customer touchpoint[16]. This vision of providing such personalised experiences implies that retailers are prepared to harvest the data from multiple channels and convert it into intelligence that adds value for the customer but also for the business as it can help identify those customer segments that are deemed most profitable. These me-tailing scenarios require the integration of multichannel data from online, mobile and physical in-store interactions and thus a technological infrastructure that can deal with this data. This includes data storage, the analysis of the data and conversion of this information into insights that are suitable to drive business decisions. Consequently, the technological requirements to manage large amounts of data and transform this data into business intelligence are complex and new to many retailers. We hope that this report goes some way towards pointing retailers into potential directions how to deal with this kind of data.

### 3.2.1 Curation

One of the trends in retail is the curation of products. Retailers are increasingly searching and filtering a multitude of information about products with the aim to organise and present it to shoppers in meaningful ways. One can see that this can be a very successful strategy. Apple retail stores are a good example of curation as they only show a small number of selected products. The inventory consists of Apple products and a few selected accessories from third party producers. While there is a risk that content gets stage-managed through curation in order to serve the best interest of retailers,

15 http://www.independent.co.uk/news/business/analysis-and-features/retailtainment-the-future-of-shopping-2303942.html

16 http://www.forbes.com/sites/sap/2013/02/06/in-a-me-tail-world-its-all-about-you/

there are also new social contracts emerging based on transparency that balance this risk. Consequently, this leads to personalisation of retail stores and retailers are taking individual shopper's preferences into consideration when providing tailored and focused retail experiences by presenting the right products to the right audiences. While this filtering behavior is already prevalent and well established in online shops such as Amazon it has yet to be entrenched in physical stores on high streets. Consequently, it seems likely that curation will be one of the areas that will see significant attention and investment from retailers in the near future. Curated retail is also likely to increase in multi-category mass retail environments. In these settings where a shop carries a large number of different products, success will also rely on the right mix of technologies such as augmented reality and mixed reality applications that can help to filter content based on customer preferences and provide way-finding functions.

**Figure 4: "Apple Retail Store, NYC (#28896)" by Mark Sebastian**

### 3.2.2 Payment

Another area where Internet of Things technologies will impact retail is mobile payments. It is already possible in many shops to use NFC readers, tap and go systems or virtual wallets and the number of shops that support these forms of payment will likely increase at a fast rate. Customers appreciate the simplicity and convenience that many of these transaction systems provide while for retailers mobile payments provide opportunities to engage in more personal ways with their customers e.g. through loyalty schemes. In order to realise these advantages retailers will increasingly need to rethink how to design customer experiences at points of sale and checkout. It is also notable that convenience payment services such as Barclays Pingit (which enables people to pay using UK mobile numbers to identify sender and receiver) are seeing an increased uptake[17].

## 3.3 Technical Building Blocks

Internet of Things applications in retail are often based on recurring technological building blocks. In this section we identify and discuss some of these frequently employed technologies and their purposes in retail. The examples depicted in Section Four are based on a combination of the technical building blocks we introduce and describe here, which goes to show the relevance of these building blocks in different contexts.

17 http://thenextweb.com/apps/2013/11/19/barclays-pingit-app-now-lets-large-firms-pay-individual-customers-using-just-a-mobile-number/


**Figure 5: Tales of Things – Scanning of a QR Code with a mobile client**

### 3.3.1 Smart Labels and Unique Identifiers – RFID, NFC, QR Codes

In many retail environments store items are tagged with labels that uniquely identify an item and sometimes perform additional functions (e.g. the use of RFID for theft protection). The latest mobile phones come often with NFC (Near Field Communication) capability and applications to decode QR Codes (Quick Response Codes), which can launch a URL in a web browser (if that is what is encoded in the QR Code information). The linking of unique identifiers of retail items to networked applications can also enable a number of novel retail scenarios. For example services that establish these links let people get additional information about an item at the point of sale. Thus this enables in-store marketing and personalised information access. Another use for marker technologies is to enable augmented reality applications. An example application of this is the IKEA augmented reality catalogue[18,19]. Items from IKEA's catalogue are shown as a virtual overlay over the actual space when people place the catalogue with the item they would like to see on the floor and point the phone camera at the catalogue. In this way people can get an idea about the visual impact that a piece of furniture would make to their living space before buying it. Another example is an in-store visualisation of how a LEGO model will look like when its assembled (see Figure 3).

### 3.3.2 Sensors

Another central component is the use of sensors for shaping user experiences in retail. An example of this are proximity sensors and cameras that signal and trigger a change in the environment when shoppers are moving into the proximity of an interactive display. Such sensor data can also be used for in-store analytics for example in order to measure the flows of shoppers and dwell-time in different locations of a retail store. In some of these scenarios sensor data needs to be stored and the data needs to be analysed in order to gain useful business insights from ambient sensors and in-store camera feeds.

18 http://www.dezeen.com/2013/08/05/ikea-launches-augmented-reality-catalogue/
19 http://www.youtube.com/watch?v=vDNzTasuYEw

### 3.3.3 Bluetooth Low Energy (BLE) – iBeacons

Increasingly gadget and smartphone manufacturers integrate the Bluetooth® Low Energy (BLE) stack for wireless network communication in their products (e.g. smartphones, tablets, watches, home electronics, and fitness gadgets). The main advantages of BLE compared to prior iterations of the Bluetooth standard include amongst others low-power consumption, indoor location tracking, wide-range communication and content push to nearby devices. Also in some scenarios BLE might be able to circumvent (e.g. through location detection and push information about the nearest products) the need for QR Codes and NFC tags and thus can help to simplify the required technological assets in a retail environment. However, this last use case is highly situation dependent and is not necessarily the main application of BLE. The creation of BLE applications is supported by Android and iOS operating systems and recently Apple have launched a new API that provides a convenient wrapper around their BLE API for proximity detection. The following paragraph describes this new API in more detail.

When Apple launched iOS7 it also launched iBeacons®, which is a new Core Location API that enables any iOS device with a BLE compatible chip to know where it is located relative to other BLE compatible devices. The iBeacon API builds on the inherent properties of BLE devices, and indeed any BLE device that broadcasts its transmitted power (or whose power output can be calibrated by the user) can in principle be used for proximity ranging by a BLE client via the received signal strength indicator (RSSI). However, the RSSI measured by a client at a given distance from a beacon device is affected by many factors including relative orientations of the respective devices and obstacles in the 'line of sight' and hence can at best give approximate estimates of range (for example 1m, 10m, 100m) that are classified as 'immediate', 'near', 'far' or 'unknown' in the iBeacon API.

At the Apple Worldwide Developers Conference (WWDC) in June 2013 Apple declared an intention to release an iBeacon specification to allow third party manufacturers to produce stand-alone iBeacon devices. This became available under NDA as part of Apple's 'Made for iPhone' (MFI) program in February 2014. Devices adhering to this specification will be able to use the iBeacon trademark. Prior to this a number of "iBeacon-like" third party products such as Estimote[20] have already emerged and we can expect more to follow in the near future.

New services in retail environments, based on iBeacons such as proximity marketing, in-store-analytics, indoor navigation and contactless payment solutions are being trialed. Selected Apple stores for example are already augmented with iBeacon technologies[21]. iBeacons could get an additional early push as the technology is set to roll out in MLB (Major League Baseball) stadiums throughout the US[22] in order to deliver specific information (e.g. way-finding, such location of food stalls or seats) and offers to iOS devices, depending on people's location within the stadium. Early response to the release of the iBeacons API seems encouraging and the API might see increased uptake in the retail sector in the future. Commentaries on iBeacons pointed out that the technology seems particularly well suited to support multichannel retail scenarios[23]

**20** http://estimote.com/
**21** http://www.slashgear.com/brighter-beacons-up-close-with-qualcomms-gimbal-for-apple-stores-13316864/
**22** http://techcrunch.com/2013/09/29/mlbs-ibeacon-experiment-may-signal-a-whole-new-ball-game-for-location-tracking/
**23** http://www.telegraph.co.uk/finance/businessclub/technology/10345004/iBeacons-the-saviour-of-high-street-retail.html

and as a simple cost effective solution to connect with customers while they are browsing through stores[24].

Unfortunately from a development perspective there is no single solution that would automatically work on all of the most widespread mobile phone platforms. While BLE itself is a standard, the interfacing to BLE-enabled devices can be relatively complex and different platforms such as Android or iOS come with their own wrappers and developer API's to interact with BLE-enabled devices in order to create platform specific applications. For now this can mean that it will be necessary to develop multiple versions of the same application for different service endpoints in order to reach the widest possible audience. Further it might prove difficult to design these endpoints such that user experiences match completely due to idiosyncrasies of the different platforms. Despite these issues BLE is a promising technical building block for IoT applications in retail and it looks like it might be instrumental in enabling new forms of engagement and in-store location services.

### 3.3.4 IoT Data Platforms

In recent years a number of IoT data platforms (Evrythng, Xively etc.) have emerged that offer services that, while not specifically retail driven, have core components that should be of interest to retailers. The scope, overall foci, cost and technical implications of these platforms vary profoundly. With large amounts of data and analysis of data being one of the grand challenges for the retail sector this segment has a high volatility in terms of number of market players, offers and type of services being available. Data that these platforms store can be low-level sensor data or data that is associated and linked to interactions with a particular item or object which enables more complex forms of analytics of in-store behavior. To this end these platforms can provide event logging, visualisation and other services to retailers. Retailers might also develop bespoke tools and infrastructures to support multichannel retail and in-house data analysis depending on the context and overall strategy.

### 3.3.5 Visual Light Communications

Philips has been trialing an in-store location-based service based on visual light communications (VLC)[25]. Intelligent lighting acts in this scenario as a positioning grid system that smartphones can use to determine their in-store location. The obvious disadvantage is that the phone needs to be able to detect the light via its camera so it requires a line-of-sight to the light source and the phone cannot be in a pocket, for example. Advantages are that retail stores already have light fittings so that unlike with iBeacons no extra installation is necessary. VLC seems an interesting alternative technology for in-store way-finding in retail environments. One can imagine that VLC might be used in some environments possibly in addition to Bluetooth Low Energy (BLE).

24 http://www.theguardian.com/media-network/media-network-blog/2013/nov/11/apple-ibeacons-retail

25 http://www.slashgear.com/philips-led-lights-flicker-out-a-challenge-to-ibeacon-and-gimbal-17317150/

4



# Examples of IoT in Retail

A number of examples exist that demonstrate the use of IoT technologies in retail contexts. In this chapter we discuss some of these examples and elicit lessons learned in terms of what seems to work best in these scenarios. We will initially look at a number of applied research projects and their outcomes before moving on to present some examples of IoT technology use by high street retailers. To start this section we will take a closer look at our own research experiences in adding digital object memory to second-hand retail objects. This research was carried out in collaboration with the charity Oxfam GB and as part of a University trial also employed in pop-up retail shops.

## 4.1 Tales of Things and Oxfam Curiosity Shop

Tales of Things (talesofthings.com) is linked to a centralised database that contains information about real world objects (e.g. pieces of clothing, works of art, gadgets). The Tales of Things service provides an automated mechanism for linking QR Codes and RFID/NFC tags uniquely to these real world objects. When people scan a Tales of Things tag with a generic QR Code or RFID reader the public URL on Tales of Things for this particular object is launched. People can use the standard phone browser to interact with the web representation. If people use the bespoke Tales of Things app (freely available for iOS and Android platforms) they get a customised, tailored mobile experience and also have the opportunity to leave their own stories and comments about the object they have just scanned. Rather then it being solely a virtual experience, being in the presence of and interacting with a physical object provides permissions to add to the provenance of the object. Each individual object has its own event or memory log associated with it.

Over a period of about two and a half years we worked with Oxfam GB on various pilot studies and projects that explored how second-hand items in charity shops can be augmented with digital object memory and what value this provides. This collaboration was supported by the research project TOTeM[26] (Tales of Things

26 http://fields.eca.ac.uk/totem/?page_id=2


Figure 6: Curiosity Shop

and electronic Memory) that was funded through an EPSRC Digital Economy[27] grant. The idea behind electronic or digital object memory (DOM) is that events related to a product can be logged over the lifecycle of an item. Related to retail use of DOM, added value information could include for example information about the production process of a product (e.g. ethical sourcing, producer information or data about production related CO2 emissions), which can impact people's buying decisions at the point of sale. Also people's past interactions with a product might be revealing and suitable to inform future iterations and improvements of a product. Additionally, as in the case of second-hand retail having this provenance information can be beneficial for the perceived value of a product. The next paragraphs describe an example of a scenario were the value of a product has been be enhanced through digital object memory.

In 2010 we designed, in collaboration with Oxfam GB, Edinburgh College of Art, the University of Dundee, Brunel University, the University of Salford and Selfridges, the Oxfam Curiosity Shop, a temporary pop-up retail and performance space, located in the Selfridges flagship store in Oxford Street, London. The aim of this event space was to raise awareness and funds for Oxfam GB. The Oxfam Curiosity shop focused on designing a shopping experience centered on vintage designer clothing. Consequently the event space was designed with a vintage theme in mind. A small number of items (25) were donated by well-known celebrities (such as Annie Lennox) and videos were recorded in which the celebrities revealed something about the provenance of the items on sale e.g. when they bought them and why, on what occasions they wore the items etc. For example the Annie Lennox dress on sale was worn during Nelson Mandela's 90th birthday party in Hyde Park, London.

Not surprisingly many of the celebrity donated items sold at a value significantly above their regular retail value. The awareness about the history of an object can be very attractive as it can lead to an increase in perceived authenticity, value and persuasion to buy a (second-hand) good. The Annie Lennox dress for example, was sold for roughly three times its retail price. More generally though the pilot showed that product provenance as captured by DOM can add value to a range of goods other than celebrity donated items. At a later stage the concept was explored further and we continued to collaborate with Oxfam GB to roll out Tales of Things technologies in ten Oxfam shops in Manchester. The service was called Oxfam Shelflife[28] [29] [30] and enabled people that donated items in these ten shops, aided by a shop assistant, to leave a story about the item they dropped off. These stories were subsequently available to other people via a QR Code as identifier that linked the object to a DOM.

## 4.2 UCL Launchbox

UCL Launchbox[31] was a pop-up retail space that was set up for a limited period of time (approximately four months) in the Boxpark[32] pop-up mall in Shoreditch in London. UCL Launchbox sold items such as original clothes, jewelry and poster prints that have been created by student and academic entrepreneurs. Tales of Things technologies have been used prior to opening of the shop in order to capture the stories from producers about the products that are on display. Additionally video records verify the authenticity of some of the printed artworks by adding records of the signing sessions of the artist to the DOM. The latter application is one we would like to explore further in future as

27 http://www.epsrc.ac.uk/research/ourportfolio/themes/digitaleconomy/Pages/digital.aspx

28 http://www.bbc.co.uk/news/technology-17152221
29 http://shelflife.oxfam.org.uk/
30 http://www.youtube.com/watch?v=I897sK8rSe0
31 http://www.ucl-launchbox.com/
32 http://www.boxpark.co.uk/


**Figure 7: UCL Launch Box**

certain forms of transactions such as in sports memorabilia retail rely on the authenticity of an item. It is often difficult for customers to know if a product is genuine (e.g. limited edition signed by the national football team) or a fake. The recording of the signing session seems a possible way to increase the trustworthiness and authenticity of memorabilia. The store also featured a dedicated section where kiosk-mounted iPads can be used in engaging ways to record customer feedback about the different products on display. The concept behind this is that we wish to experiment with the idea of rapid product iteration based on customer feedback in the near future. In combination with 3D printing this could be used to modify and adapt items in a very short turn around time (same day or next day) based on customer preferences. Similar to agile software development technologies this will enable rapid product iterations on a physical level. To this end Launchbox was also a pilot project for testing some of the pre-requisites.

Tales of Things employs a centralised database and web application framework in order to deal with the data that is generated. While the system does not currently consist of fully featured data analytics functions these could be created and customised fairly easily. Tales of Things technologies also seem suitable to increase the dwell-time of shoppers. It was evident from observations in the Oxfam Curiosity shop and UCL Launchbox that technology that suits the purpose (e.g. short product demo videos) can increase dwell-time, shopper engagement and add entertainment-like elements to shopping experiences. Certainly a solution like the one we employed in Tales of Things gives people access to just in time information about the product. The system did not offer any price comparisons but due to most trials being run in second-hand retail or with highly bespoke items that were not on sale anywhere else this aspect was less relevant.

## 4.3 My Grocer

An earlier investigation of IoT technologies in retail was the My Grocer design concept which looked at how item-level RFID tagging could be used to extend the supply chain onto the aisles of the supermarket floor and even into the home (Kourouthanassis and Roussos, 2006). The basic scenarios are as follows: on entering the supermarket a smart shopping trolley presents the customer with a suggested shopping list based on previous behavior as well as the shopper's domestic stock levels as monitored by smart fridges and storage cupboards. As the shopper collects items from the aisles these are scanned using an RFID reader console on the shopping trolley, which displays product information and updates the shopping list. The system would also incorporate in-store navigation to assist in locating shopping list items and provide the potential for personalised targeted promotions and offers. At the checkout the items are re-scanned and the customer's account debited. When the shopper reaches home the items are scanned as they are placed in the smart storage while the home inventory gets updated. The system also allowed for online and mobile shopping based on the home inventory-generated shopping list, as well as price comparison among different retail outlets. The authors of My Grocer suggest that this type of pervasive retail system may transform the consumer experience as a result of the continuous replenishment process at home as well as creating novel retailtainment opportunities.

## 4.4 Kate Spade

Whereas the previous paragraphs presented research prototypes or design concepts, the following examples represent actual deployments by high street retailers. Kate Spade has rolled out an iPad system in their flagship store in Tokyo[33]. iPads are replacing conventional paper labels and add features for additional product information e.g. video product demonstrations, integration of social software but they also provide other functions such as shopping analytics and inventory and supply chain management. The connectivity of the iPads to enable social sharing and access to networked in-depth product information and the supply chain information makes this more than just an interactive label. Kate Spade employed this technology successfully to increase dwell-time and social sharing amongst its customer base.

## 4.5 BaubleBar

BaubleBar[34] is an online jewelry shop that recently experimented with physical shopping experiences through the opening of a couple of pop-up shop locations. These pop-up shops employ interactive display technologies that enable shoppers to engage with additional information about an item by picking the different items up[35]. If a shopper picks up a piece of jewelry from an interactive display then this activates an animation and gives shoppers access to additional digital and social media information about the product. The solution employs sensors and unique product identifiers to enable this service.

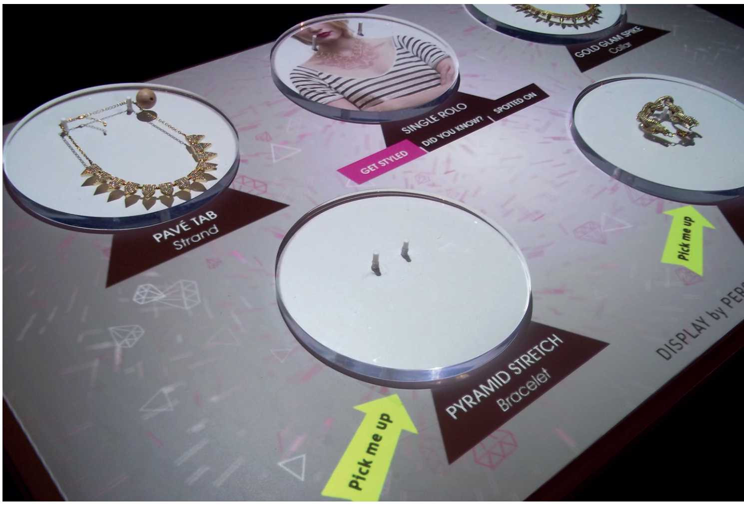


**Figure 8: Perch Interactive Display in a BaubleBar shop by BaubleBar**

33 http://www.fastcolabs.com/3006774/future-retail/most-ambitious-store-retail-ipad-integration-weve-ever-seen

34 http://www.baublebar.com
35 http://screenmediadaily.com/baublebar-nyc-pop-up-store-features-interactive-retail-displays/

## 4.6 Burberry

One of the brands that started to converge online and offline experiences is Burberry. The Burberry flagship store on Regents Street, London models the online brand experience closely[36]. The shop uses sensors, RFID technologies and interactive media to create a highly choreographed shopping experience. In store there are interactive mirrors and video walls that contain a number of sensors. The behavior of these displays changes interactively when shoppers walk up to the wall or pickup certain stock items in store. Audio and video media are used to create takeovers when people move through the shop and engage with the products in the retail space. The flagship store is also used as event space and to stream live events such as high profile fashion shows that are important for Burberry.

## 4.7 Macy's

In 2011 the US retail chain Macy's announced it was to introduce RFID tagging into its Macy's and Bloomingdale department stores to improve inventory management and its integration with multiple sales channels (online, mobile, and bricks and mortar). Stock is tagged at the item-level (i.e. individual items) with EPC codes which can be read by handheld RFID readers deployed in distribution centers, store rooms as well as on the shop floor. By the end of 2013 it is expected that more than 500 stores are going to be integrated into the system[37]. One of the goals is to improve order fulfillment by allowing the retailer to deploy its full inventory to satisfy the needs of the shopper, regardless of their location or the point of sale. So, for example, if an item is out of stock at a particular shop the item will be sourced from a different location (where it is in stock) and delivered to the customer. Studies have found improvements in the speed and accuracy of inventory management compared with barcodes as well as a reduction of losses[38].

36 http://www.youtube.com/watch?v=CokbQWI_15U#t=32

37 http://www.rfidjournal.com/articles/view?10783

38 http://rfid.uark.edu/papers/ITRI-WP147-0809.pdf

Figure 9: Burberry Flagship Store London by **Burberry**

5



# The IoT-enabled Retail Space of the Future

To date most of the deployments of IoT technologies in retail have focused on the inventory and supply chain management with RFID tags used at the stock keeping unit (SKU) level (i.e. pallets or cartons) rather than at the item level (i.e. tagging individual merchandise). Item-level tagging has been reserved to higher value items due to the historical cost of RFID tags. However, there are other reasons for the resistance to item-level tagging as well as cost. Early trials of item-level tagging including ‘smart shelves’ were abandoned partly due to protests from consumer activist groups raising privacy concerns including the potential for tracking and customer profiling (Fleisch and Tellkamp, 2006).

However, recently item-level tacking is beginning to move out of the research environment and into mainstream commerce as illustrated by the Macy’s example. This is partly a result of the reduction in the cost of RFID tags, but is also probably a reflection of the increasing familiarity with RFID (and other sensor) technologies by consumers. For example, millions of commuters carry an RFID tag in their pockets in the form of Oyster cards. In addition, they happily yield GPS location information to various sources via their smartphones. Furthermore NFC readers are becoming increasingly common in smartphones thus bringing the ability to read RFID tags into the hands of the consumer. All this, we feel, has led to an increasing acceptance of RFID technology by consumers and help paved the way for item-level tagging.

Once item-level tagging of merchandise becomes more common it opens the possibility of integration of IoT technologies into the full product lifecycle (from manufacture, through retail and finally into the consumers home) bringing about the potential for realisation of previous future retail research concepts such as MyGrocer (Kourouthanassis and Roussos, 2006) or Tales of Things (de Jode et al. 2012). Digital Object Memories that are related to a specific object and that are stored throughout the lifecycle provide a number of new avenues for interaction with retailing items. Once information about the production of an item is recorded (e.g. critical incidents, producer information, process information such as emissions) this information can for example be used in retail environments for various purposes including enabling on-demand access to information or to persuade shoppers during decision making in store (e.g. ethical sourcing, environmental friendliness). Currently shoppers have to actively request and pull this information by using smart labels. In future retail environments it is more likely that shoppers will receive ambient cues that will make them aware of interesting information and activities to engage with. The triggers for ambient cues for shoppers may be manifold and are likely to be enabled by real-time analytics of multichannel data.

It will be interesting to see what kind of social contract[39] between brands and shoppers will emerge and if people are likely to opt in to such services for their convenience or if concerns about privacy and security will be an obstacle to uptake. Establishing trust and providing data security in IoT scenarios is a complex and important topic. However, it is out of the scope of this report to provide a detailed discussion of possible strategies to tackle privacy and security challenges in such environments.

Another technology that will shape retail spaces of the future is 3D printing. 3D printing is at the time of this writing still largely a domain for hackers and makers. However, there is clearly a huge potential for 3D printing to change the way products are designed, produced and distributed by empowering mass customisation on a completely new scale. Good early examples of how 3D print could impact retail are enabling customers to print their own shoes[40]or customisable jewelry[41], indeed the Form1 printer[42] is partly aimed at the jewelry market due to its ability to print high quality small scale objects. It is arguably five years away from 3D printers becoming widespread in people's households, although already retailers such as ASDA have recognised this gap and offer a service to scan and print small objects[43] to customers.

New wearable technologies such as Google Glass[44] are also likely to impact how people will experience retail environments and how additional information is accessed. While the use of mobiles in retail environments (e.g. to look up product information) might be occasionally at odds with accepted social practices, wearable technology is less intrusive and will likely enable new user experiences and augmented and mixed reality applications in retail.

**39** http://data-informed.com/cisco-sees-retailers-harvesting-internet-things-analytics/

**40** http://www.wired.co.uk/news/archive/2013-08/06/3d-printed-shoes
**41** http://fashionista.com/2013/10/3d-printed-jewelry-neiman-marcus/
**42** http://formlabs.com/products/our-printer
**43** http://www.retailtechnology.co.uk/news/4880/asda-launches-3d-printing-trial/
**44** http://www.cloudsoftwareprogram.org/rs/2256/9ed65124-0873-400e-bc8a-9c85c1f1afa8/bb2/filename/mobile-augmented-reality-for-retail-environment.pdf

# 6



# Conclusion

The use of ambient sensors, interactive tailored media, digital object memories, and Bluetooth Low Energy to name but a few technologies, in networked shopping environments provides potentially benefits for retailers, consumers and thus the entire retail economy. We say "potentially" as a number of obstacles have to be overcome in order for these benefits to be realised. These new forms of engagement in retail spaces require new ways to design shopping experiences and in some cases also an investment in additional IT infrastructure in order to make most of the outlined potential. However, the good news is that there are already a number of early examples and success stories of using IoT in retail that can lead the way. Many of these interventions did not require significant amounts of investment in IT infrastructures in order to be realised and rolled-out, merely a vision. Another advantage of having these examples is that they can provide insights into what works in IoT enabled retail environments and potential pitfalls that need to be avoided.

From a consumer perspective there are a number of opportunities such as personalisation, curation and interactivity that IoT in retail spaces can enable that add value to shopping experiences. However, people have different needs and preferences when it comes to retail shopping and it will be interesting to see if and how retail will use multichannel data to personalise the high street. From the perspective of retailers the main benefits of personalisation include the potential to improve customer relationships, a better understanding of customer needs, improved supply chain management and the possibility to reuse curated content across different channels. From a customer perspective benefits of the outlined IoT-enabled future retail space include - increased transparency through ubiquitous information access in physical stores, timesaving's, personalisation and improved service quality.

Time will tell if the applications that were described in this report will see an uptake or if completely different scenarios will emerge. It seems credible that those retailers that find creative, elegant, engaging and widely accessible solutions to increase the dwell-time of their customers are the ones to profit most from these transformations. It is likely that those solutions that subtly enhance and augment existing social practices are going to be most successful. IoT in retail will be disruptive, that is beyond doubt. However, the uptake of some of the transformative technologies such as 3D print, wearable technology or Bluetooth Low Energy will take some more time to diffuse into the mainstream. Nevertheless now seems to be an opportune time to innovate in this area and gain recognition, as industry leaders and innovators in the retail environment.

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